D5.5 – Canvas business models for the most promising system concepts

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List of acronyms and abbreviations

ABEP	Atmosphere Breathing Electric Propulsion
AIS	Automated Information System
AOI	Area Of Interest
API	Application Programming Interface
CDTI	Centro para el Desarrollo Tecnológico Industrial
COTS	Commercial Off – The – Shelf
DAP	Digital Access Pass
DISCOVERER	Disruptive Technologies for Very Low Earth Orbit Platforms
DMC	Disaster Management Constellation
EO	Earth Observation
ESA	European Space Agency
EU	European Union
GBDX	Geospatial Big Data Platform
GEO	Geostationary Orbit
GEOINT	Geo – Intelligence
GIS	Geographic Information System
GSD	Ground Sample Distance
IMINT	Imaginary Intelligence
JAXA	Japan Aerospace Exploration Agency
LBS	Located-Based Services
LEO	Low Earth Orbit
MCOP	Mega - Constellation Operations Platform
NASA	National Aeronautics and Space Administration
NGA	National Geospatial – Intelligence Office (U.S.)
NOAA	National Oceanic and Atmospheric Administration (U.S)
NGO	Non – Governmental organization
OCS	Operational Control System
R&D	Research and Development
SAR	Synthetic Aperture Radar
SSO	Sun – Synchronous Orbit
UAV	Unmanned Aerial Vehicle

UHD	Ultra High Definition
UPC	Universitat Politècnica de Catalunya
U.S. DoD	United States Department of Defence
UV	Ultra Violet
VAS	Value-Added-Services
VHR	Very High Resolution
VHR-HP	Very High Resolution – High Performance
VHR-LC	Very High Resolution – Low Cost
VLEO	Very Low Earth Orbit
WP	Work Package

1 Executive summary

The aim of this document is to produce a set of Business Models (BM) for the most promising concepts of exploitation of VLEO for EO purposes. The starting point for producing this document is two folded:

- In the previous *Deliverables D5.1 and D5.3*, an up-to-date analysis of the **EO market** has been conducted. D5.1 deals with the present EO market, and D5.3 with the **trends for EO at VLEO**. As a result, both the present stakeholders, and the expected growth of the market, arise.
- *Deliverable D5.2* makes a deep analysis of the **benefits and challenges of VLEO for EO** purposes, and *Deliverable D5.4* draws the most **promising system concepts of platforms** suited to the DISCOVERER technologies.

Some **context** figures (*table 4.1*):

- **19% of all satellites** launched so far are devoted to EO.

Table 4.1. Summary of EO market (Deliverable D5.1) Source [1]

	2007-2016	**2017-2026**
Type of prominent operator	Governments	Commercial operators
# Countries with EO satellites	35 + ESA	48 + ESA
Total launched EO satellites (>50 kg)	181	601
Manufacturing Revenues	$17.4 billion	$33.6 billion
Cumulated Commercial data revenues	13.5	25
Cumulated VAS revenues	22.6	47

When defining the new BM for EO at VLEO, an **exhaustive analysis** of several present companies has also been performed and the **BM of eight companies** has been created. The companies are: *Planet, DigitalGlobe, Urthecast, Satellogic, Deimos, Spire Global, GomSpace, and Space Flight*. Each of the case studies is related to a more extensive analysis in its respective *Attachment*.

The **success factors analysis** of those companies lets to identify one general strategic behaviour pattern, the **Democratizing Pattern**, that has been extrapolated to every new BM. The five main characteristics of this new pattern are:

- The companies face an open market with an increasingly number of new customers.
- The companies have (need) a large partnership network.
- The companies tend to offer low prices for the added-value services.
- The companies devote efforts in reducing their variable costs.
- The companies offer tools for an automatic relation with their customers.

This pattern allows the identification of five virtuous cycles in the BM feedback loops (Methodology: *Casadesus and Ricart (2010), figure 7.21*):

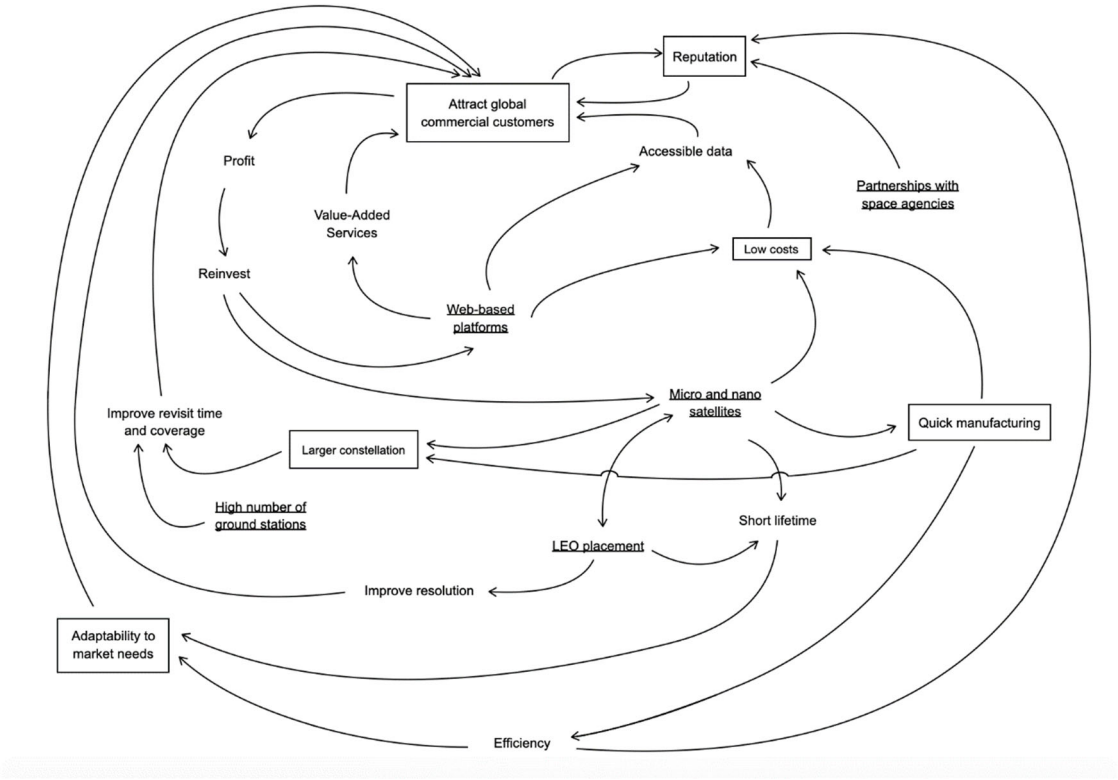


Figure 7.21. Feedback Loop Diagram for the Democratizing Pattern

The analysis of the **market trends** and the **new system concepts**, including the previous **success factors** produces a set of promising Business Models:

- **Access to space** at lower orbits and smaller satellites is gaining the attention of several projects. *This deliverable suggests some key operational aspects to be considered by those projects and the coming ones*.
- The increased number of missions and the reduced communication windows at lower orbits, will see a growth in the number of **ground stations** and some capacity aggregation will be necessary. *This deliverable foresees new BM for those activities*.
- The increasing number of satellites by different stakeholders will also see an increasing demand for **space brokers or turnkey providers** that can fulfil some of the necessary stages of a mission. *This deliverable analyses the aspects to be considered for the interested companies*.

Besides those VLEO related opportunities in terms of BM, **some promising concept platforms** have also been designed (*deliverable D5.4*) and their market approach has been analysed in this deliverable:

- Very High Resolution – High Performance platform (**VHP-HP**).
- Very High Resolution – Low Cost constellation (**VHP-LC**).
- Synthetic Aperture Radar (**SAROptic**).

Finally, those platforms are also analysed under the **Value Proposition CANVAS** (VPC) to also consider the integration of the DISCOVERER technologies:

- New materials with reduced drag and low erosion.
- New aerodynamic attitude and orbital control.
- New air breathing electric propulsion.

The results of this deliverable plus the work performed in the different DISCOVERER technologies will allow the production of **two sets of roadmaps focused on** the companies' Business Models and the Discoverer technologies for the future EU conquer of VLEO for EO purposes.

2 Introduction

The EU funded DISCOVERER project started in January 2017 aiming at identifying the technological challenges and suggesting improvement possibilities that may allow the commercial exploitation of near Earth Orbits (Very Low Earth Orbit) for Earth Observation purposes.

The project was started upon three technological research questions:

- *How can we improve our understanding of, and make best use of, the orbital aerodynamics of the space platform and its ability to perform attitude and orbit control manoeuvres?*
- *Are there propulsion methods which use the residual atmospheric gas as a propellant, providing drag compensation whilst removing the lifetime limits caused by carrying a limited amount of propellant?*
- *Are there materials or processes which reduce the induced drag on spacecraft surfaces?*

Plus, one additional, non-technological research question:

- *In case of technological success of DISCOVERER, what are the most promising business models that may allow exploiting VLEO for EO purposes?*

The DISCOVERER project is a FET proposal (Future Emerging Technologies) dealing with Technology Readiness Levels (TRL) still far from commercial application. Even though it is quite obvious that the successful commercial development of companies taking advantage of VLEO is based on the previous technological successes, and it may still take some years till possible; the WorkPackage WP5 of the project will provide some insights on how that commercial presence may look like.

This apparent incoherence in the early study of the future market prospects for EO at VLEO suggests that the best tools to be considered are the Business Models (BM), that provide an improved drawing of each Business Idea, even though, for obvious reasons, BM are not so detailed as a Business Plan may be.

3 Purpose

The aim of this document is to produce a set of Business Models (BM) for the most promising concepts of exploitation of VLEO for EO purposes. Even though the DISCOVERER project objectives are just related to the BM for the DISCOVERER technologies, this documents extends its scope to the whole VLEO exploitation spectrum.

The starting point for producing this document is two folded:

- In the previous Deliverables D5.1 and D5.3, an up-to-date analysis of the EO market has been conducted. D5.1 deals with the present EO market, and D5.3 with the trends for EO at VLEO. As a result, both: the present stakeholders, and the expected growth of the market, arise.
- Deliverable D5.2 makes a deep analysis of the benefits and challenges of VLEO for EO purposes, and Deliverable D5.4 draws the most promising system concepts of platforms suited to the DISCOVERER technologies.

As a result, this deep analysis of market and system concepts produces a set promising business ideas that become Business Models at the end of this document.

Thus, the structure of this deliverable is:

- **Introduction, Purpose, and Context** are explained in *chapters 2, 3 and 4*.
- The most advanced Business Models methodologies, namely **BM CANVAS** (*Osterwalder et Pigneur (2013)),* for an operational approach, and **BM Feedback Loop** (*Casadesus et Ricart (2010)*), for a strategic approach, have been described in *chapter 5*.
- The present **BM CANVAS for eight EO companies** (*Planet, Digital Globe, UrtheCast, Satellogic, Spire Global, Spaceflight, and the DISCOVERER partners Deimos and GOMSpace*) have been summarized in *chapter 6*. Besides, one specific Case Study for each of those companies is also presented in the Appendices of this deliverable.
- *Chapter 7* makes a deep analysis of **the success factors** of the previous companies in order to develop a new pattern that is common to all of them, the **Democratizing Pattern**.
- **Four promising system concepts and Business Ideas** defined at the previous deliverables are further analysed as new updated Business Models in *chapter 8* (two of the arisen promising concepts are already in operation as shown in *chapter 6* (*Very High Resolution – Low Cost platforms in Constellations, and SAROptic*)):
    - Access to Space → Micro-launchers, including rockoons.
    - Ground Station Services.
    - Space Brokers.
    - Very High Resolution – High Performance Platform.
- *Chapter 9* takes those previous platform concepts and combine them with the **DISCOVERER technologies**, in order to first set **new Value Proposition CANVAS**, and second include these new value propositions into existing EO companies in order to see how their respective BM CANVAS could change.
- *Chapter 10* will draw the **conclusions and recommendations** in order to go one step further in WP5, **linking with the technological and BM roadmaps** (deliverables D5.6 and D5.7, respectively).
- *Chapter 11* summarizes the **internal and external references** of this document.

4 Context: Space market and its strategy

This section summarizes what has been done in previous deliverables in order to present an overview of the current Very Low Earth Observation (VLEO) status and the space market trends.

4.1 Space market

Humans have looked up into the sky since they existed, but the space industry did not start until 1957 with the successful first artificial satellite mission, Sputnik 1. More than sixty years later, the space industry has become the centre of many innovations, and a new booming market playing an essential role in daily life.

Artificial satellites can be used for different applications depending on their mission. Some applications for satellites orbiting the Earth are weather forecasting, navigation, communications, astronomy, and Earth Observation (EO). Figure 4 .1 shows the current operational satellites divided by application.

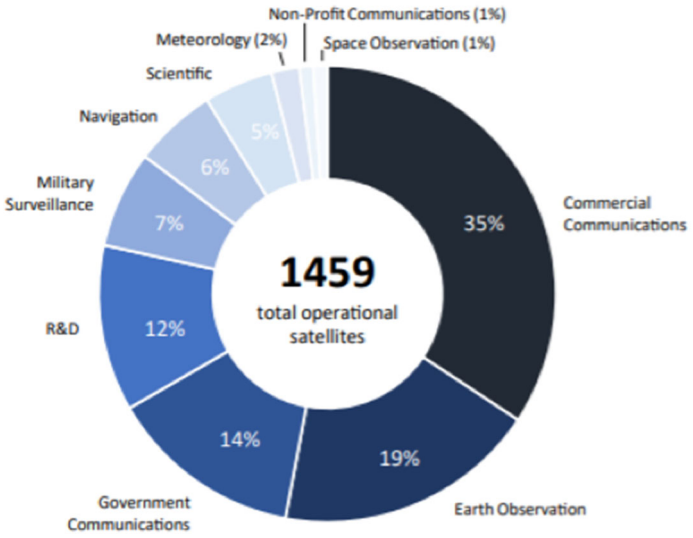


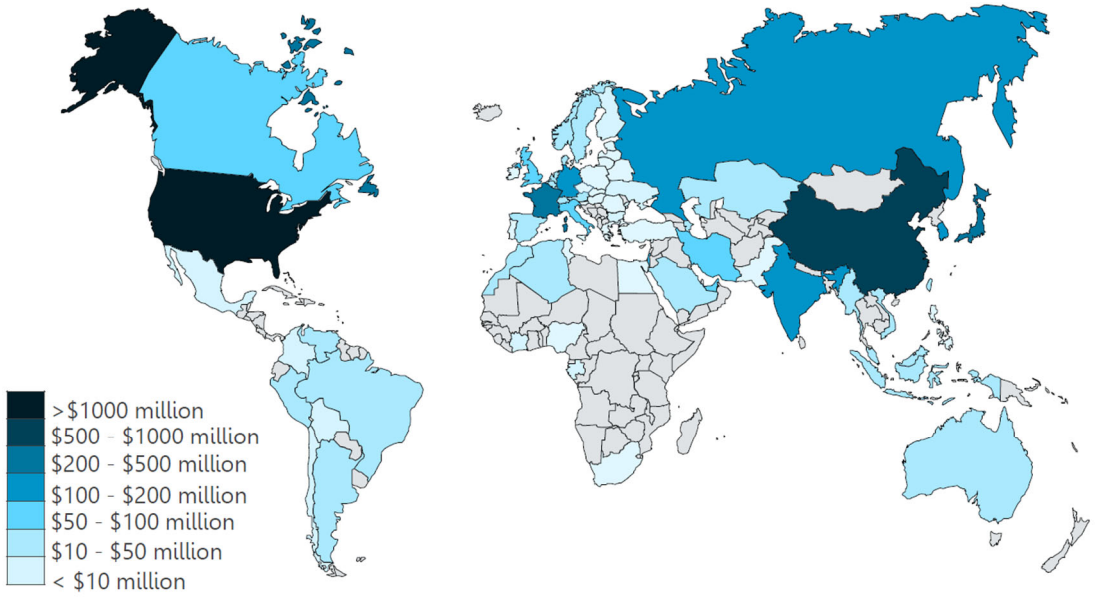
Figure 4.1 Operational satellites by applications, Source: [1]

In this study, the main focus is Earth Observation satellites with an especial interest in their commercial applications. That means 19% of all launched operational satellites.

4.2 Current EO market

At the present *Information Age*, power can be measured by the amount of information possessed by a country, and the World Powers are well aware of it.

Over the last decade, the number of satellites dedicated to Earth Observation has exponentially grown, and governments are the primary investor by financing military, civil and dual-use satellites. The global EO investment can be seen in Figure 4 .2.



*Inclusive of both satellite manufacture and programs supporting application development. European budgets include contributions to ESA where relevant.

Figure 4.2 Global EO investment. Source: [2]

In the last few years, private EO companies have appeared in the market to provide images and low-cost satellites to society. The main difference between government satellites and those new ones is the target focus, public satellites being focused on one or two specific missions such as global warming or research, and the private ones are diversified towards a variety of clients. These new businesses, those providing value-added services (VAS) to the EO market, are processing and analysing the images before selling them.

Extended information about this can be found at *Deliverable D5.1* from the DISCOVERER project, and a summary of the main figures for the EO market are listed in Table 4.1.

Table 4.1 Summary of EO market (Deliverable D5.1) Source [1]

	2007-2016	**2017-2026**
Type of prominent operator	Governments	Commercial operators
# Countries with EO satellites	35 + ESA	48 + ESA
Total launched EO satellites (>50 kg)	181	601
Manufacturing Revenues	$17.4 billion	$33.6 billion
Cumulated Commercial data revenues	$13.5 billion	$25 billion
Cumulated VAS revenues	$22.6 billion	$47 billion

It is crucial to understand how the industry is distributed and adapted to the current market scheme. This sector is mainly split into two types of operators, upstream and downstream. The upstream operators are focused on manufacturing and sending objects into space and explore it while downstream uses that research and technology for different applications by processing and selling images and data.

Each stage has different characteristics, and they are split forward into investors, manufacturing, launching, ground segment (upstream - Figure 4 .3), data operation, distribution, and VAS (downstream

- Figure 4.4). Both figures, Figure 4.3 and Figure 4.4, present the value chain of the EO market (*see also Deliverable D5.1*).

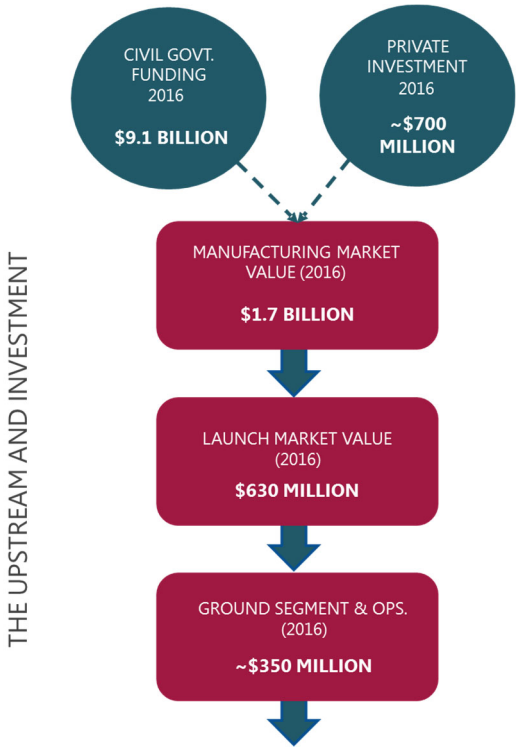


Figure 4.3 The EO upstream value chain. Source: [1]

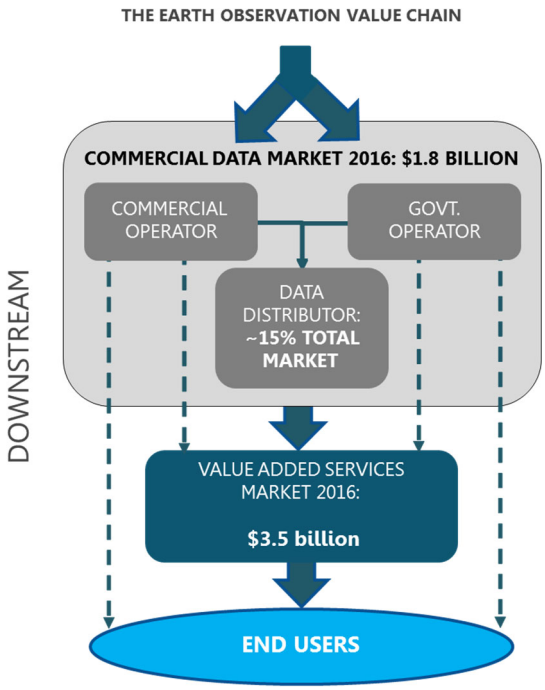


Figure 4.4 The EO downstream value chain Source: [1]

Examples of current and future capabilities of EO operators can be DigitalGlobe & MDA, Airbus Defence and Space, DMCii, Planet, Blacksky, Spire, Hera, and Uthercast. Some of these companies are studied along with this document in *Chapter 6* (*Existing Business Models*).

The exploitation of space resources is the most profitable activity, so downstream is where the more significant benefits can be found. In 2016 the cumulated turnover ratio was 3% for upstream and 97% for downstream with a total of 250 billion dollars. This means that the satellites' services and data providers are popular products, so it is easy to see why the most profitable sectors are Communication and EO.

Moreover, the space market (Figure 4.5) is changing and evolving to fulfil the needs of the society and new emerging services. This development is mainly caused by the inclusion of the private companies that add business model innovation with significant cost reduction besides new products.

In the following sections, some current business models and some new ones are shown to identify the change of the space market and its patterns.

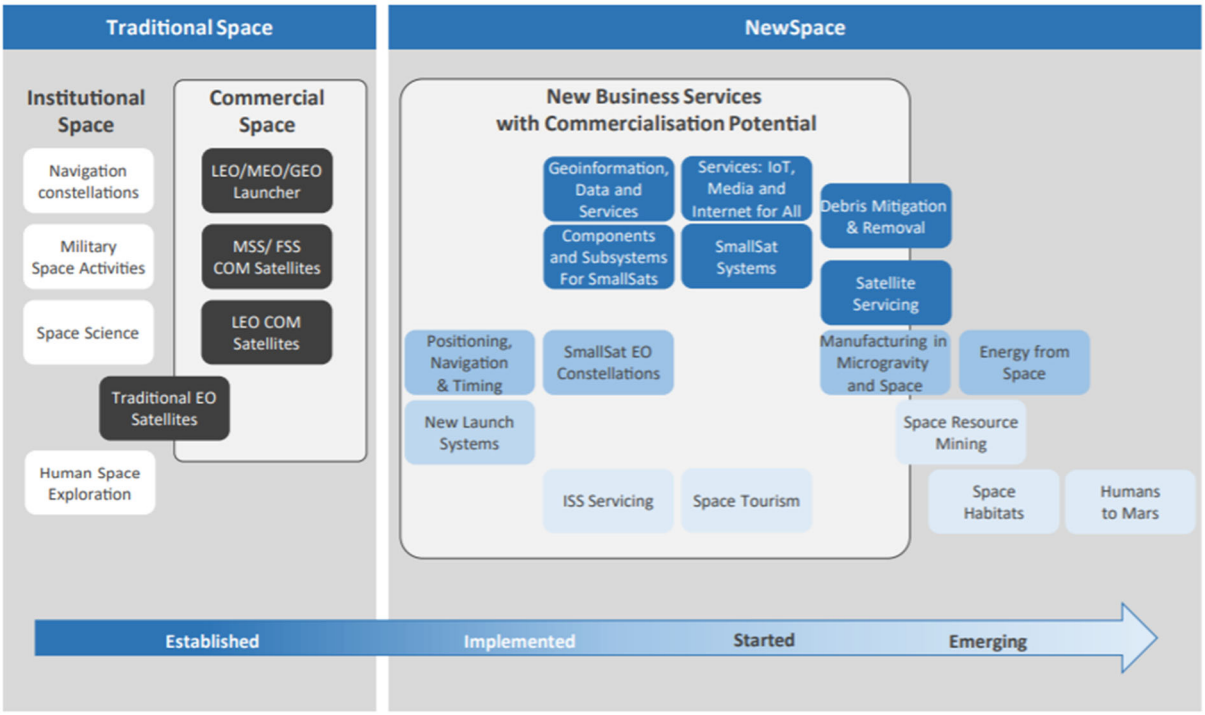


Figure 4.5 The Space market evolution. Source: [3]

As downstream is the most profitable segment, it is important to focus on the commercial data market and its business. In Table 4.2 presents the summary of the key results of *Deliverable D5.1*.

Table 4.2 Summary of Key figures on the EO commercial data market Source: [1]

	2007-2016	**2017-2026**
Cumulated all commercial data revenues	$13.5 billion	$25 billion
Main vertical market	Defence	Defence
Main data type	VHR	VHR
Main customer	U.S. DoD	U.S. DoD
Main customers region	North America	North America

In this document, the existing business models that have been studied to have a better understanding of the private upstream and downstream are *Planet, DigitalGlobe, UrtheCast, Satellogic, Deimos, Spire Global, GOMSpace, and Spaceflight*.

4.3 Very Low Earth Orbit characteristics

The DISCOVERER project is focused on providing solutions for VLEO. However, operating a satellite under 450 km has some specific particularities to be considered (*extracted from Deliverable D5.2)*.

VLEO orbits are **placed in the thermosphere**, the layer of the atmosphere between 95 km and the thermopause, varying with the solar radiation, the location, the time, the season, among others, and it can fluctuate between 500 and 1,000 km.

In this region, the atmosphere temperatures have very abrupt changes between day and night and climb fast with the altitude. In the upper thermosphere, the range can vary from 500 and 2,000ºC. Due to the

high temperatures and the UV solar radiation, the molecules are broken into atomic oxygen, so the main component in VLEO is the **atomic oxygen** with some atomic nitrogen and helium.

It is important to highlight that the variations of height of the thermosphere due to the solar radiation and the temperature changes affect the air density, which means that all satellites orbiting in VLEO not only have to **cope with drag but with force variations**.

The best way to introduce the VLEO orbits is by discussing their benefits and challenges. Let us summarize the keynotes of *Deliverable D5.2*:

- The sensor resolution of the spacecraft changes when changing its altitude. Spatial, geometric, temporal, and radiometric resolutions depend on the distance between the camera and the target, but the spectral resolution only depends on the equipment.
- Mapping errors as a result of attitude determination and pointing accuracy are reduced at lower altitudes, improving the geospatial accuracy of ground imagery and location-based services.
- The spatial resolution of a camera is directly related to the distance to the objective. Changing EO satellites from LEO to VLEO allows higher resolution for the same satellite or reduces the aperture of the sensor and the size of the spacecraft without reducing resolution.
- It is easily noticed that increasing spatial resolution by approaching the satellite to the Earth surface also reduces the spacecraft's swath, so its resolution gets worse than before.
- Another effect is that due to the lower altitude and the elevation angle constrains of the satellite, the available window for data downlink is reduced.
- The revisit time of a spacecraft is general worse in lower altitude orbits, though it is more complex to synchronize and control a constellation of satellites. Even though as the satellite is nearer to the Earth, the revisit period will be shorter.
- A short orbit cycle is not crucial in EO because having a repeating ground-track is not strictly required, though it helps capture regular images of a region and have lower revisit time. In VLEO, the perturbations of the residual atmosphere and the external satellite forces continuously change the orbit, so the repeating ground-tracks are only possible with new technologies such as aerodynamic control or propulsion.
- On the other hand, many EO small satellites orbiting in VLEO or LEO have a near-polar sun-synchronous orbit [4]. These orbits have a particular condition: the satellite covers a determinate area of the globe at a constant Sun time, providing the same illumination to the area in different acquisition times. These orbits at low altitude ranges have large revisit times, although the effect can be reduced using non-SSO orbits.
- The radiometric resolution can be improved by lowering the orbits of the satellites because the electromagnetic signal received by the sensor increases by reducing the distance to the target. Despite this, it is necessary to emphasize that at low orbits, the noise signal received at significant off-nadir angles might increase.
- Another benefit of flying a probe at 450 km is that the satellite would naturally deorbit at the mission ending without any extra propulsion because the atmosphere would re-enter any object in less than 25 years. This effect allows us to have a clean space environment and reduce possible debris collisions. Moreover, as the VLEO are not used yet, the amount of debris is reduced, provoking a safer environment for the satellite.
- Finally, a range of further benefits of operating at lower orbital altitudes exist that are yet to be accounted for in the system modelling framework, for example increased launch vehicle capability, reduced radiation exposure, and lower collision risk. Besides, significant uncertainty also remains in the development and implementation of the enabling technologies.

All these benefits and challenges are trying to be exploited and solved in the DISCOVERER project framework by studying aerodynamics, materials, and propulsion system that a satellite in VLEO would have and need.

4.4 New market opportunities

WP5 is focused on studying the **system concepts** implications and **applications** in the DISCOVERER technologies such as ABEP, aerodynamic control, and materials which are studied in chapter 8 and 9 in more detail.

Deliverable D5.4 - System Models Description of VLEO Platforms with Promising Opportunities in the EO market mentioned four promising systems concepts that can be performed at VLEO and they are classified into four categories: VHR-HP; Constellation; VHR-LC and SAR Platforms. The business models for those concepts are developed in chapter 8.

One of those promising concepts is the **very high resolution-high performance satellites** (VHR-HP). This platform let the distance from the target to be reduced and so the imaging requirements allow the companies to achieve higher stability and quality. There are some existing satellites with these characteristics, such as the *WorldView-1, -2, -3* among others. They are mainly used in defence, infrastructure and location-based services (LBS) markets.

Another promising EO concept is the **very high-resolution low-cost satellites** (VHR-LC). This market is focused on providing sub-metric resolution and high-revisit time at an affordable price. They are used for precision agriculture, defence, energy and urban development markets. Some examples of companies that are currently working under this kind of business model are *Blacksky and Satellogic*.

The last passive optical trending concept is related to the **Coverage**, satellites with lower spatial resolution than the previous ones but with wider swatch and higher temporal resolution. Some examples of **optical high-resolution coverage** can be, for instance, *Satellogic and Planet*. These satellites have a high response due to the **frequent data collection** and can be used for mapping, humanitarian and environmental monitoring, and disaster monitoring like the *Planet Dove CubeSats and DMC*.

Finally, the **Synthetic Aperture Radar** is also studied in *Deliverable D5.4* as a promising concept. The interest in these active satellites lies on their ability to provide new EO products without depending on the light and on the methodological conditions.

To have full knowledge and understanding of VLEO in the EO market, studying the possible different businesses that do similar activities is essential because they could act as competitors or partners.

Taking images of the Earth is not restricted to satellites; other devices such as UAVs, airships, balloons, probes, aircraft, etc. can do it. All of these options do not orbit the Earth so they cannot always be working. They need to know where to take the picture and be sent to the Earth's precise spot. These alternatives have some advantages and disadvantages, like a higher resolution and a great accuracy on the image without wasting resources but with the inability to monitor large areas along big periods.

These kind of businesses can be market competitors but also partners. Since it is possible to monitor a vast portion of the Earth with a satellite orbiting in VLEO and detect the precise spot that needs to be studied to send one of the other devices to take the final image.

Also, the business models of **new launching concepts** such as rockoons and micro-launchers are studied in chapter 8. These other companies have appeared around the EO market, providing access to space with new dedicated methods (see Deliverable D5.3) that differ from the typical rocket in which the satellite travels as a piggyback. Besides, *Deliverable D5.3* presents an increasing raise of other **new promising concepts**, especially suited for VLEO, such as space brokers or VHR-HP platforms also studied in chapter 8.

Other promising concepts shown in *Deliverable D5.3* such as "Global Coverage" or "Low Cost", since they are already applied in existing companies, will also be analysed in chapter 8 of this document.

5 Business Models Methodology

It is a well-known fact that there is not a globally accepted definition of a business model. As a consequence, not all definitions include the same components. For this reason, when trying to compare several business models, a framework plus a shared language is needed. It is strictly at that point where the business model methodologies play an essential role.

B.W. Wirtz et al. [5] claim that while in the early years, it was easy to identify whether a business model was defined from an operational, technological or strategic point of view, nowadays, definitions seem to converge towards a global understanding. However, those three points of view are not completely merged yet. Therefore, to provide an exhaustive analysis, more than one framework has to be applied.

Thus, this study opts to analyse the business models from two different approaches, one operational and another more strategic one. The methodologies that we will use for each case are the **Canvas** template and the **Feedback** loop diagram, respectively.

5.1 The Canvas template

"*A shared language for describing, visualizing, assessing, and changing business models*" [6] is how both authors, A. Osterwalder and Y. Pigneur, define the business model Canvas template. As aforementioned, this methodology is used to analyse the enterprise from an **operational** point of view. It represents, by means of **nine building blocks**, how the company organises itself to create, deliver and capture value.

5.1.1 Template representation

Before going deeper into describing the nine building blocks, it is vitally important to have a quick overview of the complete Canvas template (figure 5.1). This representation will be the basis to understand, afterwards, the interrelations created among blocks.

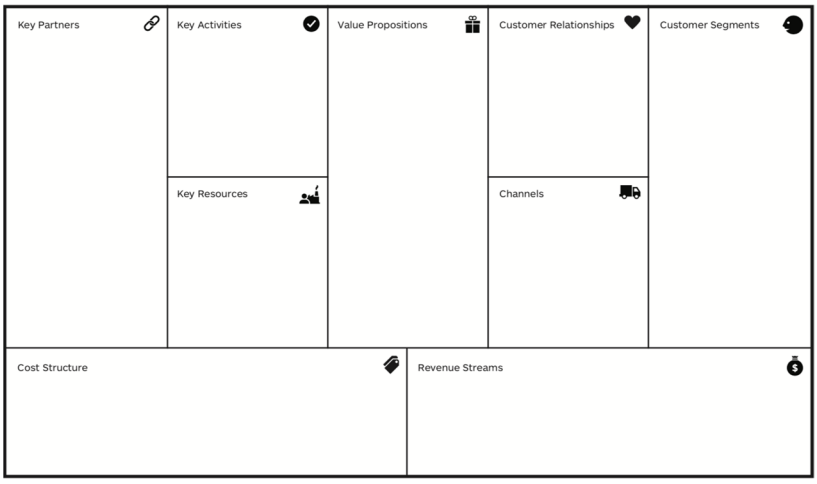


Figure 5.1 Business Model CANVAS. Source: [6]

It is worth noting that the Canvas template splits into two different sides: the value and the cost side. The right side of the Canvas describes the value that the company is delivering to customers. In contrast, the left side identifies how the company manages to create that value with its associated costs.

To better understand the Canvas template's sides, it is necessary to go into further detail in each of the nine building blocks.

5.1.2 Identification of the nine Building Blocks

As aforementioned, the Canvas template is composed of nine building blocks interacting with one another. Down below, you can find the description of each of these blocks:

- **Customer segments (CS):** "*Different groups of people or organizations an enterprise aims to reach and serve*" [6]. It is one of the most critical blocks because the whole Canvas is designed to satisfy customers' needs to make profit. There are different types of customers, among which stand out:
  - **Mass market:** customers present similar needs and problems. Therefore, value propositions, channels, and customer relationships are the same for all the customers.
  - **Segmented:** customers present slightly different needs and challenges, and with that, value propositions, channels, and customer relationships present minor differences for each segment.
  - **Niche market:** the company serves a specific customer segment. For this reason, value propositions, channels, and customer relationships are specifically designed for that customer.
  - **Diversified:** contrary to the mass market, customer segments present entirely different needs and problems. Thus, value propositions, channels, and customer relationships are tailored to each segment.
- **Value proposition (VP):** "*Bundle of products and services that create value for a specific Customer segment*"[6]. Values can be quantitative or qualitative. More specifically, some elements that can contribute to the value creation are: newness, performance, customization, design, brand, price, getting jobs done, cost and risk reduction, accessibility, and usability.
- **Channels (CH):** *"How a company communicates with and reaches its Customer Segments to deliver a Value Proposition"[6].* Thus, this building block is vitally crucial for customer experience. There are two different types of channels, direct and indirect ones (figure 5.2). Also, it can be distinguished between owned channels and partner services.

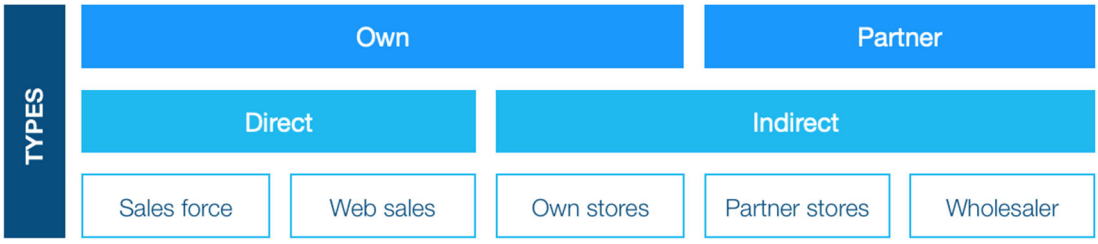


Figure 5.2 Types of channels. Adapted from [6]

However, what is important are the five different channel phases among which the company can decide where to focus on several or to offer all of them.

1. Awareness 2. Evaluation 3. Purchase 4. Delivery 5. After-Sales

- **Customer relationships (CR):** *"It describes the types of relationships a company established with specific Customer Segments" [6].* There can be found different types of customer relationships, depending on the degree of automation.

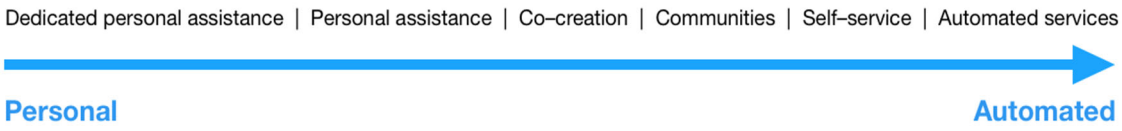


Figure 5.3 Types of customer relationships from personal to automated.

- **Revenue streams (R$):** *"The cash a company generates from each Customer Segment"[6].* There are two types of revenue streams, transaction revenues and recurring ones. However,

what is important to know at this point is how these revenues can be generated by asset sales, usage fees, subscription fees, leasing, licensing, brokerage fees, and advertising.

- **Key resources (KR):** *"The most important assets required to make a business model work"[6].* To create and offer Value Propositions to Customer Segments, each company needs physical, financial, intellectual, and/or human resources.
- **Key activities (KA):** *"The most important actions a company must take to operate successfully[6].* Depending on the main Value propositions, the required key activities can be categorized as: production, problem-solving or platform/network.
- **Key partnerships (KP):** *"The network of suppliers and partners that make the business model work"[6].* A company cannot handle all key resources nor key activities. Thus, they need to establish some key partnerships. There are four types of partnerships: strategic alliances, joint ventures, coopetition, and buyer-supplier relationships.
- **Cost structure (C$):** *"All costs incurred to operate a business model" [6].*

5.1.3 Canvas template

As described above, the Canvas template is formed by nine different building blocks. However, it is worth noting that these blocks do not work in isolation; they are arranged in a way that fits one to another. Following this idea, the template can be divided into two main areas, the value side and the efficiency/cost side, likewise the brain (figure 5.4).

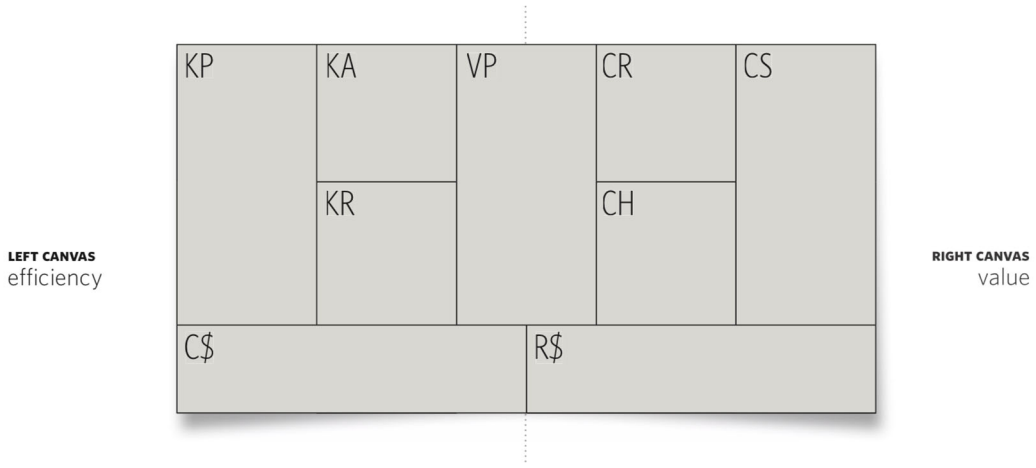


Figure 5.4 Sides of the Canvas Template. Extracted from [6]

By analysing the complete template, we can create a logic story that each company must follow to create their proper Canvas Template.

The story begins with the **Value Proposition Canvas**. Through this technique, a company defines its main value propositions according to the customers that it wants to serve. This methodology consists of listing the gains, pains, and jobs to be done of the different customer segments the company wants to reach. The next step is analysing whether the company offers some products or services able to solve a job to be done, design gain creators for the customer gains or create pain relievers for customers' pains.

Once the company has identified its customer segments and how they are going to create value for each of those customers, businesses have to define how they are going to reach this value to their customers, which **channels** they are going to use to do so. Furthermore, it is quite essential to retain these customers, and it is for that reason that a company has to define some **customer relationships**. For acquiring these values, customers provide some **revenue streams**. However, to create each value proposition, deliver them to the customer and try to retain all customers, the company has to invest in resources that will enable them to develop the key activities needed to manufacture their value. Also, it is crucial to note that no company can provide all **key resources** nor **key activities** by itself. Due to this fact, they have to establish some **key relationships** with other suppliers or investors. Finally, the

development of these activities, resources needed, and established relationships define the **costs** for the company.

To sum up, the Canvas template defines how a company organises itself to create and deliver value. However, to beat the market, it is vital to develop a **strategic analysis** in this aspect where the Feedback Loop Diagram will be decisive.

5.2 The Feedback Loop Diagram

The Feedback loop diagram is a visual representation of a business model developed by J.E. Ricart and R. Casadesus [7]. Contrary to the Canvas template, this methodology tries to represent each business model from a more strategic perspective.

5.2.1 Diagram representation

Its representation is composed of **concepts linked by arrows**. It is important to stand out that not all concepts are presented in the same way. Due to this fact, a legend is needed.

The **choices** are presented in bold and underlined. In contraposition, **consequences** are presented in normal font. However, in order to represent their rigidity, **rigid consequences** are highlighted in a box as we can see in figure 5.5.

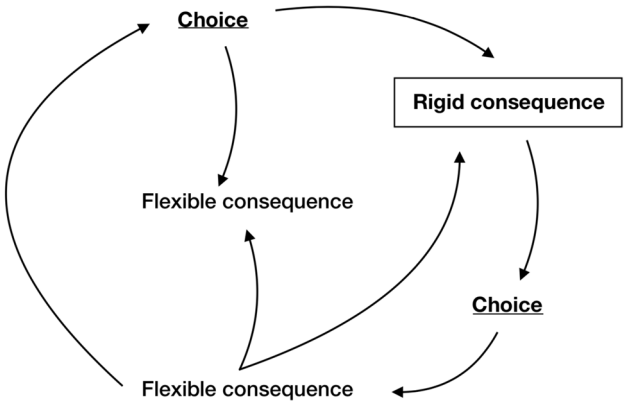


Figure 5.5 Legend for the Causal loop diagram. Adapted from [7]

5.2.2 Definition of the parameters

To be able to understand the representation introduced above and all the cycles that will be created among the whole diagram, first, some theoretical concepts have to be described:

- **Choices:** it refers to each decision that the company takes to define how the enterprise must operate fully. There are three types of choices:
  - **Policy choices**: "it refers to courses of action that the firm adopts for all aspects of its operation" [7].
  - **Asset choices**: "it refers to decisions about tangible resources" [7].
  - **Governance choices**: "it refers to the structure of contractual arrangements that confer decision rights over policies or assets"[7].
- **Consequences:** each choice has a consequence; these consequences can be rigid or flexible.
  - **Flexible**: a consequence is considered flexible when highly dependent on the choices that have generated it [7].
  - **Rigid**: contrary to a flexible consequence, a rigid consequence is not very sensitive to their choices [7].

As mentioned above, the relation among these choices and consequences shape the Feedback loop diagram, the visual representation of a firm's business model.

5.2.3 Feedback Loops

Sometimes, this representation may seem quite complicated. However, the truth is that it might be overpowering when identifying the strengths of the company.

What is important is trying to identify more straightforward cycles inside the whole diagram. These new cycles can be categorised as **virtuous or vicious feedback loops**. Although not being part of the business model itself, they have particular importance when analysing its performance:

- **Virtuous cycles:** *Ricart-Casadesus* define them as “feedback loops that strengthen some components of the model at every iteration” [7]. So, these loops reinforce rigid consequences that may lead to new capabilities and higher competitive advantage of the enterprise.
- **Vicious cycles:** they take place when the virtuous circles are interrupted or reversed and, consequently, they can induce the malfunction of the whole business model[7].

In other words, vicious and virtuous cycles are both feedback loops that strengthen some business model’s components, **the virtuous ones with positive feedback and vicious ones in a negative way**. Due to this fact, it is vitally important to reduce the probability that a virtuous cycle turns into a vicious one. This fact can occur when a feedback loop is interrupted or affected by an external factor. For this reason, it is in this situation when rigid consequences play an important role: the more rigid consequences a business model has, the more difficult is that a virtuous loop turns into a vicious one thanks to the complexity that a rigid consequence becomes modified.

Taking all these ideas into account, it can be concluded that what is essential is to create and feed as much as possible the virtuous cycles and avoid the vicious ones. To achieve that, the business has to establish rigid consequences and take care of them.

With both methodologies introduced, it is vitally important to see how they are used in the market. To do so, some existing business models are deeply analysed to be afterwards able to gather the information needed to see the application of the Canvas template and the Feedback Loop Diagram.

6 Existing Business Models

In the present section, some of the most representative private companies in the Earth Observation sector will be represented by means of a CANVAS business model. Following the CANVAS methodology, the following treats will be presented for each of the studied companies: Customer segments, value proposition, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structure.

The companies that are going to be studied are: *Planet, DigitalGlobe, Urthecast, Satellogic, Deimos, Spire Global, GomSpace, and Space Flight*. Each of the case studies is related to a more extensive analysis in its respective *Attachment*.

This section aims to present the characteristics of each of the representative companies, so that they might be summarized and studied in Section 7, under the Feedback Loop methodology, and related to proposed **general business traits and behaviours**. Moreover, it ultimately leads to the **success factors** implicit in the success of the Earth Observation companies.

6.1 CANVAS Business Model for *Planet*

Planet is a significantly young company, founded in 2010, based in San Francisco, California. It focuses its value proposition on creating low-cost Small Satellites, which assemble a large Low Earth Orbit constellation. Therefore, the company offers a small period of global Earth coverage, combined with medium to high resolution in images. Besides the image capturing activities, this company also develops tasks in data analysis and geospatial solutions and intelligence development to its customers. The company has been in constant expansion since its foundation.

In the following lines, each of its operating characteristics will be briefly described to develop its CANVAS business model ultimately. Additionally, this case study is attached to ***Appendix A***, where more in-depth analysis and information about the company are presented as a summary of several final theses referenced at the end of the document: [*TFE-1*], [*TFE-2*], [*TFE-3*] and [*TFE-4*].

6.1.1 Customer Segments

Planet possesses a **Segmented Type** of customer segment, meaning that the company is serving a large number of customers, each having slightly different needs. So, all customers require information that can only be provided through satellite imagery. Nevertheless, each customer will require different degrees of processing in the imagery and different kinds of post-developed intelligence from the data to obtain concrete solutions to their problems.

Planet main customers can be mainly grouped into five segments:

- **Engineering and infrastructure data analyst** companies from the private sector.
- **Environmental and agriculture data analyst** companies from the private sector.
- **Non-Governmental Organizations (NGOs)**
- **National and international agencies**
- **Minor customers**: which would include researchers and universities, amongst others.

6.1.2 Value Proposition

It begins with the imagery captured with its three constellations (*PlanetScope, BlackBridge, and TerraBella*). This value proposition is defined as a combination of customized services related to Earth Observation activities.

The Earth Observation data is updated daily and at different resolutions. The access to the imagery and/or pre-processed data is rather easy and cheaper than the traditional competence, allowing nearly

all customers to acquire and extract profit from them. If this is combined with the uniqueness of the service, it creates a great value proposition.

6.1.3 Channels

So that the company might keep constant communication with its customers and vice-versa, it has established robust channels.

Planet, through conferences, reaches the potential clients, exposing which is the product that they are commercializing with. If this proposal attracts the client, the purchase process starts. Depending on the location and size of the client, this process will be done directly (through *Planet*), or indirectly (through intermediates). Afterward, the customer gains access to an online platform, where the purchased imagery is awaiting to be analysed. Finally, if required, the customer may keep in contact with the company to obtain help or provide feedback in the personal development and evolution of the acquired product.

6.1.4 Customer Relationships

It can be said that *Planet* does establish all kinds of relationships; this includes:

- Personal and dedicated personal attention.
- Self-service processes.
- Automated services.
- Communities: it regulates a community where customers might share their experiences and doubts about the imagery.
- Co-creation relationships with key clients. These kinds of relationships simply vary depending on the customers that are being served by providing different assistance to each of the clients, depending on their needs.

6.1.5 Revenue Streams

The company's payment mechanisms are mainly recurring: regular payments are made by each client to keep on having access to the imagery and data provided by Planet. Occasionally, single transactional payments might also be made. Planet's means to generate revenues are the usage and subscription fees and the licensing over its imagery.

6.1.6 Key Resources

They mainly imply:

- **Planet's physical resources:** Compose by its manufacturing facilities, constellations, headquarters, ground station facilities, data storage facilities, and online platforms.
- **Intellectual resources.** The ones that the company trades with. Composed by its licenses and owned imagery.
- **Human resources:** It is formed by all the costs related to the over 150 employees in 2019.
- **Financial resources:** Considering the economic resources related with the investment.

6.1.7 Key Activities

The key activities developed by *Planet* might be sorted into three categories:

- **Those related to production**: the designing, development, and assembly of the current orbiting satellites and constellations; the control of the satellite's orbital positions, the ground monitoring of the constellations, the process of obtaining the captured imagery, the storage processes of this obtained imagery data and the post-processes of data analysis and processing, so that concrete results might be achieved and delivered to each of the customers.
- **Those related to problem-solving**, such as co-creation with partner customers, aim to enlarge the present product offer.
- **Those related to the platform:** Summarized as software development and maintenance activities that keep the delivery platform at optimum conditions. And additionally, the development of an extension of the platform for Planet's analytic missions.

By the end of 2019, *Planet* was also undertaking some activities related to the development of their *Mission 2 phase*; these activities mainly include the development of Artificial Intelligence and Machine Learning methods for the development of a new platform were all objects on Earth are itemized day by day, and the development of mega satellite designs for the observation of the Solar System.

6.1.8 Key Partnerships

Planet has established key partnerships with some strategic companies. Four kinds of partnerships have been established:

- **Strategic Alliances:** with a large number of companies, the company's more concrete products might be developed thanks to some first-hand feedback.
- **Coopetition relationships:** i.e. with *Airbus S&D*, to reduce the risk in starting new projects.
- **Buyer-Supplier relationships**: specially with launchers and material providers.
- **Joint Ventures:** reached with *Google and SpaceX* to start developing the *Mission 2* activities.

6.1.9 Cost Structure

All this efficiency side of the CANVAS reflects in a cost of maintenance, some of the most representative costs that the company needs to deal with are those related to maintenance of assembling facilities, acquisition of machinery and materials for developing the satellites, the recurrent payments for launching the satellites, and the costs related to data storage.

All the ideas previously described are summarized in *Figure 6.1*, and can be better understood after reading ***Appendix A***, which presents *Planet*'s case study, a detailed analysis of the company and its evolution.

It is important to outline that for all the Business Models CANVAS that are presented in this Deliverable, it is used a colour scheme in order to connect the topics and items which are related. Hence, for example, in the following figures all the topics coloured in the same blue range are related.

PLANET

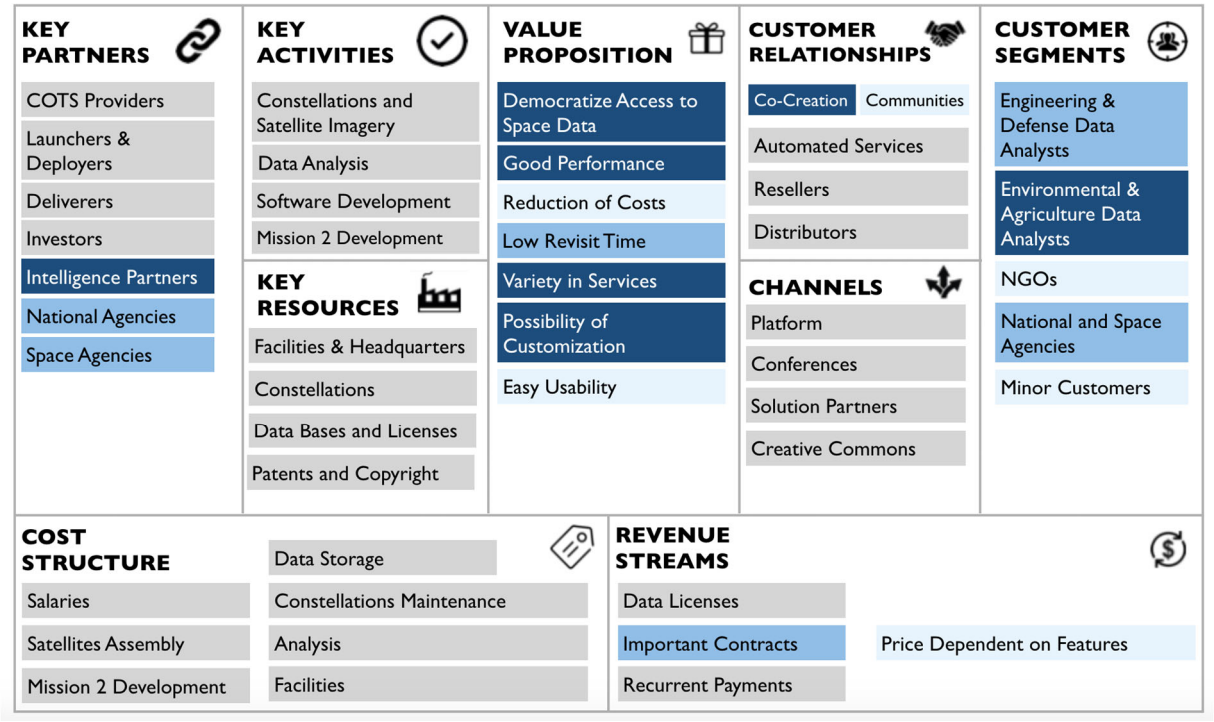


Figure 6.1 CANVAS Business Model for Planet

6.2 CANVAS Business Model for *Digital Globe*

Digital Globe was founded in the 1990s, and it is based in Longmont, Colorado. It is now one of the leaders in the private sector of Earth Observation developing tasks related to image capture, satellite development, and geospatial intelligence development.

In the following lines, each of its operating characteristics will be briefly described to develop its CANVAS business model ultimately. Additionally, this case study is attached to ***Appendix B***, where more in-depth analysis and information about the company are presented as a summary of the final thesis [*TFE-3*].

6.2.1 Customer Segments

Customers that typically use *DigitalGlobe's* imagery and intelligence offer are enterprises specializing in advanced image analysis for consulting services, addressed at different sectors of the industry, such as energy production, infrastructure development, or agriculture production. This set of customers (represented in dark blue in *Figure 6.2*) is interested in high-resolution imagery, as well as the full product offer and product specialization in particular fields. Additionally, *DigitalGlobe* also possesses a set of agreements with the U.S Defense Ministry, through an NGA contract. On a smaller degree, the company commercializes imagery for environmental intelligence.

6.2.2 Value Proposition

DigitalGlobe trades with the value proposition characterized by some general traits, and some specific ones, which make the offer unique. The general ones, shared with other Earth Observation companies are the commercialization of Earth Observation imagery and Earth Observation intelligence data. Nevertheless, what makes this offer unique is that it might be processed so that the final intelligence

results, perfectly adapt to the customer's needs. However, the most distinctive value trait is that the imagery that *DigitalGlobe* provides possesses one of the highest resolutions on the commercial market. In this case, even though revisit time is substantially low, the company prioritizes resolution over periodicity.

6.2.3 Channels

So that the company might keep constant communication with its customers and vice-versa, it has established robust channels.

DigitalGlobe delivers and makes its products accessible through indirect delivery channels, which change depending on the kind of contract that the customer has reached with the company. These channels, mainly are:

- *GBDX Web Platform.*
- *Amazon Cloud Services.*
- *Premium Access DAP.*
- *MAPS API*.

All these channels are owned and operated by the company and aim to grant access to the acquired products through computer-based means easily.

6.2.4 Customer Relationships

In order to reach the customer so that the products are accessible, *DigitalGlobe* presents some different kinds of client-to-company relationships; these relationships might be either direct or indirect, depending on the customers' needs, as well as bi-directional so that information might be exchanged in both ways between customer and company. Additionally, and intending to reach a maximum of customers, *DigitalGlobe* possesses a network of resellers that act as intermediaries. Finally, two extra communication relationships, which imply no direct interaction, might be used: a set of web services and attention through automated services.

6.2.5 Revenue Streams

The payment mechanisms used by the company depend on the kind of contract which has been reached. A significant part of the company's incomes come from the multi-year contracts signed with the *U.S. Government and the NGA*. The rest of the incomes come from the fees related to the acquisition of the imagery products (acquired by private companies related to intelligence and industrial activities), which are either recurrent or dependant on the number of acquired services.

6.2.6 Key Resources

They mainly imply:

- ***P*hysical resources:** Its manufacturing facilities compose its manufacturing facilities, constellations, headquarters, ground station facilities, data storage facilities, and online platforms.
- **Intellectual resources:** The ones that the company trades with; composed by its licenses and owned imagery., as well as an extensive library of satellite imagery, with historical satellite data.
- **Human resources:** Resources applied to the team.
- **Financial resources:** The ones related with the investment.

6.2.7 Key Activities

DigitalGlobe's key activities are related to the satellite assembly and operation activities and the processes of control and image capturing and image and data storage. Once the satellite data has been

acquired, the company develops intelligence-related activities over the raw data, so that the final ready to be delivered product might be obtained. Additionally, the company develops innovation tasks, related to satellite updates as well as software updates.

6.2.8 Key Partnerships

DigitalGlobe has established key partnerships with some strategic companies. Some of the most representative partnerships are the ones displayed in the lines below:

- **National Geospatial Intelligence Agency (NGA):** They present a government-industry partnership through which satellite imagery, captured by *DigitalGlobe* is helping in military operations and civilian healthcare issues, amongst others. The partnership program is the *EnhancedView* program and is supposed to last at least until the end of 2020.
- **Taqnia Space:** Both companies are working together so that the Scout constellation, composed of six small satellites, and manufactured by this Saudi Arabian company, might be launched as soon as possible. The scheduled launch date was supposed to be during 2019, but it has been delayed at least until 2020.
- **SAAB:** Back in 2015, *DigitalGlobe* and SAAB announced a joint venture, called the Vricon Joint Venture to create the globe in 3D. This model would be a photo-realistic 3D model and digital elevation model for enterprise and government geospatial markets, with unmatched coverage and delivery timelines.
- **Timbr:** By the end of 2016, *DigitalGlobe* acquired Timbr, expecting to make it easier to explore the algorithms developed by their GBDX ecosystem and data partners, and accelerating the creation of new customer solutions. Timbr, a data science company, was supposed to provide new technologies and expertise to improve the usability and accessibility of the GBDX platform, allowing more customers to derive valuable insights about *DigitalGlobe's* satellite imagery.
- **Radiant Spatial Energy:** Back in 2014, *DigitalGlobe* acquired Spatial Energy, a leading source for digital imagery and related services to the energy industry.

6.2.9 Cost Structure

All this efficiency side of the CANVAS reflects in the cost of maintenance. Some of the most representative costs that the company needs to deal with are those related to:

- Maintenance of assembling facilities
- Acquisition of machinery and materials for developing the satellites
- Recurrent payments for launching satellites
- Data storage and analysis
- Scout satellites development and updates that have to be made to the already orbiting constellations.

All the ideas previously described are summarized in *Figure 6.2*, and can be better understood after reading ***Appendix B***, which presents *Digital Globe's* case study, a detailed analysis of the company and its evolution.

DIGITALGLOBE

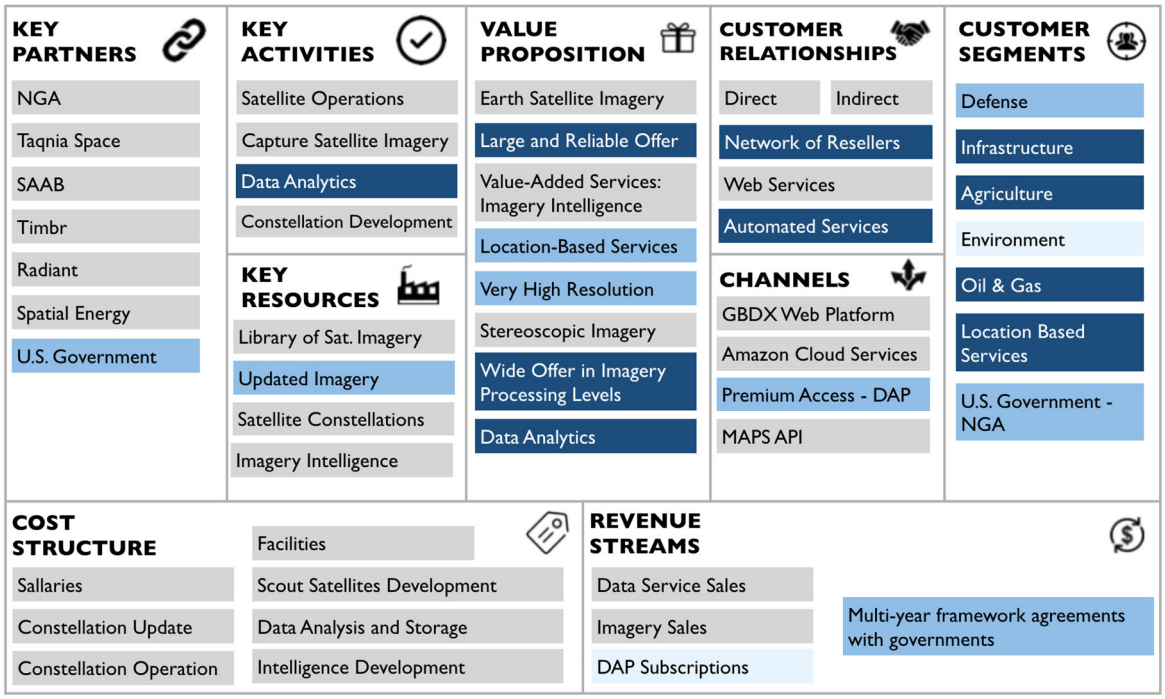


Figure 6.2 CANVAS Business Model for Digital Globe

6.3 CANVAS Business Model for *UrtheCast*

UrhteCast was founded in 2009, and it is based in Vancouver, Canada. The company is a satellite, imaging, and geoanalytics developer company. It tracks long-term trends, monitors shorter-term changes, and provides intelligence about guided, strategic actions to fulfill required missions.

In the following lines, each of its operating characteristics will be briefly described, with the aim of ultimately develop its CANVAS business model. Additionally, this case study is attached to ***Appendix C***, where more in-depth analysis and information about the company are presented as a summary of the student's final thesis [*TFE-5*].

6.3.1 Customer Segments

UrtheCats possess a **Segmented Type** of customer segments, all accessing the same Earth satellite imagery, yet each with slightly different needs. In other words, all customers require information that can only be provided through satellite imagery. Nevertheless, each customer will require different degrees of processing in the imagery and different kinds of post-developed intelligence from the data to obtain concrete solutions to their problems.

The primary customer segment groups might be divided into three, which at the same time have subgroups:

- Government Institutions: This would imply national governments, defence ministries, and activities related to defence, such as borders and maritime surveillance. These kinds of customers are interested in being provided with high-resolution imagery as well as small revisit times.

- Private Companies. Notably, companies related to infrastructure and engineering intelligence, natural resources monitoring, and disaster management. These companies would be more interested in obtaining imagery on a broad spectrum of possibilities and vast areas at once.
- Streaming Platforms: Economically, this is the weakest customer segment; however, taking profit of the cost reduction in reaching space-related products, they might as well be a customer to keep in mind.

6.3.2 Value Proposition

Through its Iris and Theia cameras, located on the Russian Module of the International Space Station, and its fleet of orbiting satellites, *UrtheCast's* value proposition is characterized by delivering a wide offer of Earth Satellite Imagery which is easily accessible. This imagery is available in different band spectrum, resolutions, and even as an UHD Video. Additionally, the value proposition has a high degree of customization and also offers access to an archive of Earth Imagery, which had been captured by a previous image capturing tasks from the orbiting satellites.

6.3.3 Channels

In order to make the products accessible to the customers, UrtheCast owns a series of delivery channels. The company disposes of Direct Communication Channels in a bidirectional way so that communication between customers and the company might be kept. Once the communication has been established, products are delivered through an owned *API platform or GeoTIFF Data*.

6.3.4 Customer Relationships

The relationships that *UrtheCast* maintains with its customers are either direct, through traditional meetings, when the customer requires it, or, in most of the cases, indirect. To make the communication more fluid and secure, the company also disposes of automated means.

6.3.5 Revenue Streams

In order to sustain the entire company, *UrtheCast* owns some revenue streams. They mainly come from the following activities:

- **High Resolution Images Sales:** The main customers that make use of this kind of product are the government and government-related enterprises. At a minor degree, some intelligence companies also acquire this kind of product.
- **Mid Resolution Images Sales:** Mainly acquired by the private company customer segment.
- **API Subscription**: Recurrent payment.

6.3.6 Key Resources

UrtheCast's key resources are represented by the ones presented in the following lines:

- ***P*hysical resources**. Composed by its operations centre, its *DEIMOS-1 and DEIMOS-2* satellites, the Iris and the Theia cameras, located on the ISS, and its network of ground stations.
- **Intellectual resources.** They are composed of its licenses and owned imagery and an extensive library of satellite imagery, with historical satellite data and its API platform.
- **Human resources:** Resources applied to the team.
- **Financial resources:** Those related with the investment.

6.3.7 Key Activities

The company's key activities are those related to satellite operations (from satellite control, monitor, to design and assembly), those related to image and video obtainment, including data capturing,

downlinking and storage, and those related to image intelligence development, which consists on transforming the raw imagery data into sellable and valuable data intelligence.

6.3.8 Key Partnerships

UrtheCast counts on a series of key partnerships so that its activities might be successfully undertaken to keep on expanding. *Figure 6.3* displays the primary key partnerships that *UrtheCast* possesses nowadays, and they are all explained in detail in section 4 from ***Appendix C***. The most important partnerships that sustain the *UrtheCast's* operations are those established with *Roscosmos, RSC Energia, Rutherford Appleton Labs, and MDA Corporation*.

6.3.9 Cost Structure

All this efficiency side of the CANVAS reflects in a cost of maintenance, some of the most representative costs that the company needs to deal with are those related to the satellite and cameras maintenance, as well as the new satellite design and assembly tasks, or those related to maintaining the ground station network. An essential part of the costs also goes to the data storage and analysis tasks, and the maintenance of the API software.

All the ideas previously described are summarized in *Figure 6.3*, and can be better understood after reading ***Appendix C***, which presents *UrtheCast*'s case study, a detailed analysis of the company and its evolution.

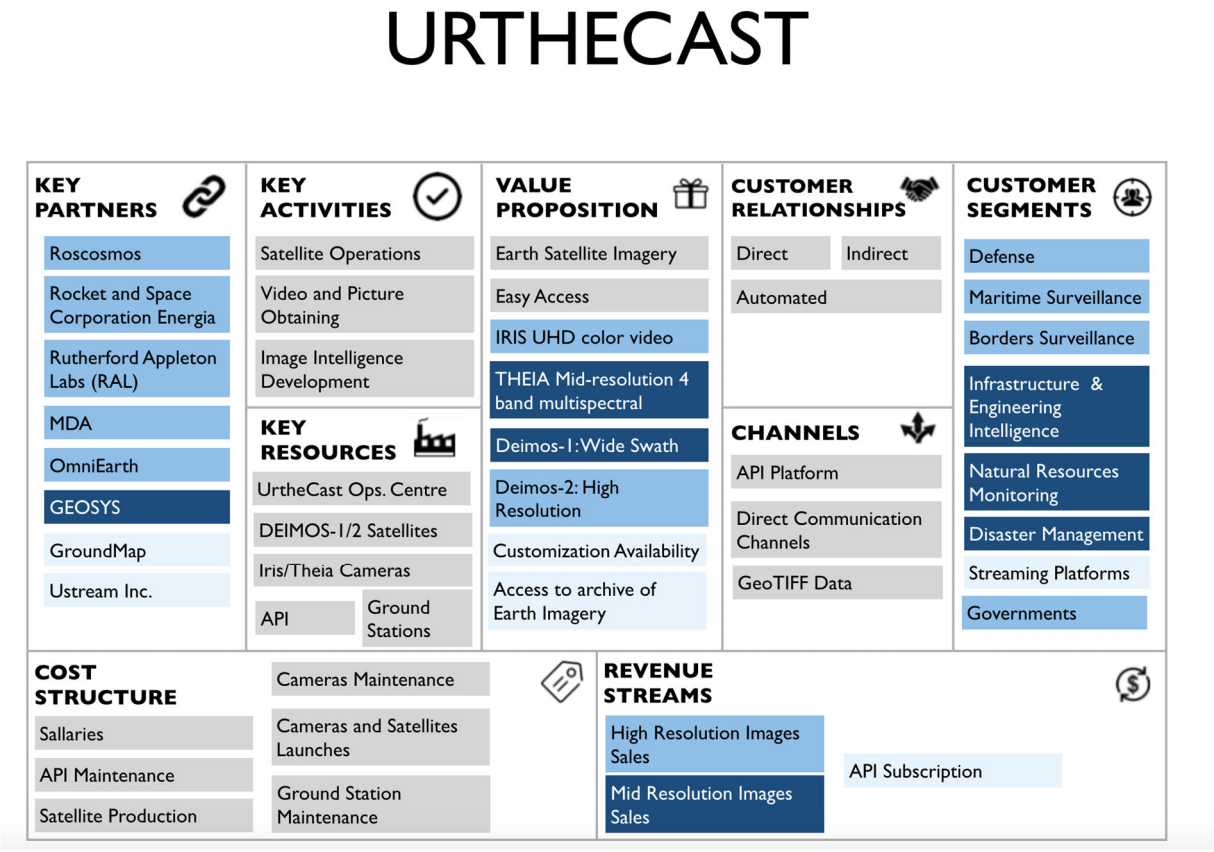


Figure 6.3 CANVAS Business Model for UrtheCast

6.4 CANVAS Business Model for *Satellogic*

Satellogic was founded in 2010, and it is based in Buenos Aires, Argentina. *Satellogic* is the first vertically integrated geospatial analytics company, and they develop tasks related to satellite design and assembling, AI expertise or geospatial intelligence and solutions provident.

In the following lines, each of its operating characteristics will be briefly described, with the aim of ultimately develop its CANVAS business model. Additionally, this case study is attached to ***Appendix D***, where more in-depth analysis and information about the company are presented as a summary of [*TFE-5*].

6.4.1 Customer Segments

Satellogic, as a relatively newly created company, at the moment, does not possess a strong network of customers yet. However, its products have been created, keeping in mind the kind of target they are aiming to. Therefore, it can be said that the company is aiming to possess a **Segmented Type** of customer segments. It means that *Satellogic* is actively looking for serving a large number of customers which base their activities in a large number of similar yet different needs. These different needs will be satisfied by applying different ways of processing the Earth data imagery.

The leading Customer groups that *Satellogic* is focusing its attention to are presented in the following lines:

- **Environment and Agriculture:** By targeting natural resources monitoring, they aim to present analysis and concrete results in these fields. This information is susceptible to be used either by individual farmers as well as Governments.
- **Energy:** Both for energy production as well as energy distribution.
- **Disaster Response:** Increasing the reaction capacity and reducing the time for responding a natural disaster, among other possible issues.
- **Security:** Developing new technology for increasing the national security, although it can be applied for individual targets too.
- **Infrastructures and Engineering Intelligence:** Development of new software technologies applied in this area.
- **Non-profitable means:** Humanitarian and scientific free distribution.

6.4.2 Value Proposition

When exposing *Satellogic's* value proposition, it has to start by clarifying that it is in its process of being fully developed and operative. Up to the moment, *Satellogic* operates a small constellation of eight satellites, through which they have started obtaining high-resolution and specific kinds of Earth Imagery. Down on Earth, they have also been developing data analysis means to develop the added value services related to this imagery.

Keeping an eye on the future, their value proposition aims to offer Earth imagery at both low prices and very small revisit time (the company claims that it might be reduced to five minutes between image and image). At the same time, this imagery will have a wide range of resolution (from low to high), will be processed so that it might be used in a large number of investigation fields (regarding the customer segments that might use this imagery), and will be easily acquirable at low prices.

6.4.3 Channels

The company possesses the usual communication channels with its customers, which means that communication is mainly direct, between company and customer, through a communications salesforce. Since the company is still under development, it could be expected that their communication channels will expand and refine. These will potentially translate into the development of more communication services which are automatic-based, and with an expansion in the resellers and intermediates networks.

When it comes to the delivery of images and results, by now, apart from direct channels, *Satellogic* is also able to deliver via *Azure*, an online data analytic platform, thanks to the *Microsoft* partnership contract.

6.4.4 Customer Relationships

In a similar way to what happened with the communication channels, since *Satellogic* has not fully started its commercial activity, regarding the full commercialization of its imagery products, the customer relationships cannot still be completely profiled. At present, relationships are mainly direct, which implies that the customers receive the personal and dedicated personal attention and might have a certain degree of co-creation relationship when it comes to obtaining the required product.

6.4.5 Revenue Streams

Satellogic possesses two main ways of obtaining revenues through the commercialization of its imagery and data services (leaving the incomes that come from the investment rounds apart). These two ways are the recurring payments received through its subscription fees and the single payments which correspond to a kind of pay-per-picture payment.

6.4.6 Key Resources

They mainly imply:

- **Physical Resources:** Up to the end of 2018, this would be eight orbiting satellites, two ground stations, the Buenos Aires headquarters, and the Montevideo manufacturing facilities. By 2020, these physical resources are expected to increase, reaching a fleet of 300 orbiting satellites, increasing the number of owned ground stations, and potentially acquiring new facilities as well.
- **Intellectual Resources:** They are composed of the Earth Observation imagery obtained, the derived data and intelligence from the imagery, and the designs of the owned satellites and the data analysis software, amongst others.
- **Human Resources**: Its teams of employees composed them.
- **Financial Resources:** Which includes, amongst others, the funds obtained after the investment rounds.

6.4.7 Key Activities

The key activities developed by *Satellogic* imply an extensive list of activities since the company has chosen to develop all kinds of activities regarding satellite design and manufacturing, data analysis software development, satellite operation, and intelligence development on its own. All of this reflects the Lean Manufacturing philosophy with which they operate.

6.4.8 Key Partnerships

Up to 2018, *Satellogic* was collaborating with the *National Atomic Energy Commission*, the company *INVAP*, which assisted in the manufacturing process of the first launched satellites, *Microsoft Azure*, which, through a contract, provided services related to data storage and analysis, and on a smaller scale, with the scientific community, which received open-sourced software and imagery from the company, and which was expected to return scientific knowledge and conclusions about them.

Regarding the future of the company's partnerships, they have actively stated that they count on establishing key partnerships in the ground operation areas.

6.4.9 Cost Structure

Some of the most representative costs that the company has to face are those related to satellite design and assembly. These costs will decrease its value once the 300 satellite constellation is operative, however, since the expected lifetime of the satellites is of around two to three years, the constellation will have to be constantly renewed, hence, some fixed costs regarding satellite manufacturing will remain.

The other most representative costs are those related to software development. This software is the one that will transform the raw data obtained from the satellite's imagery into value-added products, ready to be commercialized.

All the ideas previously described are summarized in *Figure 6.4*, and can be better understood after reading ***Appendix D***, which presents *Satellogic*'s case study, a detailed analysis of the company and its evolution.

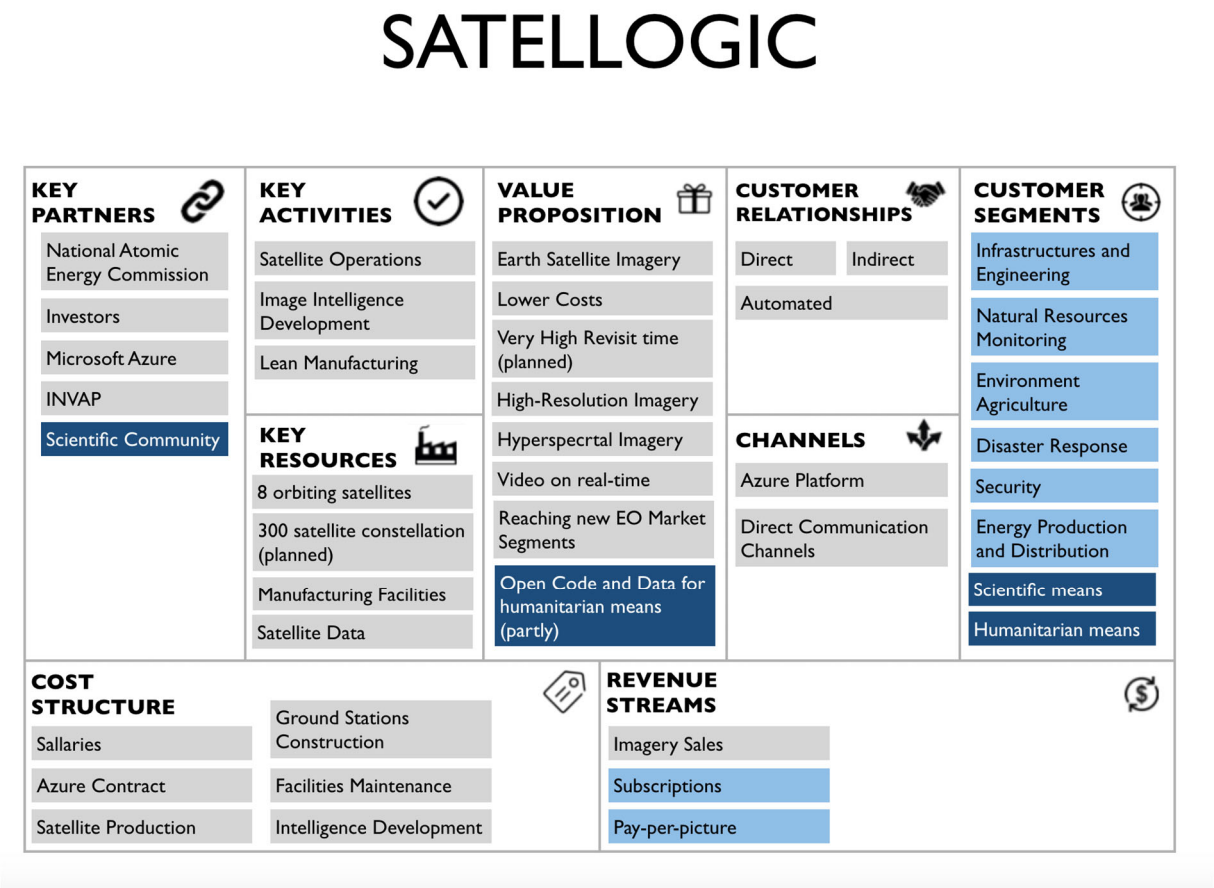


Figure 6.4 CANVAS Business Model for Satellogic

6.5 CANVAS Business Model for *Deimos*

Elecnor Deimos was founded in 2001, aiming to develop and provide high-tech systems and engineering solutions. Based in Tres Cantos, Spain, this company is the technology branch of *Elecnor,* one of the leading Spanish companies in engineering, infrastructure and construction projects, and a prominent investor in renewable energy, environmental infrastructure, and space.

In the following lines, each of its operating characteristics will be briefly described, with the aim of ultimately develop its CANVAS business model. Additionally, this case study is attached to ***Appendix***

E, where more in-depth analysis and information about the company are presented as a summary of [*TFE-6*].

6.5.1 Customer Segments

The customer segments that *Deimos* is currently serving are mainly ten, schematically presented in *Figure 6.5* and explained in the following list:

- ***UrtheCast*****,** which in 2015 purchased the satellite *Deimos-2,* still operated by *Deimos Imaging.*
- ***ESA and NASA:*** With which *Deimos* collaborates in various programmes, providing multiple solutions depending on the mission's parameters.
- **Deimos Imaging:** Currently subsidiary of UrtheCast.
- ***Open tenders:*** An example would be the leadership that was granted by the Ministry of Spain within the European Union in the Neptuno project.
- ***SATRECi:*** Based on the flight segment.
- ***DMS:*** Regarding the ground segment software.
- ***VERTEX:*** An antenna manufacturer.
- ***KOSMOTRAS:*** Based on the launch segment.
- ***Elecnor Group:*** Security and multiservice network.
- ***Spanish Government:*** Regarding the mining funds.

Besides this, *Deimos* is also providing intelligence in more extensive areas regarding its customer segments, such as agriculture, defence, or disaster monitoring, which might be better assessed through *Figure 6.5*.

6.5.2 Value Proposition

The value proposition that *Deimos* is offering is focused on the following areas of activity:

- **Space Consultancy:** It mainly specializes in the feasibility of any satellite in technological and business teams.
- **Data Reception and Distribution:** The company owns three antennas for satellite monitoring to third parties.
- **Data reseller:** Satellite or other kinds of data.
- **Hardware and software developer:** Related with research and development of a new technology.
- **Ground Information Systems (GIS):** As well as provider of other downstream services.
- **Value-Added Services (VAS).**

Its value proposition is complemented by a series of services related to satellite monitoring, mission planning, data storage, and processing integrated into its *Gs4EO* suite of services. All these services characterize the value proposition as broad, efficient, and reliable in all areas related to Earth Observation activities, from upstream to midstream and downstream.

6.5.3 Channels

To communicate with its potential customers, the company possesses a series of direct and indirect channels. The direct channels imply personal contact, as well as telephone contact. The indirect channels are related to its website and social media. When it comes to delivery channels, part of the services used in the *Gs4EO* suite are used. These services would be, concretely, the *USER4EO* services.

6.5.4 Customer Relationships

When it comes to the relationships which are established between company and customer, it is worth mentioning that after-sales services are offered; since some of the services which are commercialized

require the aid of the company to be used. Apart from this, *Deimos* also aims to have feedback from clients in order to improve products.

6.5.5 Revenue Streams

Regarding the company's revenue streams, the selling of the price and price strategy is confidential; nevertheless, the revenue streams come from the sales and renting of the following services:

- Hosting of antennas.
- Data Selling.
- Satellites development, integration and operation.
- 4EO suite of product licensing.
- Imagery selling.
- Feasibility and risk assessments.

6.5.6 Key Resources

The resources that the company possesses in order to develop its Key activities, which will be explained in the following lines, are characterized by the following groups:

- **Financial Resources:** *Elecnor Group* funds, public space agencies programmes, European open tenders, and internal assets.
- **Physical Resources:** Subsidiaries in five countries, ground system facilities, and physically developed technology.
- **Technology Resources:** Facilities IT-controlled, antennas for satellite surveillance, Gs4EO suite of products and services, a business strategy based on diversification, space technology knowledge.
- **Human Resources:** Highly qualified staff.

6.5.7 Key Activities

The key activities that the company needs to develop in order to be able to provide the value proposition to its customers are those related to the space consultancy projects, the data related activities, such as data obtaining, storage and processing, in order to commercialize these products; the hardware and software development to be sold to third parties, and the development and commercialization of the 4EO suite products.

6.5.8 Key Partnerships

To develop the key activities that the company needs to perform so that the value proposition might be developed, *Deimos* counts with the following key partners:

- ***GUDNUS:*** company that provides efficient solutions for energy engineering projects. Its partnership is addressed to provide thermography services by using a self-developed tool developed in the project *APPIDE*.
- ***ORBEX:*** company that develops an innovative launch vehicle for small satellites called Prime. Deimos Space has become an investor of *Orbex* for the partnership for satellite launches.
- ***ESA:*** European Space Agency, a public agency that carries out missions into their different space programmes.
- ***Mars Sample Return:*** this is a project carried out in collaboration by ESA and NASA, which is addressed to bring to the Earth different samples of Mars. In this project, there are many partners involved, such as *Thales Alenia Space, GMV, OHB, and Deimos Space*, apart from the public agencies.
- ***Neptuno Project:*** project for the CDTI (from the Spanish *Centro para el Desarrollo Tecnológico Industrial*) within the European Union that faces the main challenges of maritime surveillance.

- ***Dauria Aerospace:*** its partnership is aimed to develop *Deimos Perseus*, which will be the first satellite constellation to provide frequent images of the entire Earth.
- ***Mohammed Bin Rashid Space Center (MBRSP):*** partnership funded by the International Partnerships in Space Programme from the *UK Space Agency* to automate the geospatial information that will feed the initiative *Smart Dubai* will help to plan and monitor the urban transformation. All this within the *SAFIY* project.

6.5.9 Cost Structure

The company must face the cost structure so that the projects might be undertaken mainly characterized by the activities listed in the lines below:

- Highly qualified staff.
- Significant investment in R&D.
- Infrastructure related costs.
- Marketing and sales-related costs.
- Raw material acquisition costs.
- Logistics related costs.

All the ideas previously described are summarized in *Figure 6.5* and can be better understood after reading ***Appendix E***, which presents the *Deimos* case study, a detailed analysis of the company, and its evolution.

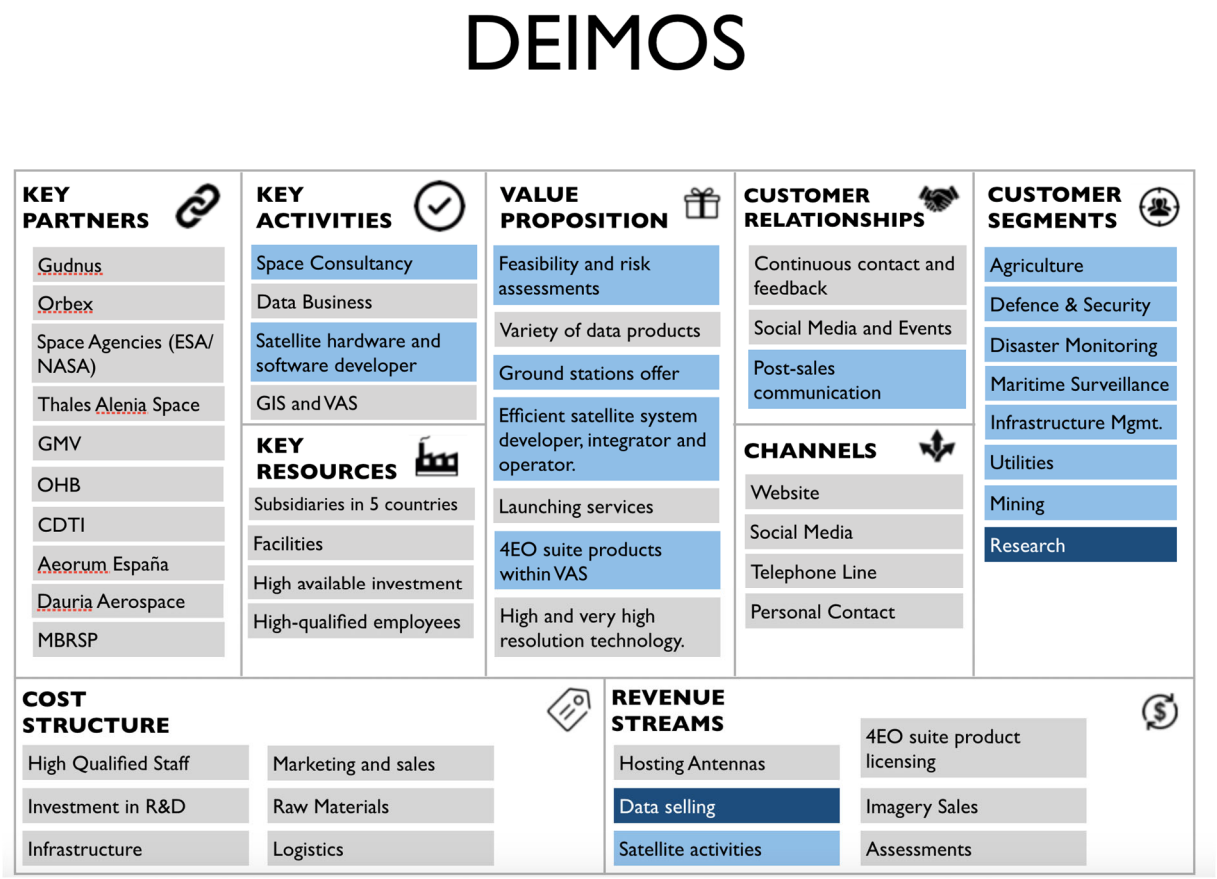


Figure 6.5 CANVAS Business Model for Deimos

6.6 CANVAS Business Model for *Spire Global*

Spire Global was founded in 2012, and it is based in San Francisco, California. It provides the most advanced aviation, maritime, and weather tracking in the World through satellite data algorithms. All of this is possible thanks to a wholly-owned and a developed constellation of Nanosatellites, a global ground station network, and continuous operations that bring real-time Earth coverage.

In the following lines, each of its operating characteristics will be briefly described, with the aim of ultimately develop its CANVAS business model. Additionally, this case study is attached to ***Appendix F***, where more in-depth analysis and information about the company are presented as a summary of the thesis [*TFE-7*].

6.6.1 Customer Segments

Spire's customer segments might be firstly divided into those customers who make use of the satellite imagery for aerospace purposes, those customers who are in the maritime sector, and a final group that is not in any of the two previous groups. Considering each of the groups:

- **Aerospace Sector:** This includes the governments, which make use of satellite data, the air traffic control companies, those companies which monitor the weather from space, and those used linked to the aerospace defence. This sector is interested in high-quality imagery, which might be continuously updated, and which might cover any area of the entire World.
- **Maritime Sector:** These sectors make use of the daily updates of the company's satellite imagery to locate ships in open waters and control the maritime ways.
- **Investigation Sector:** This last vital sector is the least economically representative; however, it makes use of the imagery and data that Spire can provide, in order to create intelligence from it and innovate, through data science, in different fields.

6.6.2 Value Proposition

Spire Global sustains its value proposition on three main pillars that improve the Earth Observation market by using customizable software and multifunctional sensors to adapt to customer requests and choosing quantity oversize by:

- Offering continuous coverage of any place on Earth and taking advantage of their location in LEO.
- Leading customers to use low-cost devices.
- Having responsible treatment of space debris by using smallsats.

Spire Global also aims to become an inspiration and a leader in the Earth Observation business by using LEO orbits and developing new technologies and solutions to further explore in this newly emerging sector.

6.6.3 Channels

The firm's ways to get in touch with their customers are mainly online-based using an owned web page, where anyone can get information about the values and services that the company offers. Additionally, the company also does broadcast through social media and allows those who are more interested in the firm and its signs of progress to request news via email subscription to their blog. To deliver the products to the customers, the company possesses a suite of GIS products and an owned API platform.

6.6.4 Customer Relationships

Spire Global makes excellent efforts to provide a transparent image to its customers, offering and sharing as much information as they can, trying to give a close relation through news or online chats, amongst others. Moreover, the company had to offer, at the moment only to the maritime sector, but

perspectives point towards expanding to other sectors, the Developer Portal, an online space where customers might develop their own AIS projects with cloud-based APIs.

6.6.5 Revenue Streams

The revenue streams that the company possesses in order to sustain the entire structure is represented by the incomes which come from the EO studies which it delivers, which mainly are sold to the investigation sector; the meteorology and the air traffic data, which are sold to different aerospace companies, as well as the maritime Earth observation data, sold to the maritime sector. All of these products might be sold to any of the customer segments, so the company can make an extra profit of commercializing the EO imagery.

6.6.6 Key Resources

Human resources and supplies to assemble the small satellites, and maintain an appropriate degree of production activities are essential. As the lifetime of the performed missions is significantly short, compared with traditional satellite lifetimes, a larger number of satellites need to be assembled, so the number of orbiting devices in missions remains constant. Additionally, ground stations that allow constant tracking and data collecting are essential.

6.6.7 Key Activities

The company is trying to become a leader in the technology innovation field; therefore, the development and investigation which concerns the small satellites is an essential activity to improve the efficiency of their operations and services. The maintenance of these devices and the servers to keep safe data storage is also vital. Lastly, the transformation of this obtained data into a more valuable product, related to data intelligence, is another of the key activities developed by the company.

6.6.8 Key Partnerships

In order to complete the information treatment, it is indispensable to collaborate with the sectors, which are specified in this block in Figure 6.6. These three main sectors are also the principal customer segments, which give Spire Global the necessary information to accomplish the studies added to the information collected from orbit. Usually, the relationship between these customers and the firm is managed from governments that comprehend these three sectors in a particular country, so they are considered partners. In the aerospace sector, partnerships with *Ball Aerospace* and the *NGA* are considered of high importance, in the meteorological sector, it is the *NOAA* partnership, finally, in the data storage field, the partnership with *Amazon Cloud* based services is of great importance as well.

6.6.9 Cost Structure

The main costs of this company are the contracts that allow it to include these small satellites into large launchers and the human costs and the infrastructure costs to complete the firm's key activities.

All the ideas previously described are summarized in *Figure 6.6*, and can be better understood after reading ***Appendix F***, which presents *Spire Global* case study, a detailed analysis of the company and its evolution.

SPIRE GLOBAL

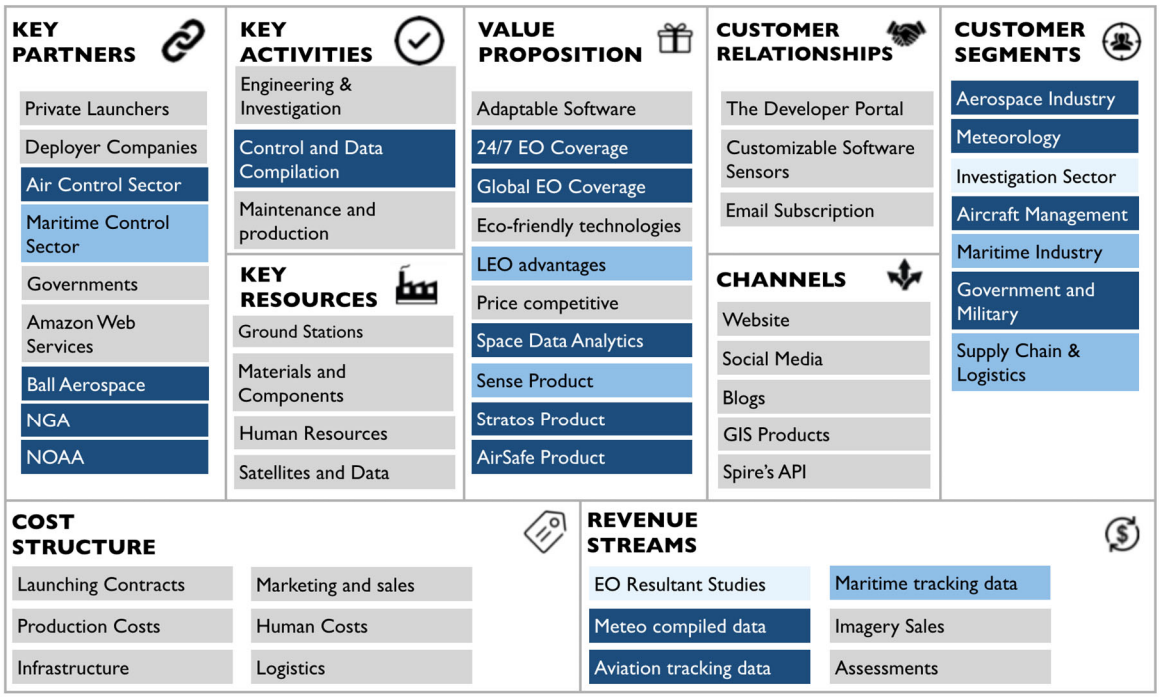


Figure 6.6 CANVAS Business Model for Spire Global

6.7 CANVAS Business Model for *GOMSpace*

GOMSpace was founded in 2007, and it is based in San Francisco, California. With the parent company now being *GomSpace Group AB*, it provides turn-key solutions for space-based business, developing and commercializing off-the-shelf payloads and platforms in the nanosatellites sector. Based in advanced radio technology, *GomSpace* solutions include the Internet of Things (IoT), communications, tracking, surveillance, and remote sensing.

In the following lines, each of its operating characteristics will be briefly described, with the aim of ultimately develop its CANVAS business model. Additionally, this case study is attached to ***Appendix G***. More in-depth analysis and information about the company are presented as a summary of the thesis [*TFE-7*] and [*TFE-8*].

6.7.1 Customer Segments

The more significant customer segments that the company serves are the National and Private Spaces agencies, followed by the military defence industries. The sector oriented to University investigation, as well as general scientific investigation, is also representative. The last sector that the company offers services to is private companies. The company self-defines its customer segments as *Science, Academia, Commercial and Defence*; however, more subgroups have been decided to be significative enough as to be displayed in *Figure 6.7*.

6.7.2 Value Proposition

GomSpace offers devices, as well as services. Their devices have multiple options of modular plug-&-play accessories such as propulsion, communication, and control systems from an operational point of view, and the possibility of selecting the mission payload with its modules. *GomSpace* offers custom-

made devices and services to enhance the exploitation and endurance of the missions. These services are oriented to take place in large operations; therefore, they are considered to be related to the previously presented customer segments. Besides the focus of its operations, the customization of missions, the proposals related to space data analytics, the Internet of Things, and the communications and remote sensing are remarkable.

6.7.3 Channels

GomSpace owns a network of communication channels, represented by its web page and social media, through which the customers can keep up with the company's news, developments, and announcements. Additionally, to cover the larger and more important missions, *GomSpace* owns a net of headquarters around the World, which gives full coverage and assistance to this sort of customer.

6.7.4 Customer Relationships

GomSpace customers can directly communicate with the company to get specialized devices and solutions, or to request information on their mission's status. This Direct relationship might go one step beyond, allowing the customer to work with the company to co-create its concrete product or service. Lastly, the company also offers the possibility of relating to them through indirect means, such as through email.

6.7.5 Revenue Streams

Revenue Streams are mainly represented by the sales of the customized devices, as well as fees coming from the development of these devices. Other revenue streams come from the sales of satellite-related services, including the EO data imagery, the renting of the satellite platforms, or the fees from the constellation management services.

6.7.6 Key Resources

In order to correctly perform all the key activities, *GomSpace* needs to keep a certain level of material and resources, as well as qualified personnel to craft the nanosatellites and more specialized employees to develop the activities related to the MCOP operations and updates. Headquarters and facilities around the World are also fundamental. Nevertheless, the company has been opening offices all around the world to allow its expansion and evolution.

6.7.7 Key Activities

As the company offers the crafting of nanosatellites, engineering and investigation are primordial. Moreover, both the constant maintenance of MCOP network and the enhancement of its services is vital to keep this service as a differentiation of the firm. Related to this issue, as the company uses the conventional commercial ground stations to establish this connection, keeping this compatibility is essential, contrarily, the entire MCOP device would need from another solution.

6.7.8 Key Partnerships

As GomSpace aims to reach missions which lead the company to innovate and improve the offered products, since the beginning, the company has put efforts into establishing relationships with agencies and large sectors of investigation fields, which, as partners were interested in applying the technology of the nanosatellites into the success of their missions. An example of this behaviour would be the *GOMX-3*, a satellite launched in October 2015, in collaboration with ESA; this mission was a success from the perspective of performance and EO applications using novel technologies as X-band downlink. Other significant partnerships have been those established with the *Ministry of Economy of Luxembourg*, or the *AISTECH* and *Sky and Space Global* partnerships, in the launching fields.

6.7.9 Cost Structure

The development of the key activities, both maintenance, and improvement of the MCOP and the crafting of the devices, would have a cost associated. As the company became larger, its workforce had to become more extensive as well. Additionally, the number of offices and headquarters around the world was also enlarged in order to face the increasing demand. These changes translated into an increase in the cost structure of the company.

All the ideas previously described are summarized in *Figure 6.7*, and can be better understood after reading ***Appendix G***, which presents *GOMSpace* case study, a detailed analysis of the company and its evolution.

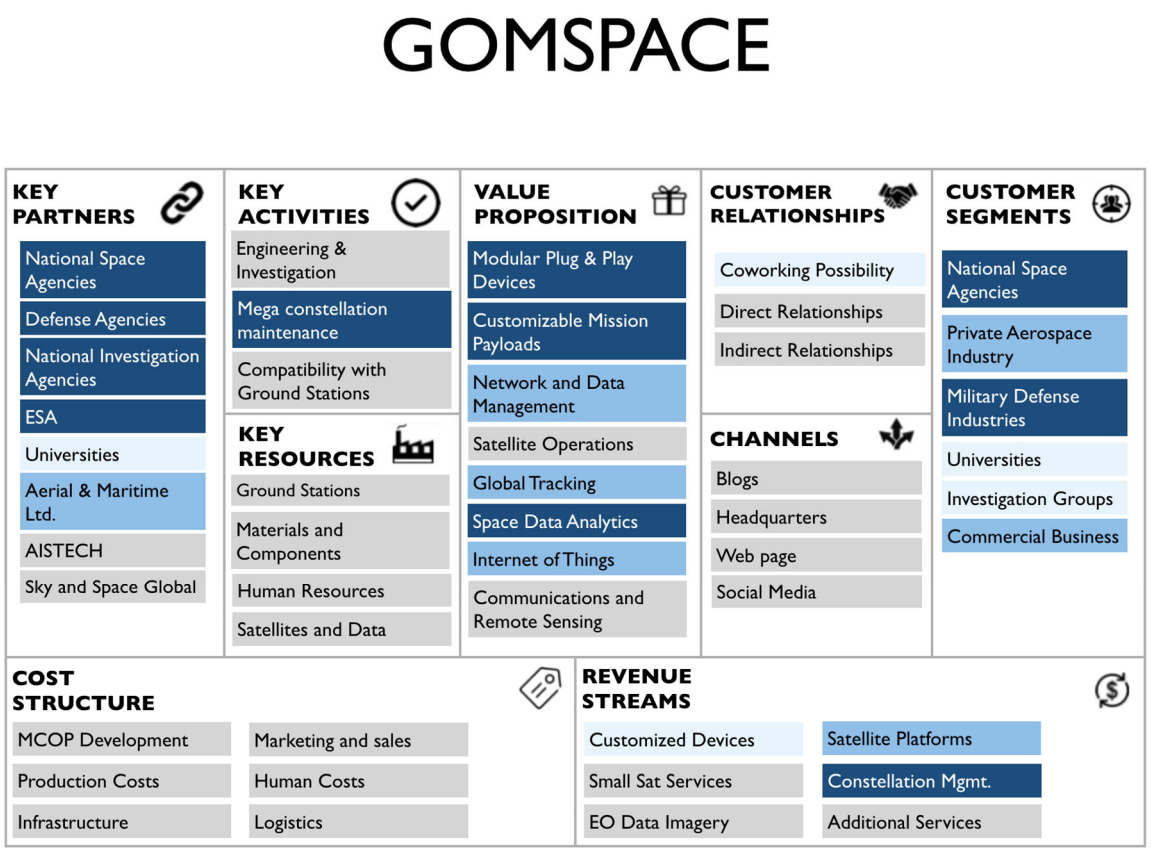


Figure 6.7 CANVAS Business Model for GOMSpace

6.8 CANVAS Business Model for *Spaceflight*

Spaceflight Industries is composed of four main branches within its internal structure. Each of these branches could be analysed as separate companies since they develop different activities and target different customer segments. However, it has been considered to be of interest to the study of the entire structure of *Spaceflight.*

In the following lines, each of its operating characteristics will be briefly described, with the aim of ultimately develop its CANVAS business model. Additionally, this case study is attached to ***Appendix H***, where more in-depth analysis and information about the company are presented as a summary of [*TFE-5*].

6.8.1 Customer Segments

Spaceflight Customer Segments might be divided into three main groups, which, at the same time, are composed of some customer subgroups. The differentiation has been made according to the kind of service that the customers are interested in accessing:

- **Interested in designing satellite missions:** Mainly, the national Space agencies and government defence institutions. These sorts of customers reach great agreements with Spaceflight in order to correctly design the kind of mission that they need with all the parameters that the mission has to accomplish. These two customers are also interested in the data services, which would be the geospatial software development and cloud services, as well as obtaining data intelligence from the Earth Observation Imagery.
- **Launching and monitoring missions:** Private satellite companies from the aerospace sector are the main customers of this service, as well as consumers of the hardware-focused on satellite functioning that Spaceflight produces.
- **Data Intelligence Consumers:** This customer segment is composed of: those companies which make use of the satellite imagery and its intelligence for maritime surveillance purposes; those companies which are interested in acquiring frequently updated information; those companies which are settled in the location-based services; and lastly, those companies interested in acquiring imagery and intelligence focusing on resolution, which would be the infrastructure and engineering-related companies.

6.8.2 Value Proposition

The value proposition of Spaceflight is extensive; as it was said, the company is composed of four branches. Each of them has a slightly different value proposition, even when all propositions are related to satellite manufacturing, launching, operation, and data analysis. This value proposition encompasses areas such as:

- Satellite components and subsystems development (hardware development).
- Mission planning for external satellite companies.
- Satellite launching services, sold in 2018 to *Mitsui & Co. Ltd* and *Yamasa*, yet still operated by Spaceflight.
- Satellite monitoring through a network of ground stations all around the world.
- Services related to data analysis and intelligence, such as the geospatial software development and cloud services, or the *Earth Observation Data Intelligence*, which is sold to third parties.

6.8.3 Channels

In order to reach the company and obtain the products which have been acquired, the company offers the following communication lines:

- **Blogs:** In order to keep up with the company's evolution and product innovations.
- **Headquarters:** In order to directly communicate with *Spaceflight* and its personnel directly.
- **Web Page:** It offers the possibility to contract some of the company's services through it, and at the same time, it offers news and information about the company and its services.
- **Social Media:** In order to present and promote the company's products.
- **Online platforms:** *Spaceflight* trough *BlackSky* is developing two different platforms, Spectra and Events.

6.8.4 Customer Relationships

Customer relationships established between company and customer are indirect, which are the vast majority, and are established using online communications, or, in exceptional contract cases, direct. These direct relationships allow both parties to have more fluent communication when it comes to

developing products and services that need to be developed as collaborations. (i. e. The development of the *GEOINT Broker Platform* in collaboration with *NGA*).

6.8.5 Revenue Streams

The revenues which sustain the company's activities come from the commercialization of different products, being the most critical revenues those that come from the launching activities, which imply that Spaceflight launches and places on orbit the small satellites of the customers, and whose payment is fractionated, depending on the stage of the launching process. Other incomes come from mission planning fees, the recurrent payments from mission monitoring, the punctual payments from satellite specialized hardware sales, and finally, from the fees of the acquired Earth Imagery and intelligence related to Earth Observation services.

6.8.6 Key Resources

To develop all the activities essential for the excellent functioning of the company, Spaceflight owns a global network of ground stations to:

- Ensure the activities related to satellite monitoring, a fleet of launchers, and contracts with launching companies.
- Undertake all the launching activities, assets of satellite software, a fleet of satellites, a library of satellite obtained data
- Perform all the key activities with a remarkable number of human resources.

6.8.7 Key Activities

The company offers activities related to satellite launching and management, including satellite launching, mission planning, or satellite monitoring. These are a big part of the company's activities and revenues, as well as services related to Earth Observation Intelligence services, including geospatial software development, *Earth Observation Data Intelligence* creation, or geospatial cloud services. Lastly, its main activities would be related to satellite hardware production and delivery.

6.8.8 Key Partnerships

Some of Spaceflight's most important partnerships are these presented in the following lines:

- **Mitsui & Co. Ltd and Yamasa:** *Spaceflight* Industries reached an agreement with this Japanese company by the end of 2018 to sell its satellite rideshare subsidiary, Spaceflight Inc., to this company [8]. The deal would see *Spaceflight* continue to operate as an independent business based in the U.S and headquartered in Seattle, with the same mission of providing rideshare launch services for small satellite payloads [9].
- **NGA:** In September 2017, both companies announced the partnership agreement in order to develop and deliver a cloud-based geospatial intelligence broker platform for the *U.S Air Force Research Lab.* [10]
- **NASA:** In 2017, both entities signed an agreement of collaboration regarding the launch of U-class payloads. [11]
- **Thales:** In February 2019, *Thales* partnered with *Spaceflight* Industries to disrupt the smallsat industry, by producing cost-effective satellites at a new state-of-the-art smallsat production facility. [12]
- **Telespazio:** In September 2017, *Spaceflight* Industries and *Telespazio* signed a partnership agreement to realize the *BlackSky* constellation.[13]

6.8.9 Cost Structure

The development of productive and commercial activities reflects on a cost structure that the company needs to face. This cost structure is mainly composed of the data storage and processing costs, as well as the costs associated with the production of either intelligence, as well as the hardware production costs. Other essential costs that need to be taken into account are marketing and sales, human costs, and logistic costs, especially when planning the launching missions.

All the ideas previously described are summarized in *Figure 6.8*, and can be better understood after reading ***Appendix H***, which presents *Spaceflight Industries* case study, a detailed analysis of the company and its evolution.

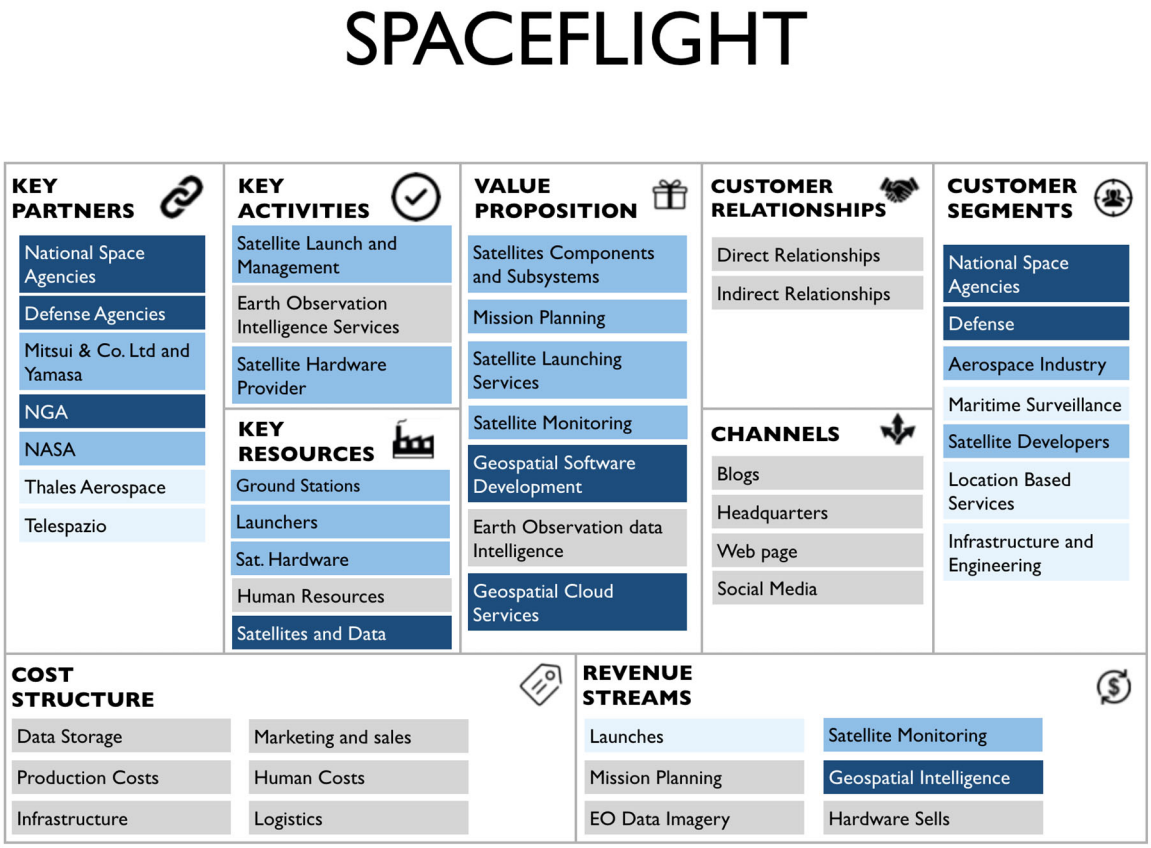


Figure 6.8 CANVAS Business Model for Spaceflight

7 Success Factors & Patterns analysis

After analysing the previous business models, it is interesting trying to see if a new business model pattern can be established in the world of Earth Observation or not. But what is a business model pattern?

7.1 Business model patterns

According to *Jay Liebowitz*, a business model pattern can be understood as a set of common behaviors that several business models exhibit [14].

The basic idea of the pattern concept is reusing solutions that are documented generally and abstractly to make them accessible and applicable to others. In this way, patterns seek to contribute to reducing complexity and increasing efficiency in problem-solving processes [15].

In the same way, the concept of business model pattern is ambiguous, and experts do not agree on a globally accepted definition. It is for that reason that it is crucial to dig into its classification. According to *Gausemeier and Amshoff* [16], there are three main categories:

1 **Frameworks:** located at the top of the pyramid, they are proven forms for the documentation and analysis of business models. This category is where the Canvas template and the Feedback loops are classified.
2 **Prototypical business models** permit a quick orientation when entering a new market but are not appropriate for developing new business models.
3 **Solution patterns:** located at the bottom of the pyramid and is the most extensive category; they are proven building blocks for designing business models.

These three categories are presented in Figure 7.1. Note that they are located in the pyramid according to their extensiveness, which means that there are many more solution patterns than frameworks.

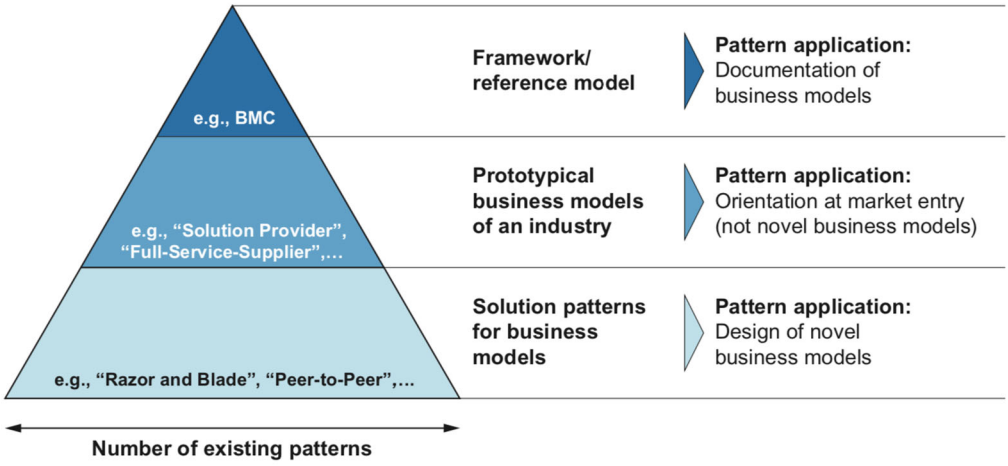


Figure 7.1 Classification of the business model patterns. Extracted from [16]

Once this classification has been introduced, it is worth noting that in this research, the attention will be focused on the third category, the solution patterns. Somehow the second category may seem more useful than the third one for the world of Earth Observation. However, this research aims to see which are the key factors to consider when designing a new business model. Thus, the solution patterns will enable the identification of the critical building blocks of the EO business models. Those help enterprises with the design or the innovation process of their business model.

7.2 Can DISCOVERER take advantage of a new business model pattern?

The title perfectly reflects the aim of this section: trying to conclude if a new business model pattern can be established in the world of Earth Observation, specifically the New Space trend. Therefore, one pattern of which the *DISCOVERER* project could take advantage of.

To do so, a systematic methodology has been applied. First of all, a set of requirements will be established to be able to gather all the information needed (*taken from section 6 of this document and its appendixes*).

The main idea is to identify if some characteristics are kept repeated along with the companies' business models. To do so, the pattern methodology will be applied.

As mentioned above, before starting with the methodology, some requirements have been established:

- All the enterprises analysed have to be focused on EO activities.
- The enterprises have to be vertically integrated.
- The enterprises cannot be all from the USA. To provide general results, enterprises from different countries are analysed.
- The enterprises should be unique to apply the case study methodology.

7.3 Pattern methodology

The pattern methodology consists of defining some configuration options for each business model variable and then, using a binary code to identify if a company opts for that configuration option.

The business models' variables are the set of factors that defines a business model element. In this sentence, some concepts need further explanation:

- **Business model elements.** In this research, the business model elements are the different building blocks of the Canvas template. Nevertheless, not all building blocks will be part of the pattern methodology, value proposition, revenue streams, and cost structure are out of the methodology:
    - Value proposition: due to their complexity, they have been analysed separately. In the State of the Art, the trends of the EO have been introduced. Then in section 6, all the value propositions from the different companies have been detailed.
    - Revenue streams and cost structure: these two building blocks are considered to be a consequence of the other one. Thus, if all the other blocks are analyzed, these two blocks will be automatically defined.
- **Business model variables.** They are considered to be the factors that best describe the business model elements. According to *Amshoff* [16], business model variables are levers a company uses for actively designing its business model.
- **Configuration options.** They are the different alternatives that can be found in each business model variable.

To better understand these concepts down below all the business model variables, their configuration options chosen for this research are detailed:

- Target group: It refers to the different groups of customers that a company aims to serve. Therefore, it can be said that this variable ultimately defines the customer segment building block. As different configuration options, general categories have been chosen. Customers in EO can come from the commercial, governmental, military, humanitarian, and educational sectors. It is worth noting that the commercial industry includes markets such as forestry, aviation, agriculture, energy, and insurance. However, for the methodology, it is not useful going deeply in that detail. Therefore, the pattern will be applied only, taking into account the general classification.

- Sales and delivery: sales and distribution are considered to be the key factors shaping the channels block. These two processes can be formed by direct or indirect and own or partner channels. However, as EO is a service entirely online, physical stores are disregarded. Taking all this into account, the configuration options considered for this variable are salesforce and web platforms.
- Type of service: according to section 5, the best factor that describes customer relationships is the type of service. As configuration options for this variable have been chosen, the different types detailed in *Figure 5.3*.
- Own activities: regarding the key activities building block for this research, it is essential to see which are their own activities. Due to this fact, like configuration options, all the activities from down, up, and middle streams have been considered.
- Owned physical resources: in the same way as key activities, it is important to see which are their own resources. Based on the activities from the EO value chain, the key resources are selected and placed as configuration options.
- Number of partnerships: the two aspects that define the key partnerships building block are the number of partnerships and their type. The configuration options for the variable number of partnerships are a high number or a low number of alliances.
- Type of partnerships: as mentioned above, another variable is the type of partnership. According to *Osterwalder [6]*, these partnerships can be strategic alliances, joint ventures, buyer-supplier relationships, and partnerships based on coopetition.

In *Table 7.1*, all these concepts can be found, and the methodology results are presented.

7.4 Pattern methodology results

As mentioned above, in this section, the results of the pattern methodology are detailed.

To better understand, it is vitally important to clarify that a binary code has been used: 1 means that the company shares that characteristic, whereas 0 means that the company does not present that factor.

Furthermore, taking into account the requirements detailed in *section 7.2*, the companies analysed employing the pattern methodology are:

- DigitalGlobe
- Planet
- Satellogic
- Spaceflight
- Spire
- Urthecast

Note that in section 6, other companies such as *Deimos* and *GOMspace* have been analysed. However, these companies are not considered to be totally vertical integrated, as they don't provide End-User services by themselves, they are disregarded from the pattern methodology.

From Table 7.1 it can be extracted that all companies serve more than one group of customers. All of them serve the commercial sector, and the vast majority also the civil one. Moreover, note that most of them provide their services to the humanitarian or educational sector too.

Table 7.1 Pattern methodology results

	BM variables	Configuration options	DigitalGlobe	Planets	Satellogic	Spaceflight	Spire	UrtheCast
			Company					
Customer segment	Target group	Comercial	1	1	1	1	1	1
		Governamental	1	1	1	1	1	1
		Military	1	0	0	1	1	1
		Humanitarian	1	1	1	0	0	1
		Educational	1	1	1	0	1	1
Customer relationships & channels	Sales and delivery	Sales force/ Partner	1	1	0	0	0	0
		Web platform	1	1	1	1	1	1
	Type of service	Personal asistance	0	1	0	0	0	1
		Self-service	0	0	0	0	0	0
		Automated services	1	1	1	1	1	1
		Communities	0	0	0	0	0	0
		Co-creation	0	0	1	0	0	0
Key activities	Own activities	Satellite design	1	1	1	1	1	1
		Satellite build and AIT	1	1	1	1	1	1
		Satellite launch	0	0	0	1	0	0
		Satellite operations	1	1	1	1	1	1
		Satellite data sales	1	1	1	1	1	1
		Satellite data analytic sales	1	1	1	1	1	1
Key resources	Owned Physical	Offices in more than two countries	1	1	1	1	1	1
		Satellites	1	1	1	1	1	1
		VAS sensors	1	1	1	1	1	1
		Launching vehicles	0	0	0	1	0	0
		Operated ground stations	1	1	1	1	1	1
		AI platforms	1	1	1	1	1	1
Key partnerships	Number	High number of partners	1	1	1	1	1	1
		Low number of partners	0	0	0	0	0	0
	Type	Strategic alliances	1	1	1	1	1	1
		Coopetition	1	1	0	1	0	1
		Joint ventures	1	1	0	1	0	0
		Buyer-Supplier relationship	1	1	1	1	1	1

Then, similarly to customer relationships and channels, all of them opt for online platforms. These online platforms enable them to reach all types of customers worldwide with reduced expenses. However, these platforms are automated-base services. To solve this matter, the companies are taking steps towards more tailored services through these platforms, both from investing in user interface and opting for personal counts.

When analysing the key activities and the key resources to develop them, it can be seen that most of them develop the complete value chain except for the launching activities. However, it is vitally important to note that they do not produce all the activities or handle all the resources on their own. Therefore, all of them opt for establishing a high number of strategic alliances.

However, one question that may arise is **why existing patterns cannot be adapted to this New Space trend**?

It is a well-known fact that nowadays, there are plenty of business model patterns that a business could take advantage of. Nevertheless, when trying to apply these methodologies to novel EO companies, some aspect is missing. A detailed analysis of the current patterns has been done to justify the previous sentence, starting from the most general category, the framework pattern, until the detailed ones prototypical and solutions patterns.

When talking about framework patterns, *Osterwalder and Pigneur* researchers did extensive work [6]. They identified five different patterns (*table 7.2*) : Unbundling, The Long Tail, Multi-sided Platforms, Free as Business Model, and Open business models. So, can the EO market be classified into one of these patterns? The answer is no.

Table 7.2 Business Model Patterns. Source: [6]

Pattern	Definition [6]	Reason
Unbundling	It is composed by three different types of businesses that they may co-exist within a single firm, but they are unbundle into separate entities in order to avoid conflicts or undesirable trade off.	Companies are not focused on one type of alternative competitive advantage
The Long Tail	It is focused on offering large number of niche products, each of which sells relatively infrequently. It requires low inventory cost and platforms to make niche content readily available to interested buyers.	They do not focus on selling a large number of products in low volumes.
Multi-sided Platforms	They are platforms that bring together two or more distinct but interdependent groups of customers. They create value as intermediaries by connecting and facilitating interactions between these groups.	Customer segments do not depend on one another and neither interact one to each other. All of them can exist without the others.
Free as Business Model	It is a business model where one substantial customer segment is able to continuously benefit from a free-of-charge offer. It is very popular in digitalization of goods and services offered via web.	Not all of the companies offer data for free, and the ones that provide the product for free is because they have an educational or humanitarian commitment.
Open business models	It is used by companies to create and capture value by systematically collaborating with outside partners.	This pattern, as the main idea is to allow to create value by collaborating with outside partners, could fit with the EO trend; however, it not encompasses other vitally essential facts of the market.

At the end of their study, *Osterwalder and Pigneur* authors claim, "*New patterns based on other business concepts will certainly emerge over time*" [6]. Therefore, it can be said that EO Space companies introduce new business concepts that will develop a new business model pattern.

However, *Gausemeier et al.* [16] identified 55 different mixed patterns (prototypical and solution patterns). Therefore, it is crucial to see if some of these patterns could fit the New Space idea. By reviewing their cluster, it can be concluded that the existing patterns cannot wholly define the EO market, and with that, this democratising trend requires a new pattern (Figure 7.2).

When trying to **democratise a service or a product**, it is vitally important to consider the needs and social concerns that new customers present. Usually, democratising means making **access to the commercial sector** through innovative and affordable services, a service that was previously wholly reserved for civil use. Therefore, companies have to focus their attention on **reducing the cost and complexity** by developing integrated IT platforms, small satellite technology, and lean manufacturing. To do so, EO opts for automated services like **Web-based platforms** that enable EO companies to **offer tailored and processed information at low prices** by reducing the variable costs, customizing the service, and analysing the imagery data. To cut expenses, companies have to focus their attention on the key resources building block. There, some standardization has to be introduced in order to be able to produce quicker and cheaper products.

Furthermore, to **strengthen the brand and key activities**, EO companies have to focus on the key partnership building block. There, some key activities have to be introduced in order to be able to build a strong market reputation, attract global commercial customers, and adapt quickly to market needs.

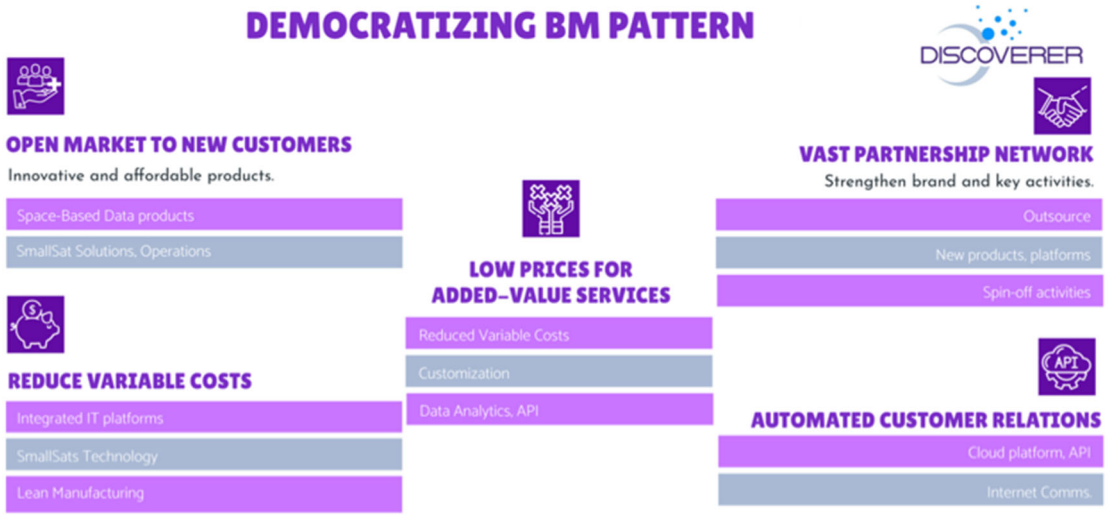


Figure 7.2 New business model patterns: Democratizing EO BM Pattern. Extracted from TFE-9.

Once the new pattern is defined, the key success factors of the market can still be identified (*table 7.3*). As mentioned above, these results were obtained through the pattern methodology.

Table 7.3 Key Success Factors in EO companies vertical integrated

Key success factors	Description
Smallsat Technology	Opting for small satellites should be a value proposition to be present in the fight for higher resolution, lower revisit time and manufacturing standardization.

Key success factors	Description
Partnerships	By establishing a high number of partnerships the company gains both reputation and reinforce its resources and activities.
Lean Manufacturing	It helps to reduce the manufacturing time and also provides complete control over the process and cost.
Satellite Constellations	Placing constellations of small satellites in LEO and VLEO enable the space community to obtain a huge amount of data in near real-time. It would transform EO imagery into a commercial product, taking benefit of their almost high resolution and their high revisit time.
Cloud-based analytics platform	When democratising activity, it is vitally important to invest in Value-Added Services (VAS). For the specific case of EO observation, companies invest in Cloud-based platforms to process the images.
Constant product innovation	Commercial customer segments involve a high degree of competence; therefore, applying recent innovations is crucial to be present in the market.
Vertically integrated strategy	This vertically integrated strategy enables companies to take control of the complete process of manufacturing from creation until delivery.

After identifying which are the factors all the studied companies share (*table 7.3*), it is interesting to see whether these factors can be considered key choices. To do so, the Feedback Loop methodology will be applied.

Note that the Feedback Loop Diagram (see *Figure 7.3*) represent circles where choices are linked to their consequences by arrows (explained in section 5). Hence, the legend used in *Figure 7.3* is: the choices are underlined; the rigid consequences are boxed and in a standard font are represented the flexible consequences.

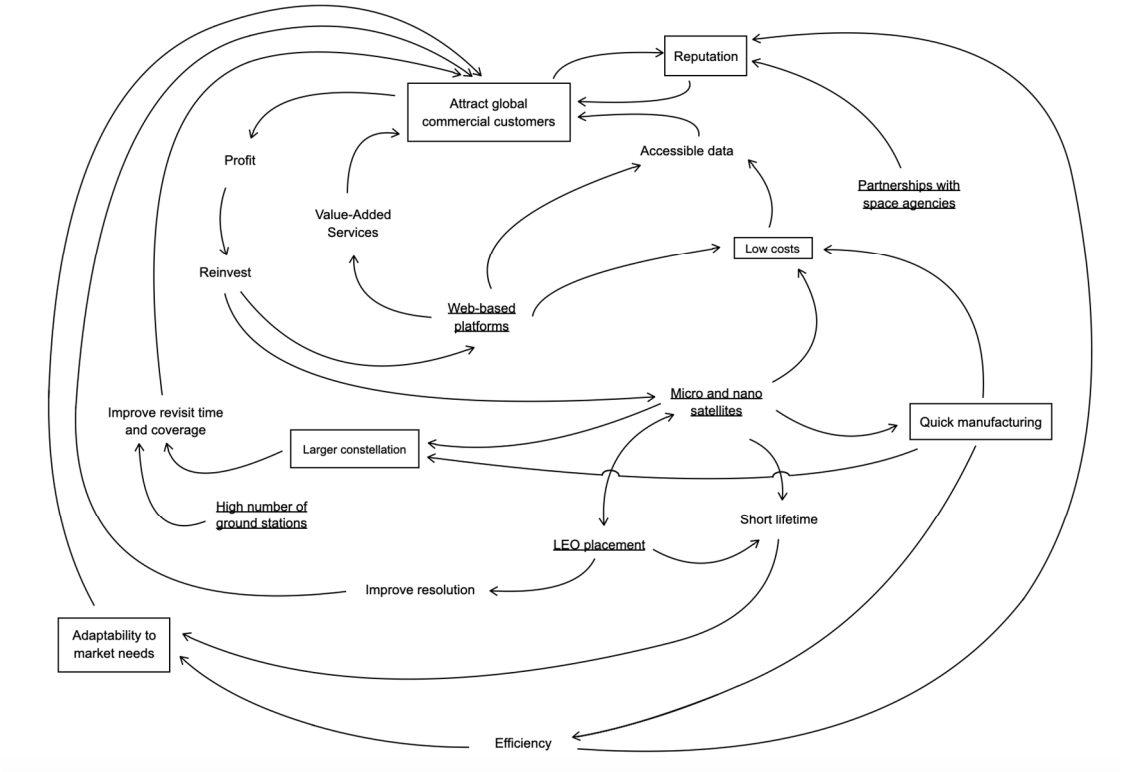


Figure 7.3 Feedback Loop Diagram

Figure 7.3 shows the feedback loops of a general vertically integrated EO company based on existing EO companies like *Spaceflight*, *DigitalGlobe* or *Planet*. One of the most important ones captures the vertical integration trend in the EO space industry. *Table 7.4* describes the feedback loops related to the observed key success. Additionally, *Figure 7.3* shows that critical choices are related to resources, channels, and customer relationships. However, if these results are consistent with the rest of the EO market, it is still wondered.

Table 7.4 Relationship between the Feedback Loops and Key success factors

Key success factors	Feedback Loops	Diagram loops
Smallsat Technology	Economic Feedback Loop	Small satellites >> Low-cost satellites >> Affordable data >> Attract commercial customers >> Profit >> Reinvest >> Small satellites
Partnerships	Partnership Feedback Loop	Partnership with space agencies >> talented employees >> quick manufacturing >> Efficiency >> Adaptability to market needs >> Attract commercial customers >> Reputation >> Partnership with space agencies
Lean Manufacturing	Production Feedback Loop	Small satellites >> Quick Manufacturing >> Large constellation >> Improve revisit time >> Attract commercial customers >> Profit >> Reinvest >> Small satellites
Satellite Constellations	Constellation Feedback Loop	Small satellites >> Large constellation >> Improve revisit time >> Attract commercial customers >> Profit >> Reinvest >> Small satellites
Cloud-based analytics platform	Cloud-Analytics Feedback Loop	Web-based platforms >> Value-Added Services >> Attract commercial customers >> Profit >> Reinvest >> Automated services >> Web-based platforms
Constant product innovation	Innovation Feedback Loop	Small satellites >> Adaptability to market needs >> Attract commercial customers >> Profit >> Reinvest >> Small satellites
Vertically integrated strategy	There is a loop that integrates the previous feedback loops that enable companies to take control over the complete process from design to image exploitation.	

Table 7.4 identify the different feedback loops created inside the big one (vertical integration). As mentioned in *section 5*, there can be virtuous (positive) or vicious (negative) feedback loops. Inside the loops presented in *Figure 7.3* five different virtuous loops can be identified:

1 **Economic cycle:** by adopting web-based channels, the companies reduce their costs, enabling them to offer more competitive prices that catch the attention of more customers. At the same time, these customers provide more profit that the enterprises can choose to invest in improving the online platform services.

2 **Production cycle:** The standardization level that the small satellites present is a critical factor that impacts quick manufacturing. Thanks to this time reduction and, at the same time, cost reduction, the company can build larger constellations and, with that, improve revisit time and coverage a value proposition that will catch new customers' attention. Then, these customers provide more profit that the enterprises can choose to invest in building more satellites.

3 **Innovation cycle:** it is a well-known fact that small satellites have a short lifetime. This factor is suitable when technology is evolving quickly. These short lifetimes enable the companies to adapt the service to the market needs quickly and attract more customers. These customers then provide more profit that the enterprises can choose to invest in adapting their new satellites.

4 **Value-Added Services cycle:** as mentioned above, the companies opt for online channels. With that, they can create Value-Added Services that will catch the attention of new customers. These customers then provide more profit that the enterprises can choose to invest in improving their online platforms.

5 **Partnerships cycle**: by establishing a high number of partnerships, the company gains a reputation that is traduced in acquiring new customers. Furthermore, these partnerships enable the company to obtain more key resources or key activities.

In the same way, it is vitally important to note that no vicious cycle can be found. However, this does not mean that over time one virtuous cycle somehow can revert and become vicious. To prevent that, isolated choices feeding these loops play an important role: items such as having a high number of partnerships and a high reputation reinforce the whole business model.

Summing up, the factors identified employing the pattern methodology are the ones that then, through the Feedback Loop Diagram, turn out to be crucial when creating rigid consequences. The higher the number of rigid consequences, the more competitive and robust the business model is. Due to this fact, when trying to enter the EO market, it is important to keep in mind these choices and then to try to reinforce the whole diagram by adding more competitive choices.

8 New Business Models

Once the key factors of the current successful players in EO have been identified, it is important to analyse if there exists the possibility that new enterprises take advantage of them at VLEO.

So, this section will include some **new Business Model CANVAS** developed from companies that would emerge from the most promising concepts extracted from *Deliverables D5.3 and D5.4*. Moreover, outline the fact that in order to be sustainable in the long-term, these companies will need to adapt the newly developed success factors (*section 7*) to their own strategies.

According to those previous deliverables, five groups of new Business Models can be generated, plus two already existing ones:

1. **Access to Space** : since there is a continuous increase the need for launching new satellites to serve the EO demand.
2. **Ground Station Services** : since the increase in the number of satellites al low orbits combined with the reduced communications window creates the risk to lose some of the achieved data if not transferred to Earth.
3. **Turnkey providers** : and, amongst them, those that can be identified as *Space Brokers*, to facilitate the preparation and launching activities.
4. **Very High Resolution – High Performance platform** (VHR-HP) : being one of the trends of EO at VLEO.
5. **Very High Resolution – Low Cost platforms (VHR-LC)** : already exploited by companies like *Planet* (*see section 6*).
6. **Constellations** : also *section 6*.
7. **Synthetic Aperture Radar** (SAR) : already exploited by companies like *Satellogic* (*section 6*).

8.1 Access to space

It is expected that the fact of having a large number of constellations, will increase the amount of satellites launched yearly, directly growing the need of sending all these platforms into space too.

Moreover, the objective of reducing costs increases the trend of launching smallsats (less than 500 kg) rather than the larger ones, provoking a bigger diversification in the access to space. This way, it was observed how in 2017 smallsats were preferred to be launched by medium size launchers, due to their compatibility issues and the launch opportunities their offered, achieving a decrease in the number of smallsats being launched as a piggyback on heavy launchers.

Hence, the sector is expected to evolve towards two very different extremes. On the one hand, the use of super heavy launchers will enable to place dozens or hundreds of satellites in orbit, allowing to develop mega-constellation projects. Besides that, on the other hand, micro-launchers solutions would be the perfect solution to place single smallsats into lower orbits.

The launch demand estimation can be seen in the *Figure 8.1*.

So, in this section the business model of a **micro-launcher company and a rockoon company** will be studied.

A **micro-launcher** is a small rocket used to launch small satellites to a specific orbit. The information used for developing this section's study was extracted from theses [*TFE-10*], [*TFE-11*] and [*TFE-12*].

A **rockoon** is a launching system which combines the rocket technology with a high-altitude balloon. Here the idea is to launch the rocket, which has the satellite inside, to the stratosphere by taking advantage of the fact that the air drag is lower in the stratosphere, allowing to use a smarter rocket or to arrive into higher altitudes using the same amount of propellant.

Hence, it can be concluded that the fact of using this new concept will allow to reduce the propellant-linked emissions and also it will enable to recover the balloons after each launch, avoiding waste in

materials and effort. The information used for developing this section's study was extracted from [*TFE-14*].

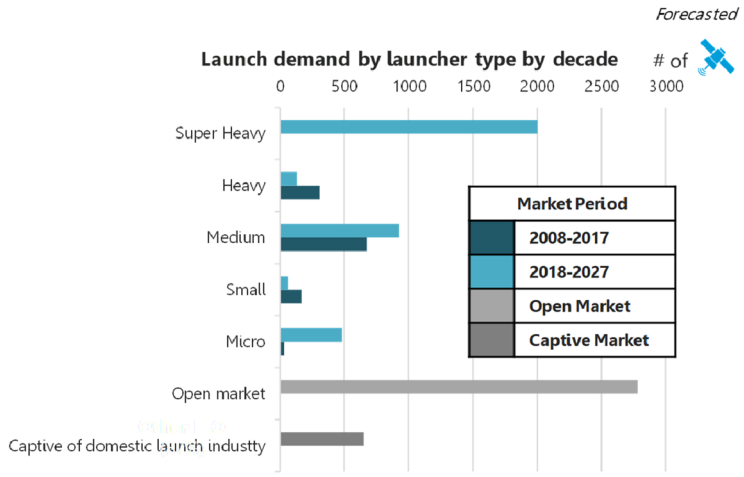


Figure 8.1 Comparison of launch demand by launcher type by decade (Euroconsult)

So, it is seen how in both business models the research component is important as the technology is new or under development. Hence, designing a micro-launcher will be one of the main challenges of the new access to space age. Besides that, highlight that integrate this new technology with a balloon will become more complex and challenging.

8.1.1 Customer Segments

The customer segments of a company can be described as the niche market which aims to have a specific service.

Consequently, different customer segments have been identified along private and public sectors, always with the objective of launching small satellites at VLEO or LEO:

- **Commercial Earth observation companies** aiming to place a small satellite into a specific orbit such as: *Planet, Satellogic, Deimos, GOMSpace*, etc
- **Commercial communication companies** with economic power that want to place a small satellite in VLEO or LEO.
- **Government and defence** institutions without an own launching system, which aim to launch a satellite for: Defence, intelligence, surveillance, meteorology, among others.
- **Space agencies** that don't own a launching system and that aim to launch small satellites, such as: *NASA, ESA, JAXA*, etc.
- **Academic institutions** willing to launch small satellites and research projects that have a reduced budget, such as: Research centres, universities, schools, etc.

In the *table 8.1*, the summary of this initial building block can be found.

Table 8.1 Access to space customer segment

Micro-launcher company	Rockoon company
Similarities	
• Commercial EO companies • Commercial communication companies • Government and defence • Space agencies • Academic institutions	
Differences	
-	-

8.1.2 Value Proposition

The conventional launchers, offer the satellites companies to send their platforms to space as one of the many devices they send or as a secondary payload, called piggy-back. Hence, with the current situation, it is impossible to choose some parameters like: the specific orbital details, schedule, among others.

For this reason, **micro-launchers** are defined as a satellite launching solution which offer the possibility to develop launches perfectly suited to the client's needs, providing a great degree of control on the mission parameters, achieving an even more accurate service in the launching and deployment processes and expending less time in the launching phase than with regular rockets.

On the other hand, as it was previously said, launching with a **rockoon** will reduce the amount of fuel needed and consequently reducing the emissions it produces, becoming an almost eco-friendly device. Moreover, since the first phase of the launching will be done using a balloon, the vibrations of the vehicle will be reduced, making the flight safer for the satellite and allowing the company to recover and reuse the balloons.

In the *table 8.2*, this second building block is summarized.

Table 8.2 Access to space value proposition

Micro-launcher company	Rockoon company
Similarities	
• Customized launching service • On-demand schedule • Customized mission parameters • Affordable price	
Differences	
• Great degree of control of the mission parameters • Accuracy in launching and deployment processes • Reduced launching time	• Reusable vehicles (balloon) • Less vibration • Eco-friendly (less emissions)

8.1.3 Channels

Analysing the way in which the companies would communicate with their potential clients, it is considered that a fluent communication would be the optimal choice. So, in order to achieve it and regarding the phases of the client's decision, the communication channels have been divided into: **Catching, capturing and converting customers**.

So, the first step would be to catch the customers' attention by advertising the launch service. This way, it is thought that the system could work with a web-based platform, where the companies would be able to make a preliminary communication with their potential clients, letting them to book the launching spots, study their options, etc.

Moreover, in order to introduce this technology and provide the necessary information into the potential clients, the companies would also have to create a communication and sales force team, and to develop an engineering team which will allow to discuss the specific mission's details.

In the *table 8.3*, the summary of the building block can be found.

Table 8.3 Access to space channels

Micro-launcher company	Rockoon company
Similarities	
• Catch customers: social media, conferences, web page, journals, advertisement • Capture customers: web-based platform, dedicated communication and salesforce • Convert customers: dedicated salesforce and engineering team	
Differences	
-	-

8.1.4 Customer Relationships

The kind of relationships that the clients expect to maintain with this kind of companies, involves having a launching insurance which fulfils the current legislation and that will protect their investment, whose technology is constantly being updated.

On the other hand, companies can offer to regular customers a reduction in costs or time preferences, using loyalty methods and personal assistance if needed.

In the *table 8.4*, the building block is summarized.

Table 8.4 Access to space customer relationships

Micro-launcher company	Rockoon company
Similarities	
• Launching insurance • Updated status of the mission • Loyalty methods • Personal assistance	
Differences	
-	-

8.1.5 Revenue Streams

The most representative revenue stream in economic terms, is the launching fee. Therefore, it is considered that the launching fees will involve individual payments per launch and the launching insurance, which price might differ between customers due to the loyalty discounts or the addition of extra features. Hence, it is possible that some of the loyalty status may involve a payment due to the client's will of getting other advantages.

Moreover, in case that a micro-launcher company decided to build its own launching infrastructure, another income might come from renting the installations to secondary users, becoming then a launchpad provider.

In the *table 8.5*, the summary of the building block can be found.

Table 8.5 Access to space revenue streams

Micro-launcher company	Rockoon company
Similarities	
• Launching fee • Extra features addition • Loyalty payments	
Differences	
• Launchpad renting	-

8.1.6 Key Resources

The key resources can be split into physical, intellectual and human. Besides, spotlight the fact that the resources required to develop both businesses are really similar, since both business models need to develop a rocket although the rockoon company needs to also develop a balloon and it's integration system.

This way, the similarities are:

- **Physical resources:** Both need to use psychical resources such as the facilities and the equipment needed to develop the project (research centre, ground station, communication room, etc.), the rockets and the web-platform used to contact with the clients.
- **Intellectual resources** such as the patents.
- **Human resources:** Having a high qualified staff is a requirement.

Nevertheless:

- The **micro-launcher** company needs to consider a launchpad which allows the rockets to be launched.
- The **rockoon** company needs to add the balloons, their launching platform and their recovery system. Moreover, as this company needs to mix two different technologies, a differentiated researcher team dedicated to each area is needed. Finally, it is important to remark that the rockoon system would need less fuel than the micro-launcher.

The *table 8.6* summarizes the building block.

Table 8.6 Access to space key resources

Micro-launcher company	Rockoon company
Similarities	
• Facilities and equipment • Rockets • Web-platform • Patents • High qualified staff (rockets)	
Differences	
• Launchpad	• Balloons • Launching platform • Recovery system • Balloon researcher staff • Less fuel

8.1.7 Key Activities

Initially, the key activities will be related to produce and manufacture the vehicles, starting with the research and development of the required technology in order to ensure the feasibility of the business. Afterwards, once that the vehicles are assembled, the key activities will be basically focused on managing and scheduling the satellites' launches in order to have revenues, taking into account possible marketing activities, as the commercial side of the companies cannot be left behind.

Moreover, outline that another key activity that a **micro-launcher** company may need to do, is to rent a launchpad in case it does not have the necessary facilities to do it.

On the other hand, the **rockoon** company mainly needs to focus itself on the research of the new technology that they are trying to develop, considering the extra steps that a two-phase launching mission may have. This means adding to the activities list items such as the research and development of the integration system of the balloon and rocket, the second stage launching, the geolocation and recovery of the balloon and the research of guarantee the stability of the mission.

In the t*able 8.7*, the building block is summarized.

Table 8.7 Access to space key activities

Micro-launcher company	Rockoon company
Similarities	
• Research and development • Manufacturing and production • Launching services • Marketing activities	
Differences	
• Launchpad renting	• Balloon and rocket integration research • Stability and accuracy research • Second stage launching • Geolocation and recovery of the balloon

8.1.8 Key Partnerships

Key Partnerships are an indispensable factor to ensure the companies' success. This way, some possible options for the micro-launcher and the rockoon companies are presented:

- **Space agencies**: They can provide to the company, through cooperation agreements, the necessary rights and permissions for certifying the launching vehicles. Moreover, this kind of partnership may allow to receive extra funds and resources to develop the required technology.
- **Research centres and universities**: They can provide high level knowledge according to their talented and skilled staff and also can collaborate through some research projects related to the companies' needs. Moreover, it is necessary to also treat them as possible customers.
- **Suppliers:** They are a main partnership, as they will provide the required elements to develop the service, directly affecting to the final costs of the project.
- **Small satellite developers:** They would provide inputs for the vehicle requirements, being potential customers.

Moreover, it is important to outline that the micro-launcher company may need to consider the launchpad providers in case it doesn't have its own platform.

In the *table 8.8*, the summary of the building block can be found.

Table 8.8 Access to space key partnerships

Micro-launcher company	Rockoon company
Similarities	
• Space agencies and governments • Research centres and universities • Suppliers • Small satellites developers	
Differences	
• Launchpad providers	-

8.1.9 Cost Structure

The final cost will be defined by all the activities, resources and partnerships previously explained, being divided in different sections. This way, some of the sections where the cost would be more relevant, are:

1 Launching costs:

- Facilities and equipment for the launch.
- Licences, taxes and insurance for doing the launch.
- Fuel and supplies.

2 Development costs:

- Facilities and equipment for doing the R+D and the required tests.
- Team salaries.
- Quality control.
- Licences, taxes and insurance for doing the tests.

3 Operational costs:

- Define the patents for the developed technology.
- Marketing costs of the company.
- Web-platform maintenance.

This way, in the *table 8.9*, the building block is summarized.

Table 8.9 Access to space cost structure

Micro-launcher company	Rockoon company
Similarities	
• Facilities and equipment • Fuel and supplies • Web-platform maintenance • Patents • Salaries • Quality control • Licences, taxes and insurance • Launching cost • Marketing cost	
Differences	
• Rocket manufacturing • Launchpad renting	• Rockoon manufacturing • Balloons maintenance • Recovery • Higher R&D investment

In order to summarise the previous points, a **CANVAS business model** for the **micro-launcher** company and the **rockoon** company has been developed in *figures 8.2* and *figure 8.3*.

MICRO-LAUNCHER COMPANY

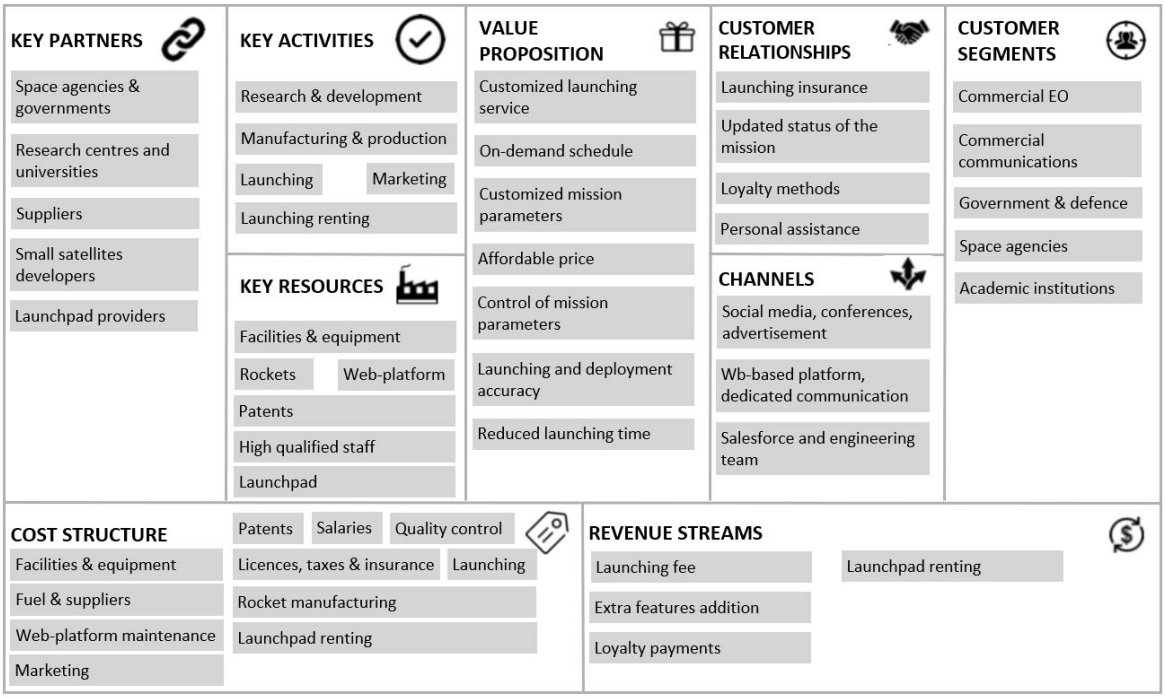


Figure 8.2 Business model canvas of a micro-launcher company

ROCKOON COMPANY

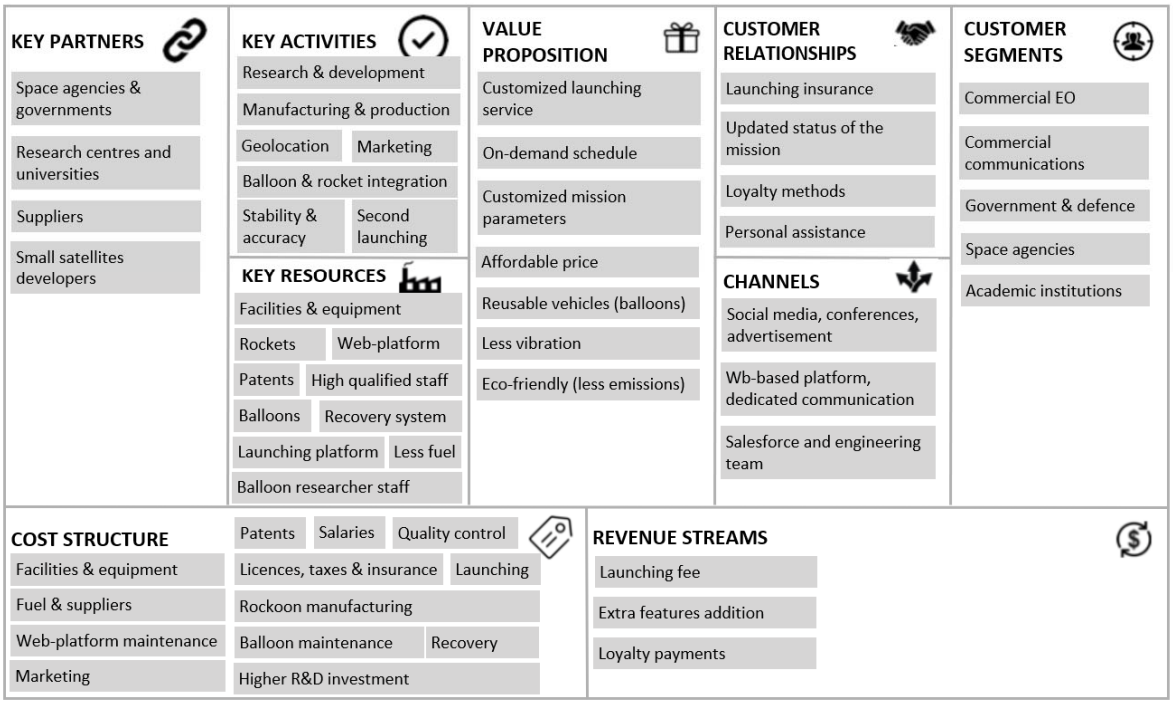


Figure 8.3 Business model canvas of a rockoon company

8.2 Ground Station Services

Ground stations are used to bi-directionally communicate the Earth's bases with the satellite, allowing to transmit commands, receive scientific data and obtain information as the satellite's status or its telemetry. Moreover, as the communication is made every time that the ground station is inside the satellite's signal range, this provokes the need of having a tailored information-storage module in the satellite which accumulates the data between each revisit time.

So, the Ground Station industry supporting EO programmes have experienced an evolution in terms of demand in the last decade. Besides, everything suggests that in the following years the industry will grow some 40% more [17], increasing the number of ground stations due to the high demand on EO data and value-added services.

Hence, in order to handle the challenge of the growth of the EO satellite market, the ground station industry will consider new goals, such as:

- The creation, in new locations, of affordable ground stations specialised in VLEO operations.
- The use of multi-mission ground stations.
- The complementarity of existing resources and the hybridization between physical and digital ones.
- The implementation of the *Electronically Scanned Array* technology, which will be able to track simultaneously several satellites, achieving higher data rates transmission due to the use of the *Ka and Ku bands* [18].

This way, the business model of a Ground Station Services company is studied, extracting the information from [*TFE-15*].

8.2.1 Customer Segments

As the EO-VLEO market is a niche market not yet fully developed, the ground station company may focus in EO satellite operators as possible customers. Hence, expertise should be focused on providing services to those operators included in one of the following EO sectors:

- **Environmental monitoring:** Real-time monitoring of the environment for preparing impact assessments. Outline the fact that the impacts can be caused by natural or human activities.
- **Infrastructure:** Companies specialised in the revision and control of critical facilities.
- **Location Based Services (LBS):** Companies specialised in georeferencing.
- **Natural resources monitoring:** Companies specialised in the preservation of the natural habitat and the analysis of the situation of the most endangered zones.

8.2.2 Value proposition

As the VLEO satellites will have different characteristics than the traditional LEO satellites, it is important to add brand new points to the value proposition list, obtaining:

- **Exclusive infrastructure:** Facilities specialised in managing VLEO missions.
- **Multi-mission bases:** Using Electronically Steered Array antennas for accomplishing the future VLEO demand, providing scalability to the business and being able to manage more than one mission at the same time.
- **New access regions:** Using smart places which will allow to reduce the latency in VLEO operations.
- **Reduce the contact time:** Using higher downlink Ka/Ku-bands frequencies.

- **Enhanced value chain:** Developing an automated, affordable and quality services which are complemented by the use of efficient VAS data.
- **No lost costs:** Implementation of a subscription fee based system.

8.2.3 Value proposition

Regarding the way in which the companies would communicate with the potential clients, the most appropriate way to do so would be to use a combination of direct and indirect channels:

- **Online platform/interface:** The implementation of this direct channel will allow to make all the required operations between the ground station company and the satellite operator, as the capacity of contracting the service or to deliver the necessary information.

- **Capacity aggregators platforms:** The implementation of this indirect channel will also allow the contract of services from the satellite operators and clients. Moreover, it is also possible to deliver the contracted services, mainly data.

- **Website:** The implementation of this direct channel, the potential clients and the general public will be reached. Moreover, it will also provide the gateway to the online platform for the clients.

- **Ground station company commercial/sales team:** The creation of a sales team will allow to capture clients by contacting them either digitally or in person. Besides, it is important to outline the fact that a commercial team will also be created, as it will be in charge of the company's promotion.

Hence, through the stated channels, the evaluation, purchase, delivery of services and after sales phases will be carried out.

8.2.4 Customer Relationships

Customer relationships will be focused on customer fidelity building and they will be managed differently according to the type of client or partner:

- Clients with higher potential revenue production will require personal assistance. Nevertheless, operations will still be completely automated through the ground station company platform, but additional, dedicated, personal assistance will be provided.

- Regular and private satellite operators, academic and non-profits clients will be assisted through automated services, via the company's ground station platform.

Besides, as part of the customer acquisition strategy, in any case there will be the possibility of co-creating the product with the customer until it is determined. Then, the corresponding relationship management presented before will start to be applied.

8.2.5 Revenue Streams

It is considered that the subscription fees will be the main revenue stream of the company. As a result, a monthly subscription will be made for each customer, providing three different levels of subscription, according to the customer needs:

- Base fee:

  This is the level recommended for occasional users, as they will only pay for what they use, not paying in case they have not used the service during the month. It is a service offered through the capacity aggregators, which works as a usage fee for every time that the customers use a

ground station to communicate with the satellites. In this case, no VAS services are included, although the customer's data will be preserved and studied by the ground station company.

- Advanced fee:

  This is the option recommended for the customers that directly book the services with the ground station company. The plan includes the customary VAS developed by the ground station company and a generous number of contacts are included per month, getting different prices for the different total number of contacts included. Outline that the contacts list will be suited depending if the customer is interested in the single satellite operators or the constellation ones.

- Pro free:

  This is the option recommended for the customers which produce a higher revenue for the ground station company due to their ad hoc petitions. Hence, this service will include specific dedicated VAS, aside from the customary ones. Moreover, a price for the service is previously fixed according to the satellite operator's requirements.

8.2.6 Key Resources

The key resources can be split in four groups, getting:

- **Physical:**
  - Central offices and the required facilities to develop the work.
  - Cloud installations, from a key partner.
- **Financial:**
  - It includes the lines of credit to assure continuous operations, especially at the beginning of the enterprise.
- **Technological:**
  - The equipment to make operations with satellite operators possible.
  - The software platform and the interface required for producing the Value Added Services
  - New technologies capabilities as: Artificial Intelligence, Blockchain, Big Data analytics, API, among other.
- **Human:**
  - High skilled technical staff specialised in the required brand new relevant technologies.
  - High skilled commercial profiles in order to promote the ground station company products and services.
  - High skilled UX/UI designers and business analysts to deliver the best experience to the clients and maintain the offer and the value proposition of the ground station company faithful to the reality of the market.
  - High skilled administration profiles, including financial and project managers to ensure the smoothness of the ground station company activities.

8.2.7 Key Activities

As the ground station company will have a platform as main key resource, it seems clear that the company's key activities will be related to continuous development and maintenance of the platform, being the most remarkable:

- **Daily operation of the ground station network:** Related to the normal procedure of the company's projects.
- **Big data management:** Based on the IT activities related to the data processing.

- **IT maintenance operations:** Developed to maintain the company's internet interface (or website) and the data treatment software, which generates most of the VAS activities.
- **Facilities maintenance:** Focused on maintaining the ground station network, mainly their antennas.
- **R+D:** Continuous improvement of the IT services and the data treatment software.
- **Marketing**: Focused on the customer relations and the promotion of the ground station company products and services throughout the VLEO-EO market, finding potential clients and ground capacity aggregator companies.

8.2.8 Key Partnerships

Key Partnerships is an indispensable factor to ensure the companies' success. This way, some possible options are presented:

- **Cloud provider:** A strategic alliance relationship will be stablished in order to develop expertise in the sector, on the other hand the cloud provider could use the platform as a test bench for the implementation of new advancements.
- **Academic (Universities) and/or research institutions:** A strategic alliance relationship will be stablished with this kind of institution in order to keep the employees updated on the technologies used as key resources. In exchange, the institution will be able to access to the ground station company platform and use it as a research asset for the development of new applications of these technologies, as well as to offer to its students learning opportunities linked with the ground station company. Outline the fact that some universities have their own ground station or antenna. Hence, this is also an opportunity to extend the network of the ground station company, as well as to place new antennas in University domains.
- **Capacity aggregators:** A *coopetition* relationship will be stablished as these companies are targeted partners. Hence, the ground station company will be able to manage some of the capacity aggregators' antennas unused time, offering it as own for the ground station company's network.
- **New players**, including a group of innovative dedicated ground station network providers: A partnership will also be done with one of the new players with mission control capabilities in order to be able to offer a more complete value chain.
- **European Space Agency:** As EO represents an important part of the agency's budget, a partnership will be pursued to collaborate on its programmes and gain knowledge through it.
- **Governments:** Strategic partnerships will be sought with Governments of several countries, mainly excluding any Defence related activities. Special focus will be made in reaching agreements with the Governments located in the new access regions.
- **EO big satellite operators:** A strategic partnership will be done in order to develop the VAS they need. Hence, an enhanced optimisation and lower data retrieval latency is obtained for the satellite operators and the final clients.

8.2.9 Cost Structure

The cost structure of the ground station company will be value-driven, as it will focus on maximising the value offered to the customer. This way, some of the sections where the cost would be more relevant, are:

- **Physical:**
  - Equipment and infrastructures ownership.
  - Equipment and infrastructures maintenance.
- **Financial:**
  - Assurance.
  - Interests from the subscribed lines of credit.
- **Human:**
  - Staff resources.
- **Technological:**
  - Administrative software and services.
  - Operations: platform software management.
  - VAS services capabilities management.
  - Cloud services.
- **R+D and other activities:**
  - Researching.
  - Marketing.

In order to summarise the previous points, the CANVAS business model for the Ground Station Services have been developed in *figure 8.4* Obtaining:

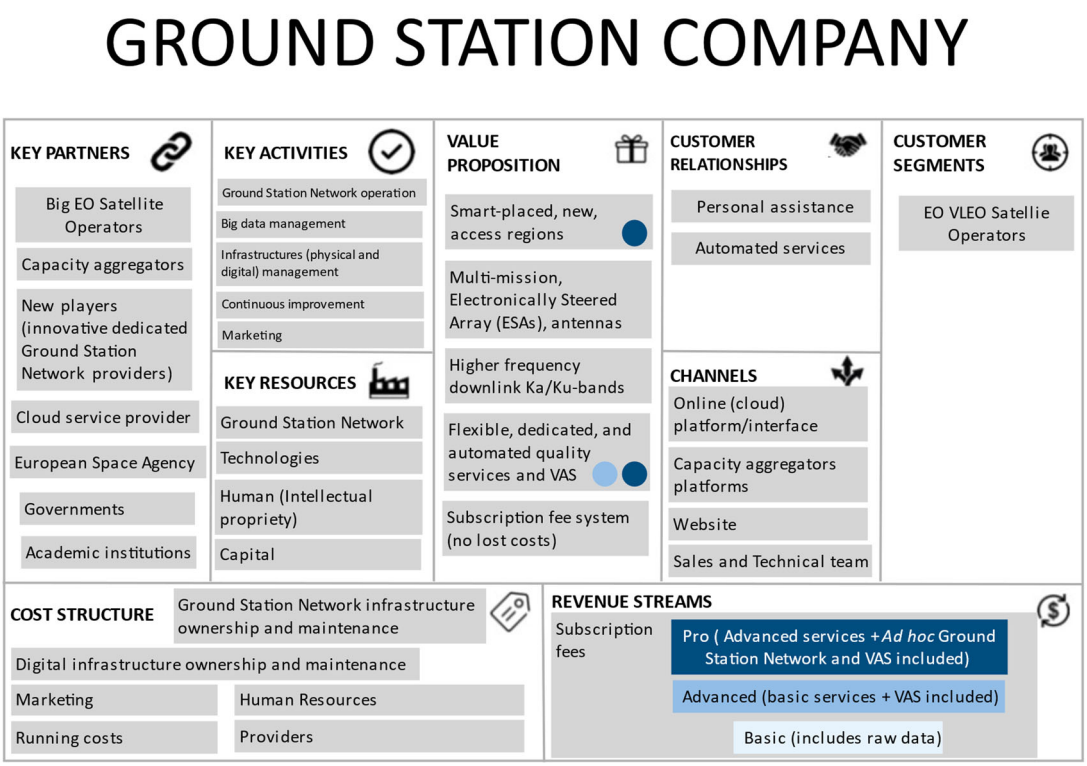


Figure 8.4: Business model canvas of Ground Station Services

8.3 Space Broker Company

The increasing number of satellite missions has given birth to turnkey providers for the preparation and launch part of the value chain of a mission. These are the so called Space Brokers and this chapter will analyse the corresponding CANVAS business model for a Space Broker Company focused on VLEO Missions, extracting the information from [*TFE-16*].

8.3.1 Customer Segments

It is important to outline the fact that the market segments that might be interested in the services that this kind of company could offer do not represent a large spectrum, as the service is focused on a specific and concrete service: launching small satellites into VLEO. Hence, the specific customer segments which may be interested in it, will be defined as ***Niche Market***.

This way, three subcategories of customers might be defined:

- **Research institutions**: Universities and other research institutions which can be interested in the study of the environment variation in VLEO and would potentially launch small satellites to undertake this kind of research.
- **Personal use:** Due to the costs reduction that the *New Space* might reach, individuals could end up being interested in sending their own small satellites into space.
- **Earth Observation**: Mainly targeting those companies which will operate their small satellites inside the VLEO.

8.3.2 Value Proposition

The main points that reinforce the project and that can match with what the potential clients want, are listed in the lines below:

- **Newness:** Achieve and offer a unique service which is focused on a part of the market that does not exist yet.
- **Customization possibility:** Regard the possibility of choosing the launch date and orbit parameter that best suits, offering small prices.
- **Easiness:** In the way that the service could help small companies to achieve their complex needs and speed up the process.
- **Quality and Performance:** By ensuring safe launches and the integrity of the launched satellites in all the phases of the spacecraft's deployment.
- **Environment Issues:** By reducing the amount of space debris which are generated.

8.3.3 Channels

The way which the company communicates with its potential customers, is divided in three parts:

- **Advertising stage**: Some advertising strategies would imply advertisements in different media, with the objective that the company could start settling its name and offer.
- **Direct contact.** It is a crucial stage which tries to convince the customers of making use of the services that the company offers. This way, the contact could be established through direct means. An example could be to provide the potential customers with a demo *SpaceApp* where the potential client could check all the possibilities that are offered.
- **Face to face assistance:** In the final part of the communications, meetings would have to take place in order to define the vicissitudes related to the launching parameters.

8.3.4 Customer Relationships

The communication process consists on directly work and collaborate with the costumer in order to help him with to design its launching strategy. It is important to outline the fact that communication between customers and business is a crucial point of a project's development, which has to be done once that a customer has decided to acquire the offered services. For this reason, devoting personal assistance to each of the customers should be taken into account.

This way, in order to help the client with this process, the development of an app is suggested. Besides, highlight that the app should be designed to provide the customer updated information related to the launching status.

8.3.5 Revenue Streams

At the time that the revenue streams are designed, one issue of a Space Broker company is to be considered, that is the price that the customers are going to pay for the acquired service. It usually will be paid in different fractions according to the features of the satellite which will be launched. This way, the company will charge the clients for a usage fee and therefore, if the client needs to use the service again, a new payment will have to be made.

Hence, it is noticed that the only circumstance that could interfere in this payment would be the fact that the process of launching the satellite ended up in failure.

8.3.6 Key Resources

In order to develop its value proposition, the company will require from a series of Key Resources:

- **Physical resources**: Mainly the communication equipment.
- **Non-tangible resources:** Which includes the communication platform, the assurances and the possible guarantees.
- **Intellectual resources:** Focused on the development of the technology improvements.
- **Human resources:** Being formed by a group of highly qualified employees which can be distributed in different countries, as they would need to communicate with business partners and customers.
- **Financial resources:** Mostly focusing in achieving the necessary funds for accomplish the required budget for developing the project.

8.3.7 Key Activities

Moreover, the main activities that the Broker company would have to perform in order to successfully operate are those focused on the platform networking, the service development and the problem solving considered and explained below:

- **Service production:** It considers the research and investigation in order to offer to the customer updated and high quality services, making agreements with new partners.
- **Problem Solving:** It involves the communication with customers and partners in order to satisfy the client's needs.
- **Platform/Network:** It is formed by different points, such as: Development of the software for constantly having the website updated, company branding, advertisement and the development of a customer's-to-company communication app.

8.3.8 Key Partnerships

Basically, the main partners that a Space Brokers company is interested in having would be the Space Agencies and other private companies that schedule the launches for larger satellites, as they can be potential launching providers. Additionally, other partners that can be interesting to have, would be the other new companies which own micro-launchers.

This way, for this kind of company is critical to have key partnerships, as the number of launchings that they could serve would be related to the quantity of customers which contract its services. Therefore, this sort of relationship would represent a quid-pro-quo situation for both partners.

8.3.9 Cost structure

The final cost will be defined by all the activities, resources and partnerships previously explained, being divided in different sections. This way, some of the sections where the cost would be more relevant, are:

- **Employees:** Mainly considering the salaries of the people who are working in the company.
- **Equipment:** As can be the costs of the facilities and the costs of achieving the required technology, as for example: renting of offices, achieve the required software for the computers, amongst others.
- **Platform:** This point basically is formed by the cost of maintaining the infrastructures and facilities that the company would own.
- **Marketing:** Regarding to promote the company and advertise it.
- **Technology:** Regarding the development of the app and other required software technology.
- **Software maintenance:** Formed by the costs of maintaining the IT services of the company.
- **Assurances and guarantees:** It is necessary to have the company ensured in case of launch failure.

This way, all the parameters previously explained, have been summed up in *figure 8.5*, which represents the CANVAS business model for a Space Broker company that based its operations in VLEO launches.

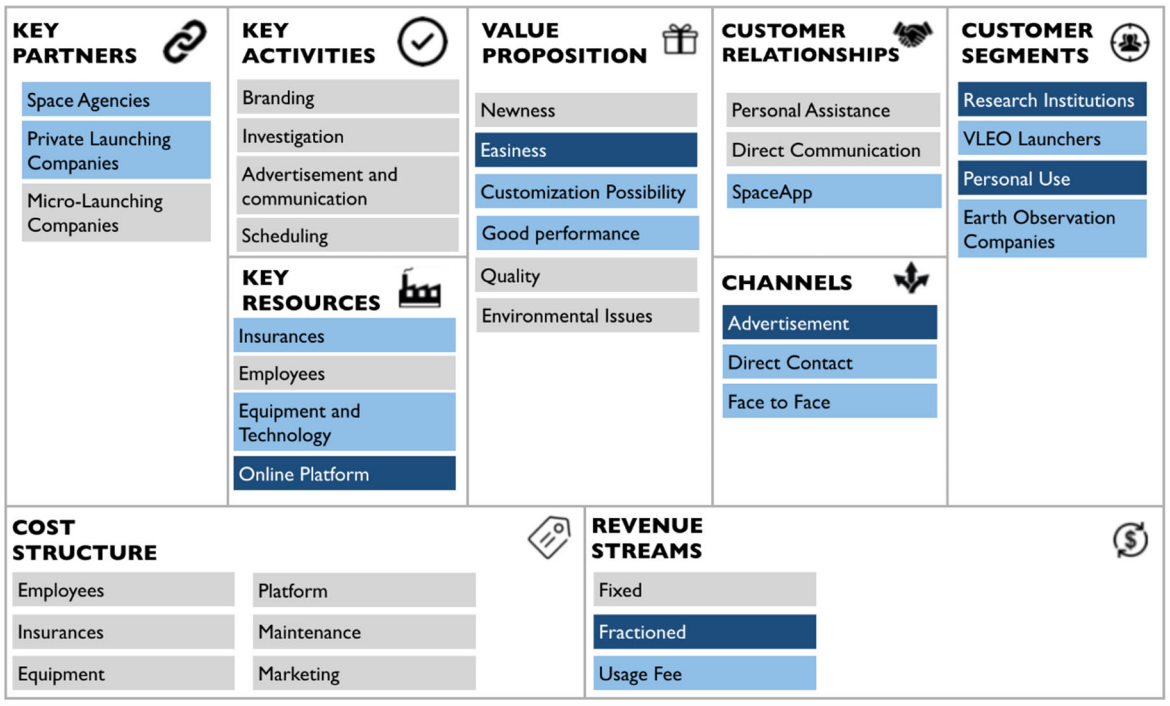


Figure 8.5 Business Model for a Space Broker company

8.4 Very High Resolution – High Performance platform (*Deimos sat4EO*)

As it was shown in section 6, *Elecnor Deimos* is a Spanish company specialised in the sector of Earth Observation which is planning to design a brand new optical sensor that will have a higher resolution than the current ones. Being implemented in a new platform that will be placed at an altitude of 500 km.

Therefore, the initial *Deimos Space's* idea was to launch a mini-satellite at VLEO, achieving a processed resolution of around 30 cm. Nevertheless, after some ups and downs during the process, it seems that the final design would consider a high specification satellite placed in a 225 kg platform at 500 km.

This way, after the success of *Deimos-1 and Deimos-2*, it is considered that the *Deimos* new satellite, (called *sat4EO*), would be smaller, cheaper and more agile than the ones from the competence. So, in order to make this possible, the company is using ESA and EU funds to develop a new Operational Control System (OCS) that will provide all the agility and accuracy that a very high resolution satellite will need.

The presented information and the company analysis are extracted from [*TFE-6*] and [*TFE-13*].

8.4.1 Customer segments

It is important to spotlight the fact that the customer segments that this platform will present, will be really reduced, because of the strict specifications and requirements than the satellite needs to accomplish. Moreover, the possible potential clients should have high standard needs and a large initial capital also reduces the segment's size. This way, the segments identified are:

- **Location Based Services:** Mainly focused on sub-metric targets, such as: Urban development, traffic monitoring, self-driving technologies, among others.
- **Engineering and infrastructure:** Includes the services to monitor rural development projects and big engineering projects, such as power plants.
- **Defence and security:** It considers the projects related to the army and the state protection, including projects inside the field of IMINT (Imaginary Intelligence), surveillance, border monitoring, among others.
- **Disaster management:** Focused on helping and managing disasters after they have happened, by capturing high resolution images of the ravages in order to analyse the Earth's surface and the affected territory, with the idea of having a faster, safer and accurate answer.

8.4.2 Value Proposition

As *Sat4EO* will be a brand new satellite, its main points will be the higher, newer and more accurate specifications that it will present. Outlining the new integrated software (*Deimos 4EO software*) which would allow the client to interact with the platform.

Moreover, taking advantage of the higher resolution that the satellite will present and considering that it is thought to be used inside the Earth Observation sector, the images provided by the satellite are planned to be distributed inside the market at a competitive price, giving also an image value-added service, as the possibility of improving the obtained images with newer post-process, the use of artificial intelligence algorithms, etc.

This way, some of the most relevant specifications that the *sat4EO* presents, are:

- **The very high resolution:** Achieving a 50 cm x 30 cm resolution after the use of the post-processing tools and the newer *Deimos 4EO* software.
- **The spectral resolution at different bands:** panchromatic + RGB (red, green and blue) + Near-Infrared
- **The high accuracy technology:** Basically focused on the OCS technology, which is currently being under development by *Deimos Space* and that will allow to provide the image value-added service using the newer *Deimos 4EO* software.
- **The revisit time:** Which is expected to be less than two days.
- **The swath:** Having an expected field-of-view of 9.5 km.
- **The competitive price:** Which will allow to compete inside the market and engage new potential clients.

8.4.3 Channels

Since the *Deimos'* project requires a large investment, the satellite and its new technology would be highly advertised, with the objective of catching potential customers. Besides, it is important to consider that as the company already had a previous success, the recommendations that the new potential clients could receive of the company will also provoke a decisive impact on making a first contact.

This way, it is thought that the best idea to communicate the potential clients with the company would be to use a fluid and direct channel, using the *4EO* software for allowing the customer to directly interact with the satellite and analyse its images. This way, it is also considered that the developed software can also be used in order to make tutorials and provide examples of already post-processed images in order to convince the potential customers, allowing to clearly show them the different services that the company provides.

Finally, in order to close the deal, the *Deimos Space's* engineering team and sales force would communicate with the customers, through a direct channel, with the idea of defining the last details and complete the transaction.

8.4.4 Customer Relationships

The relationships with the customer would be based in five main points, which take into account all the information defined in the previous stages:

- **Customized service:** The ability of customising the service, allows to obtain an even more specialised service, according with the customer's needs.
- **VAS Customization:** Mainly it considers the value-added service (VAS) that has been previously defined and explained.
- **Quick team response:** Which allow to achieve an instantaneous answer to the issues that might appear. Besides, this point can be considered in all the project's steps, not only once the satellite has been launched.
- **Software licences (4EO software):** Basically, to keep buying images from the *sat4EO*, the client would need to have some software licences which can be renewed along the time. Moreover, the fact of using software licenses would allow to offer different type of licenses (with more or less accessories) accordingly with the client's needs and economic status.
- **Loyalty Bonus:** Similar with the previous point, it is considered that the potential clients may have some loyalty bonus and discounts in order to benefit and encourage the purchase of large amount of images.

8.4.5 Revenue Streams

As the final product that the service offers is the images that the *sat4EO* has taken, it is considered that the main company's revenue stream would be selling those images. Nevertheless, it is important to outline that other possible revenues can be found, dividing them in:

- **Sat4EO images sell:** The economic benefits achieved by selling the images to the customers. Basically is the bigger revenue stream source.
- **Patents utilization:** As the satellite will develop a brand new technology system which will be more accurate than the tools stablished now, it is highly possible than other competitors or research groups may wish to use the implemented technology implemented in the new *Deimos'* satellite, needing to pay for checking its patents.
- **4EO software licence:** As the clients will need subscribing to use the company's software in order to obtain the images and be directly connected with the satellites. Hence, as it was said in the previous chapter, the use of software licenses would allow to offer different type of licenses, increasing the possibilities of getting more economic revenues for this point.

Finally, it is important to highlight the fact that Ground Station Services may also be added, although this study is just focused on the satellite itself.

8.4.6 Key Resources

This way, three groups of resources are needed to carry out for the selling of the sat4EO images:

- **Physical:**
  - The **sat4EO platform** itself with its payload and its OCS system.
  - The **facilities, and the equipment** needed to control and monitor the satellite. Besides, this point must also consider the facilities and the equipment required to previously develop and produce the satellite.
- **Intellectual:**
  - This point includes the new technologies that are being developed by Deimos Space and its partners, which would be patented.
  - Of course, the **4EO software**, which is the main strength of the developed satellite.

- **Human:**
  - As the project that is being developed would be quite complex, Deimos Space will need to involve a **high-skilled staff** which will work in the project, in order to accomplish all the design, operation and post-process phases.

8.4.7 Key Activities

Hence, the activities that must be considered in order to obtain the *sat4EO* images, include.

- **The platform development:** That means the design, production, integration, verification, testing and launching of the satellite.
- **The platform operation:** Which is focused on controlling and managing the platform once it is at the orbit.
- **Data analysis:** Which involves all the process related with the software and the image post processed value-added service offered by the company.
- **Sales management:** Which considers all the marketing process and the main point of selling the images after they have been analysed and post-processed.

8.4.8 Key Partnerships

Moreover, the key partnerships that the *Deimos* will need to produce in order to develop the *sat4EO* project, are:

- **Optical payload manufacturers:** It seems logical to consider them as a main critical partner, because the final resolution of the optical system determines the final performance of the platform.
- **Components and subsystems suppliers:** In order to achieve all the required components for the production of the satellite, regarding to obtain them with a low cost.
- **Launching partners:** In order to book the launch and place the satellite in the desired orbit, as *Deimos* does not have an own launch facility.
- **Ground station partners:** In order to monitor and control the satellite.
- **Data management partners:** Which would facilitate a warehouse, the software development and the maintenance of the satellite's software.
- **Space agencies and governmental institutions:** Which would provide the necessary facilities, resources, knowledge and funds to develop the required technology for doing the project's mission.

8.4.9 Cost Structure

Finally, it is important to outline that the cost structure related to keep the *Deimos sat4EO* operating, would be the sum up of all the activities, resources and partnerships that the satellite requires. Hence, the list of items would be:

- 1. Launching costs:
- Facilities and equipment for the launch.
- Licences, taxes and insurance for doing the launch.
- Fuel and supplies.
- *Sat4EO* operation, monitoring and control until it is at the orbit.

- 2. Development costs:
- Facilities, equipment and resources for doing the R+D of the satellite, its tests and its development and construction.
- The R+D of the *4EO* brand new software and the post processing value added service.
- High-skilled staff salaries.
- Quality control.
- Licences, taxes and insurance for doing the tests.

- 3. Operational costs:
- Define the patents for the developed technology.
- Salaries of the salesforce and engineering team.
- Marketing costs of the company.
- Ground station maintenance.
- Software maintenance and update.

So, in order to conclude, all the building blocks developed for this company are summarized in the business model CANVAS of *figure 8.6*.

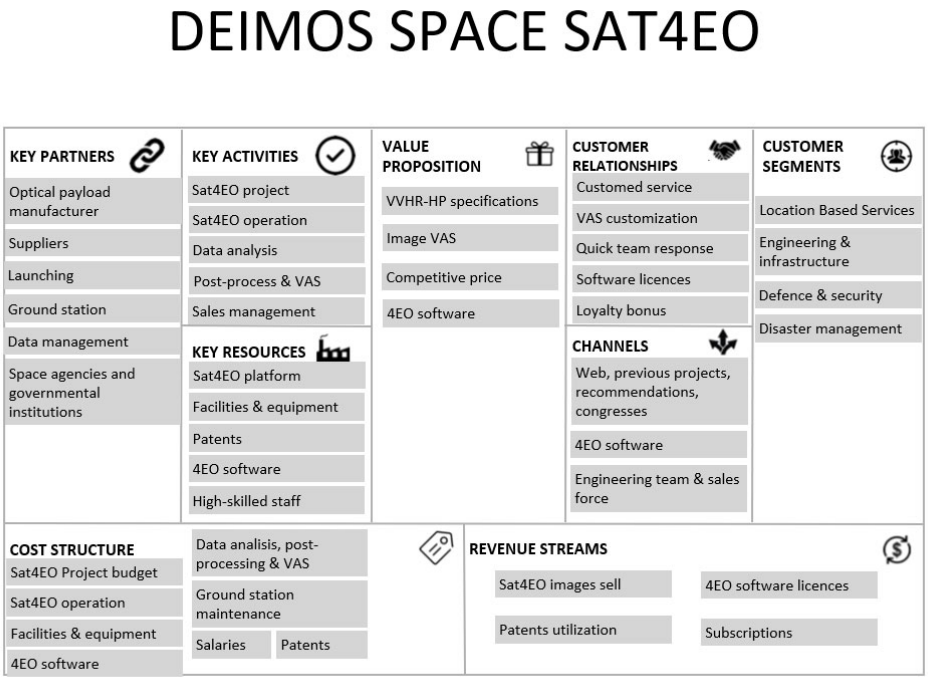


Figure 8.6: Business model canvas of Deimos sat4EO

9 Applying DISCOVERER solutions to the NEW CANVASes

9.1 Applying DISCOVERER technologies to new satellite solutions

This chapter will be focused on describing the *DISCOVERER's* findings in the technology area, which will provide some of the required VLEO satellite solutions. Moreover, it is important to state that the different items included in this section were obtained from various roadmaps included in [*TFE-17*], [*TFE-18*], [*TFE-19*] and [*TFE-20*].

9.1.1 Strengths and weaknesses of DISCOVERER technologies

The following analysis is performed using only the internal factors of the DISCOVERER project and taking into account the technological aspects. The DISCOVERER technologies are divided in three main groups, for which a summary is presented:

Table 9.1 Strengths and Weaknesses of the DISCOVERER technologies (extracted from D5.3 & D5.4)

	Strengths	Weaknesses
Atmosphere-Breathing Electric Propulsion [ABEP]	● Enables long term operation in VLEO (up to theoretically infinite): without ABEP some of those missions would not be possible. ● Potentially reduced launch costs as there is no propellant and tank required. ● Absence of propellant can compensate for ABEP system weight. ● Semi-controlled EoL re-entry possible. ● Enhanced environmental sustainability, compared with standard VLEO missions.	● ABEP technologies are currently in development. ● Limited altitude range of operation. ● System complexity may be increased (including intake). ● Possibly increased manufacturing costs. ● Increased spacecraft power requirement. ● Increased requirement for precise flow-pointing attitude.
Low drag, reduced erosion materials	● Specular or quasi-specular gas-surface interactions enable variation in aerodynamic behaviour based on geometry (i.e. surface incidence to the flow). ● Lower drag (for surfaces at low angle of incidence to the flow) reduces propulsive requirements and increases lifetime. ● Increased lift forces enable enhanced aerodynamic control. ● Increased drag (for surfaces at high angle of incidence to the flow) can contribute to end-of-life deorbit requirements. ● Materials with enhanced erosion and chemical degradation performance have been largely proven.	● Theoretical combined atomic oxygen and specular reflection properties have not yet been fully demonstrated in a relevant orbital environment. ● Possible increases in complexity, time and costs of surface coating, handling, and integration. ● Increased geometric and structure complexity to achieve low-drag benefits.
Orbit and Attitude aerodynamic control	● Takes advantage of the aerodynamic forces and torques. ● Improved satellite control and manoeuvrability. ● Can contribute to the reduction in requirements of traditional attitude and	● Still in early development stages and requires in-orbit demonstration. ● Requires specific design for different spacecraft geometries. ● Dependent on the performance of materials to produce aerodynamic

	orbit control systems with possible benefits to spacecraft mass and propellant requirement.	forces and torques. ● Fuel consumption depending on the flow alignment of the satellite.

9.1.2 System Integration and Benefits of DISCOVERER technologies

System modelling of the technologies developed within the scope of DISCOVERER has been reported in [RD-5.4] and a related paper [21]. In these documents, the system models for the technologies described are implemented within a conceptual design framework. The technologies are shown to have the potential to enable sustainable operations at these lower altitudes. However, given their low technology readiness level (TRL), there is currently insufficient data to forecast the exact benefits that can be provided and the overall system performance that can be achieved.

ABEP

The ongoing development of space propulsion systems is highly relevant to VLEO spacecraft. In particular, efficiency increases of propulsion systems will reduce the power and propellant requirements for drag compensation or mitigation. This way, the article outlines that:

- ABEP systems would enable theoretically sustainable operation in VLEO, limited only by component lifetime.
- Such concepts intend to use a forward-facing intake that collects propellant from the residual atmosphere and utilises it in an electric thruster, eliminating the need for the spacecraft to carry or be launched with any propellant.
- The development of ABEP systems is currently focused on the design of intakes that can efficiently collect the required propellant from the atmosphere under the free molecular flow conditions in VLEO and the development of electric thrusters that can flexibly utilise the range of different atmospheric gas constituents that will be collected and are resilient to erosion or degradation by the aggressive atmospheric components.
- Critical considerations for ABEP thruster development include compatibility and performance under the conditions of changing atmospheric density and composition, for example with the solar cycle or smaller shorter-term variations.
- Owing to the relative immaturity of these technologies, the efficiency of ABEP thrusters is currently lower than that of established electric propulsion types.

Electric Power System (EPS)

EPS architecture for VLEO satellites is likely to be similar to that of conventional orbiting platforms, using solar-arrays as the primary power source with supporting batteries to enable operations during eclipse periods. Nevertheless, the article states that:

- For VLEO satellites with ABEP for drag compensation or mitigation, power requirements are likely to be significantly increased.
- For solar-based power the implication on spacecraft aerodynamics (principally drag) and stability due to the presence of extensive solar arrays must also be carefully considered and captured in the aerodynamic models.

So, given challenges and the high requirements for EPS design in VLEO, the system performance is therefore critical. Consequently, high efficiency solar cells will help to reduce the solar array area and therefore reduce contributions to aerodynamic drag and therefore propulsive requirements. Finally, high specific power of solar arrays and increased energy density of batteries will also contribute to a reduction in system mass.

Aerodynamic attitude and orbit control methods

Methods of aerodynamic orbit control that utilise aerodynamic forces and torques to modify the orbital parameters of a satellite or the relative motion between multiple satellites are also being developed. Hence, the article depicts that:

- Aerodynamics-based attitude control methods include pointing and momentum management manoeuvres that can assist and reduce the requirements on traditional attitude actuators.
- Aerodynamic attitude control can principally be implemented through the use of external control surfaces, though manipulation of the centre of mass may also be used to implement some control of generated aerodynamic torques.
- Aerodynamic trim manoeuvres can also be considered to directly reject external disturbances, for example as a result of variations in the oncoming own direction, solar radiation pressure, and residual magnetic dipole interactions.
- Proposals for orbit control include constellation deployment, formation keeping rendezvous, inclination correction for sun-synchronous orbits, and atmospheric re-entry interface targeting.

System-Level Trade-Offs

In summary, the use of both EP and ABEP for drag compensation has been shown to enable operations in significantly lower altitudes than current commercial EO spacecraft. The benefit to payload design at these lower altitudes principally results in a significant reduction in the total system mass, particularly for optical observation instruments, though this is bounded at very low altitudes by the increasing atmospheric density and drag. The use of drag-reducing materials, enhanced electrical power systems, and increased propulsive efficiency further increase the system performance and enable further reductions in orbital altitude, resulting in spacecraft of even lower mass. This reduction in system mass was also found to correspondingly reduce the system development and manufacture costs, though current cost-estimating relationships were found to be ill-suited for modelling aspects of the novel technologies.

9.2 EO Platform Concepts

As it was seen in *section 8*, the platforms play and important role inside the *DISCOVERER's* goals. Thus, it is important to analyse them, considering the fact that the **main EO platforms system concepts for VLEO applications** are [19]:

- Very High Resolution - High Performance (VHR - HP).
- Very High Resolution - Low Cost (VHR-LC).
- Global coverage.
- Synthetic Aperture Radar Optic (SAROptic).

This way, the first three platforms technologies of the previous list can be classified as passive sensors, while the last one is an active sensor (SAR). It is important to consider that the Coverage and the VHR-LC platforms have been combined into the VHR-LC / Constellation platform. Therefore, we will just focus on three concepts: *VHR-HP, SAROptic and VHR-LC Constellations*.

Firstly, taking a closer look at the **VHR-HP platform technology**, the corresponding GSD of these optical sensors is lower than a meter. Particularly, the optimal resolution commercially available is less than 30cm, which is considered within this platform. Even though, in some countries, it is illegal for commercial purposes to sell imagery with a resolution lower than 50 cm. Due to this restriction, a suitable application for this platform is the defence market, but it will not be considered as only civil applications for the EO satellites are being considered in this project. Besides, some other potential customers are the disaster management sector and the infrastructure market, among others.

Secondly, the **VHR-LC platform technology** has a spatial resolution between 1 and 5 meters (GSD). This type of platform aims to offer extensive coverage of high-resolution imagery at a lower price. Thanks to the use of a satellite constellation the revisit time can be reduced and the collection capacity can be improved, without highly increasing the selling price of the images. Also, the data transmission problem, typical of VLEO, can be reduced. Therefore, the solution of using a small satellites constellation has become more popular, because it is less expensive and more reliable than a single satellite.

Third and according to the ESA's website [20], [22] the **active SAR instrumentation** transmits electromagnetic pulses to the Earth's surface provoking that the onboard system receives then the

backscattering echoes from the ground. Subsequently, the received echoes are transformed into baseband and digitised, calling it Raw Data which is stored in Solid State Mass Memories for a short period, till it is sent to Earth. Finally, once the data has arrived at the ground facility, it is processed by small blocks (due to the memory issues) in range (horizontal) direction and then in azimuth or flight (vertical) direction, obtaining as a result big images or an image mosaic.

It is important to outline that since this technology is an active sensor, it has the main advantage that it still works in cloudy areas or dark conditions. Thanks to that, the SAR instrument can constantly acquire samples under any meteorological conditions [20].

9.3 Case Studies

So, taking a closer look at the operators that are willing to exploit the VLEO for EO, three companies which use the considered platform technologies, are going to be presented:

9.3.1 Planet Labs (VHR-LC/Constellation platform):

Planet Labs is an American company whose goal is to image the entire Earth daily and make global change visible, accessible, and actionable [23]. In this company, the imagery and the global coverage is obtained by optical constellations at VLEO, being the *PlanetScope* constellation the case study considered for the VHR-LC Constellations platform.

This constellation consists of more than 130 satellites (called Doves) whose characteristics are summarised in *table 9.2* extracted from [23]:

Table 9.1 Summary of the technical characteristics of the Doves satellites [23]

Doves overview	
Altitude	475 km
Satellite typology	3U Cubesat
Weight	5 kg
Dimensions	10x10x30 cm
Resolution (GSD)	3.7 m
Spectral resolution	4 wavebands

On the other hand, regarding the whole constellation, the revisit time is daily at nadir, and the imagery collection capacity is of 200M km^2 per day [24].

Lastly, the *Planet* company is focused on analytical products for change detection, rather than the raw image [19]. Particularly, the firm principally focuses on giving insight to the following industries: Agriculture, Education and Research, Energy & Infrastructure, Forestry & Land Use, Government, Finance & Insurance, Mapping, Maritime, Planet Federal and Sustainability [23].

9.3.2 Sat4EO by Deimos (VHR-HP platform):

The *Deimos Space project Sat4EO* is a satellite programme that aims to ensure cost-efficient VHR imagery [25] by using VHR-HP satellites. It is important to outline that it is still in developing terms. Therefore, the mission specifications and the characteristics presented in [*TFE-13*] are still preliminary:

- Sun-synchronous orbit with an altitude between 450 and 500 km.
- The *Sat4EO* is expected to measure 1x1x1.5 m, weighs 225 kg and its expected lifespan is 4 years.

- Spatial resolution: 0.3 m final GSD.
- Passive sensors: multi-spectral and panchromatic (resulting imagery is pan-sharpened).
- Temporal resolution: approximately less than 2 days.
- Geometric resolution: a swath of 9.5 km.

Two Main hypothetical options are being studied:

- To produce the satellite and sell it to a private company. Thus, the main potential customers would be governments and companies that already operate EO satellites but want to acquire new ones with better resolution.
- To become a vertically integrated company which operates their satellites and then sells the processed images. In this case, the potential clients will be big companies or individuals for defence, disaster management, and engineering projects, among others.

9.3.3 Satellogic (SAROptic):

Satellogic is an Argentinian company that offers geospatial insights for various industries, such as agriculture and forestry [25]. In this case, the company uses its SAROptic satellites constellation to obtain an up-to-date picture of the Earth and to provide affordable, high-resolution geospatial imagery and analytics. Furthermore, thanks to the use of the SAROptic system, an uninterrupted coverage can be ensured [25].

Moreover, the total number of in-orbit satellites dedicated to delivering high-resolution data that Satellogic possesses is 14. Thus, Satellogic becomes the EO company which has more in-orbit capacity for high-resolution imagery.

Therefore, the improved specifications [25], [26], [27] of the constellation are:

- HP Earth imagery (0.7m resolution).
- Complete AOI remap every 4 weeks.
- Revisit a specific point of interest up to 4 times per day.
- Three different cameras: multi-spectral, hyper-spectral and SAROptic. Adding, this way, a dimension beyond the visible spectrum of the geospatial data.
- Constellation's collection capacity of 4M km^2/day.
- Register, flag and regulate the satellites.

It is important to state that these new characteristics will not be available until the recently launched satellites are completely positioned and fully calibrated, which is expected to happen at the beginning of 2021.

Considering these characteristics, the *Satellogic* company also offers data analysis to develop VAS related to the obtained imagery. As well, this company counts with dedicated ground facilities. The main purposes and characteristics of these down on Earth facilities are to develop direct tasking from their own Ground Station, to ensure a secure and encrypted end-to-end data download, and that only the operating entity knows the tasked AOI and the obtained data [25].

Finally, the leading customers that this company is focusing on are: Forestry, Agriculture, Energy, Finance & Insurance, Cartography, Critical Infrastructure Management, and Environment [25].

To conclude the section, in *table 9.3* the three case studies are summarised. The items considered are the number of satellites that form each constellation, their orbit's altitude, the spatial resolution (GSD), the imagery collection capacity per day, the revisit time per day and the type of sensor used.

Table 9.2 Summary of the technical characteristics of the three Case Studies

Company	Country	Satellite name	Constellation name	Nº of satellites	Altitude (km)	GSD (m)	Collection capacity (km^2/day)	Revisit time (days)	Type of sensor
Planet Labs	USA	Dove	PlanetScope	130	475	3.7	200 M	1	Passive
Satellogic	Argentina	N/A	Aleph-1	14	475	0.7	4 M	0.25	Active & Passive
Deimos Space	Spain	Sat4EO	N/A	N/A	450-500	0.3	57.600 (per satellite)	<2	Passive

9.4 Business Model Value Proposition CANVASes

The following section will present the proposed Value proposition CANVASes for the three previous case studies once applying the *DISCOVERER* technologies. In this analysis, the final product considered is the imagery gathered by each platform. Also, three existing Business Models will be presented highlighting the variations due to the use of these new technologies.

9.4.1 Business Model for a VHR-LC Constellation Platform

It is important to remember that the final offered product is the processed imagery and data obtained by the constellation.

PERSONA PROFILE

Nowadays, according to *Planet's* website [23], the main customers that buy imagery gathered by the *PlanetScope* constellation belong to the following industries:

- Agriculture.
- Education & research.
- Forest & land use.
- Maritime.

Specifically, in this analysis the client studied belongs to the maritime industry, needing new ways of surveillance overseas areas or to track their vessels. Also, with the *PlanetScope* products, they are able to identify vessels and objects, monitor coastlines and ports, and identify oil spillage, among other options [23].

Hence, the persona profile would be a customer willing to acquire monitoring data of overseas areas. Particularly, maritime ships detection in coastline areas, open waters imagery to see vessels activity, and tracking the company's vessels. This customer will prioritise cost over resolution.

CUSTOMER PROFILE

Once the buyer persona is defined, the next step is to define the customer profile, which consists of the buyer's jobs, pains and gains presented:

- **Jobs**
    - Processed: acquiring the already processed data to monitor the vessels, track the activity in coastlines or open waters, among others.
    - VHR (3.7m): imagery with enough resolution to correctly identify vessels or other objects, as well as, identify for instance offshore oil rigs.
    - Tracking: acquiring data on the location of the company's vessels and being able to take a look at certain marine areas.

- **Pains**
  - Bad integration: the acquired imagery cannot be correctly integrated into the used applications or work programmes.
  - Not updated: the received data is not current or not completely up-to-date.
  - Expensive: the costs of acquiring these products are higher than what can be afforded or not enough profitable.
- **Gains**
  - Adaptability: paying just for the wanted services or products.
  - Innovation: the hired services are not traditional but improve the company's performance, which causes a reduction in costs.
  - Strategy: the acquired data gives daily information about open waters areas, which helps to develop strategies to prevent risks or improve the vessels routes.
  - Historical data: access to older imagery to see the changes in some marine areas, such as climate change effects or how an oil spill affected an area.

VALUE MAP

This side of the CANVAS is formed by the products & services, the pain relievers, and the gain creators. Each one of these items is linked to the customer's profile jobs, pains and gains respectively. Hence, the Value Map is presented in *table 9.4*.

Table 9.3 VHR-LC Constellation Value Map

VHR-LC Constellation Value Proposition CANVAS - Value Map		
Customer link	**Products & Services**	**Description**
Processed	Usability	Offer easy access to the acquired imagery and analysed data. Also, provide the customer with the necessary tools.
VHR	Optical equipment	Resolution of 3.7 m
	DISCOVERER technologies	The use of new materials may help to reduce the orbital altitude whilst still providing a useful lifetime without propulsion.
Tracking	Geolocation	Upgrades in the satellites to geolocate vessels in open waters within an acceptable error.
	DISCOVERER technologies	The use of these technologies improves the satellite's accuracy (ABEP and Aerodynamic Controls) and extends the lifetime of the mission.
Customer link	**Pain relievers**	**Description**
Bad integration	Personalization	Easily integrate the imagery to the customer's company application or format.
Not updated	Revisit time	Short revisit time due to the constellation, which allows almost daily imagery updates.
	Constellation	Thanks to the high number of satellites, the collection capacity is higher and also the data transmission is improved.
	DISCOVERER technologies	These technologies help to maintain the optimised orbit and slightly manoeuvring the satellite if needed (ABEP and Aerodynamic Controls).

Expensive	Democratisation of space	Keep the prices affordable and cheaper than traditional.
	DISCOVERER technologies	Thanks to the application of these technologies the mission's costs can be reduced and more revenues can be provided due to the extended life time.
Customer link	**Gain creators**	**Description**
Adaptability	Customisation	*Planet* offers different products or services.
Innovation	Newness	*Planet* offers a revolutionary product as well as a non-traditional service.
	DISCOVERER programme	This programme researches new technologies that can enable and improve the VLEO satellites.
Strategy	Risk reduction	Thanks to the *Planet's* products certain open water areas can be daily surveilled.
Historical data	Planet's archive	The customer has access to the imagery archive

Once the different profiles and the Value Map are presented, the last step is to graphically represent all the previous information into the **Value proposition CANVAS**. Therefore, the following figure (*figure 9.1*) shows the CANVAS for a possible buyer of the imagery gathered by the *PlanetScope* constellation applying the DISCOVERER technologies.

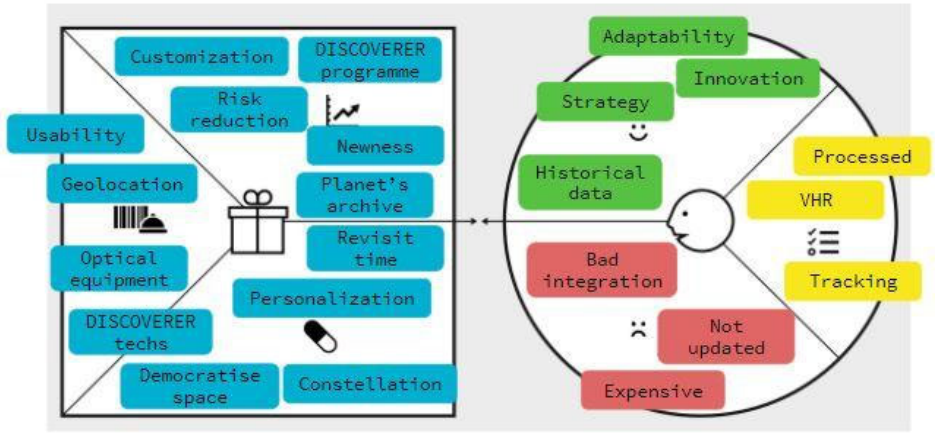


Figure 9.1: Value Proposition of VHR-LC Constellation CANVAS

AD-LIB

To summarise the proposed value proposition, it is expressed following the Ad-Lib template. Particularly, the aspects in which the DISCOVERER technologies have an important effect are highlighted in blue.

"Our PlanetScope imagery helps private firms who want to improve their company's performance by acquiring great resolution imagery at low cost and adding new monitoring and management systems."

ENHANCED CANVAS BUSINESS MODEL

Once the value proposition is developed, the summarised **enhanced CANVAS Business Model for Planet** is presented in *figure 9.2*. It is important to outline that some of the information is obtained from [28], being similar to the CANVAS business model presented in *section 6.1*. Although as this section considers the DISCOVERER technologies analysis, thus some points differ from *figure 6.1*.

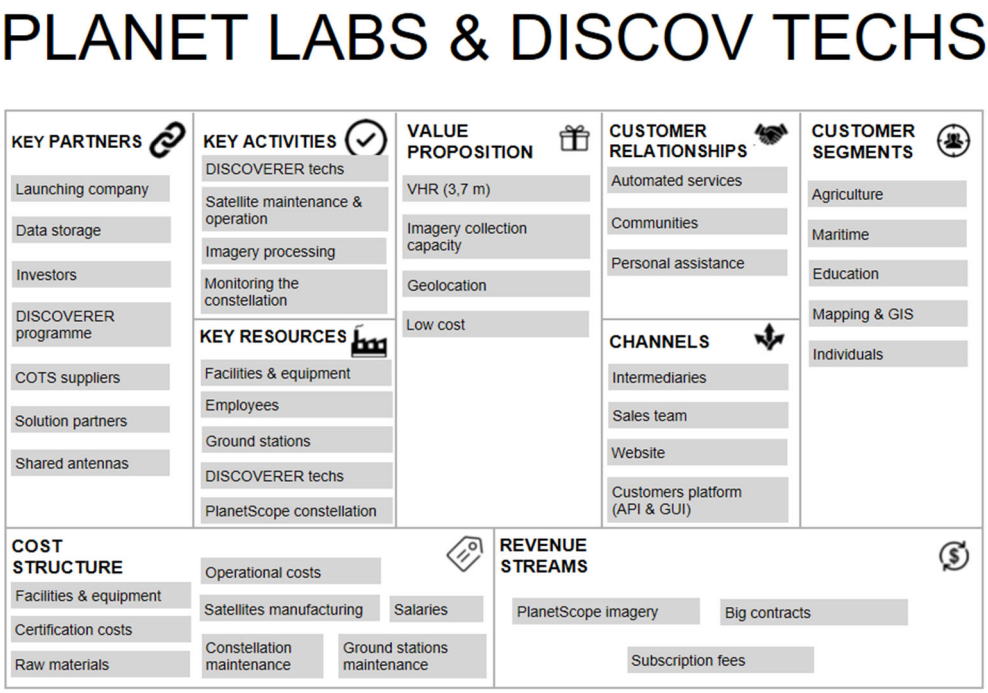


Figure 9.2: Business model CANVAS of VHR-LC Constellation including DISCOVERER improvements

9.4.2 Business Model for a VHR-HP Platform

It is important to outline that the information analysed in order to develop the CANVAS Business Model, was obtained from [*TFE-13*].

Moreover, it is expected that most of the potential customers will belong to big companies which develop engineering projects, due to the fact that they can raise higher investments in order to afford a VHR imagery system. For instance, companies needing LBS or processed imagery of a certain AOI, among other products.

PERSONA PROFILE

Therefore, the persona profile would be a client willing to acquire processed images and data of a certain AOI or of a particular topic. Usually, the needed imagery is of urban areas or big cities. Lastly, this customer will prioritise resolution over cost.

CUSTOMER PROFILE

This side of the CANVAS is formed by the categories defined in the following lists.

- **Jobs**
    - Processing: acquiring processed images which are ready to extract all the needed information.
    - Analysing: along with the imagery, acquire the necessary data already analysed and ready to use.
    - VVHR (<30cm): the acquired imagery has the best resolution possible which helps to correctly identify all the wanted items.

- Accuracy: acquire images of a particular area of interest or gather data of a certain topic.

- **Pains**
  - Lack of data: not enough images or data in order to correctly develop the project.
  - Inoperative: the acquired data does not fit with how the company works or how the data is managed.
  - Not high-end technology: the images are obtained or processed by obsolete or not state of the art technologies or equipment.
  - Overpriced: paying for services that are unnecessary or the prices are too expensive for the offered products.

- **Gains**
  - Sized services: pay just for the services needed.
  - Updated: periodically acquiring new images of the AOI or about a certain topic.
  - Problems solving: customer's assistance whenever necessary and easy to access.
  - Improvement: the best possible product is the one acquired.

VALUE MAP

In *table 9.5*, the three items of the value map are presented, as well as their corresponding customer profile item:

Table 9.4 VHR-HP Value Map

VVHR-HP Value Proposition CANVAS - Value Map		
Customer link	**Products & Services**	**Description**
Processing	VAS	Value added services for processing the raw images.
Analysing	VAS	Value added services for analysing the data gathered by the satellite and obtain the needed information.
VVHR	Optical payload	The payload is an optical sensor with a resolution of 0.3 m
	DISCOVERER technologies	The materials and ABEP allow sustained operation at a lower orbital altitude. Therefore the payload and satellite can achieve the VVHR performance with a smaller mass and volume.
Accuracy	Orbit	The mission is designed in order to target the wanted AOI.
	DISCOVERER technologies	The use of these technologies helps the satellite to maintain the orbit for a longer period and also the satellite is able to better target the AOI.
	OCS technology	Operational control system developed by *Elecnor Deimos*.
Customer link	**Pain relievers**	**Description**
Lack of data	Deimos archive	Possibility of accessing the Deimos imagery archive.
	Revisit time	As the satellite is located at VLEO, the short revisit time helps to target more often a certain AOI.
	DISCOVERER technologies	Thanks to the application of these technologies the satellite may have a better performance in terms of overall transmission and reception of data.
Inoperative	Personalization	Adapt the information format transference in order to fit with the

		customer's format.
Not high-end technology	New technologies	Using the best technology available and updating the equipment when necessary.
Overpriced	Options	The option of choosing and paying only for the services wanted.
	DISCOVERER technologies	Due to the application of these technologies, the overall mission costs can be lower than a repeated satellite substitution along time, leading to more competitive prices.
Customer link	**Gain creators**	**Description**
Sized service	Customisation	The customer just pays for the needed VAS.
Updated	Revisit time	As the satellite is located at VLEO, the revisit time is longer, and the time the satellite is targeting the desired point is shorter.
	DISCOVERER technologies	Due to the use of ABEP and Aerodynamic Controls the satellite targets better the AOI as well as it can maintain the optimised orbit for a longer period. Also, these technologies improve the data transmission.
Problems solving	Interface	Customer's assistance via software and via a platform designed by *Deimos*.
Improvement	Up-to-date	The *Sat4EO* programme staff keeps researching as well as some of the partners.
	DISCOVERER programme	The DISCOVERER project aims at research in brand new technologies that will be applied to VLEO satellites.

Once that the different profiles and the Value Map are presented, the last step is to graphically represent all the previous information into the Value proposition CANVAS. Therefore, *figure 9.3* shows the CANVAS for a possible client of the imagery gathered by the *Sat4EO* satellite applying the DISCOVERER technologies.

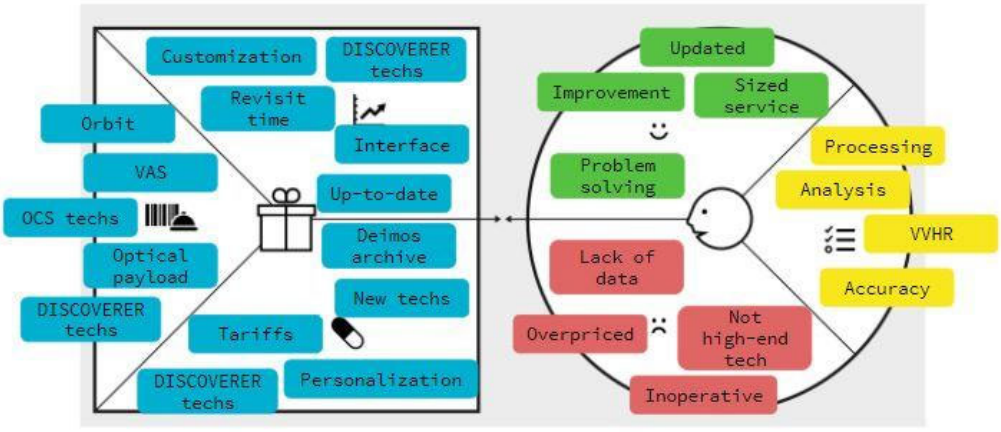


Figure 9.3: Value Proposition of VHR-LC Constellation CANVAS

AD-LIB

The aspects in which the DISCOVERER technologies have an important role are highlighted in blue.

"*Our Sat4EO imagery helps big data companies who want to improve the post-process of the acquired images by avoiding lack of data and promoting sized services at competitive prices.*"

ENHANCED CANVAS BUSINESS MODEL

Once the value proposition is developed, the summarised **enhanced CANVAS Business Model for Sat4EO** is presented. It is important to outline that some of the information is obtained from [*TFE-13*], considering only the DISCOVERER technologies, not the whole *Deimos Space* company. Thus, the presented CANVAS differs from the one presented in *figure 6.5*.

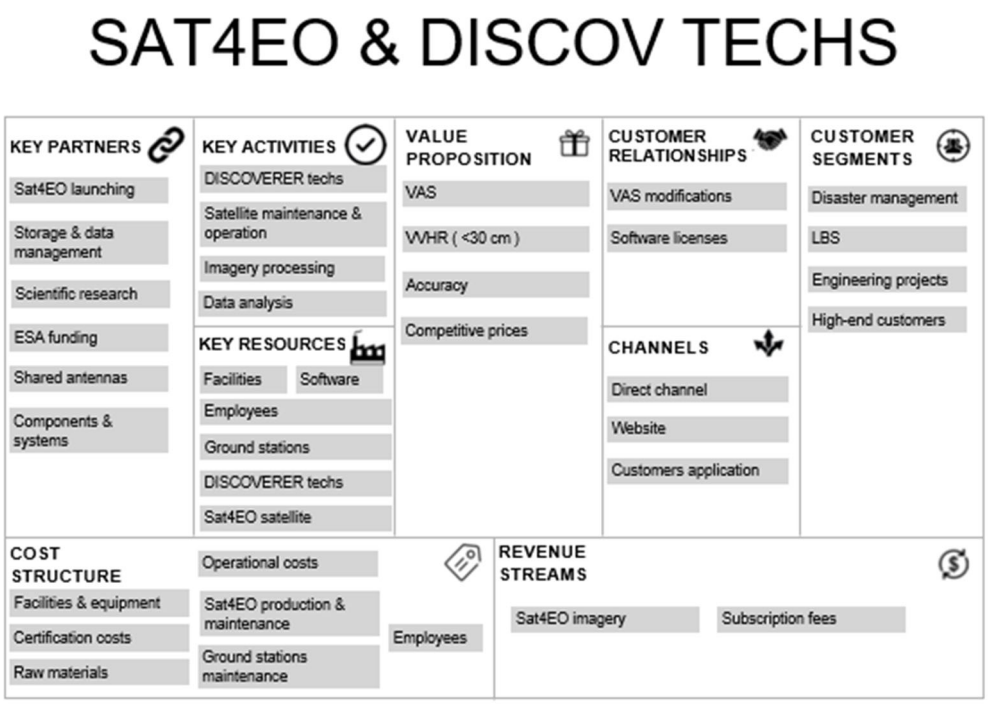


Figure 9.4: Business model CANVAS of VHR-HP including DISCOVERER improvements

9.4.3 Business Model for a SAROptic platform

Emphasise that the final product offered by the company is the processed images gathered by the constellation. Consequently, the Value proposition CANVAS which considers the DISCOVERER technologies is presented:

PERSONA PROFILE

According to *Satellogic's* website [25], the main customers of the company belong to the following industries:

- Agriculture.
- Energy.
- Forestry.

For this specific study, the considered client belongs to a forestry company whose woodlands are located in a country near the North Pole (few sunlight hours) or with a rainy climate (many cloudy days), such as Ireland or Norway.

Moreover, it may need insights for optimising woodland management or stopping illegal harvesting on their forest lands. Additionally, thanks to the *SAROptic* satellites, the company may be able to estimate current forest-stand variables, such as height, volume, and basal area [25], as well as mapping water bodies or testing inundation models [28].

Therefore, the persona profile would be a client willing to acquire processed imagery and data of the company's forest land. Particularly, the customer wants to prevent theft, track the evolution of the vegetation and map near floods, among others.

CUSTOMER PROFILE

In this case, the items analysed are:

- **Jobs**
  - Treated: acquiring the processed imagery in order to obtain the necessary parameters of the owned forest lands.
  - Accuracy: images and data of the company's woodlands and the areas surrounding them.
  - Specificity: the products and services hired gather the wanted information and the necessary specific data.
- **Pains**
  - Delayed: the received data is not updated.
  - Weather conditions: not being able to receive imagery or data during cloudy days or bad weather conditions.
  - Too expensive: the products are overpriced or not profitable enough for the company.
- **Gains**
  - Resolution: acquiring imagery with great resolution, which helps to correctly identify the necessary forest-stand variables.
  - Success rate: being confident of receiving the data when agreed and of being notified when illegal harvesting occurs.
  - Risk prevention: being able to acquire flood mapping if needed.
  - Enhancement: the hired company keeps improving their equipment in order to optimise expenses.

VALUE MAP

In Table 9.6, the items of the value map are presented, as well as their corresponding customer profile item.

Table 9.5 SAROptic Value Map

SAROptic Value Proposition CANVAS - Value Map		
Customer link	**Products & Services**	**Description**
Treated	Machine learning	Due to the use of machine learning algorithms the imagery can be processed to obtain the wanted data.
Accuracy	Constellation	Thanks to the constellation the imagery collection capacity is increased, which also helps to target the AOI.
	DISCOVERER technologies	The use of ABEP and Aerodynamic Controls can enable the maintenance of the satellites in the optimised orbit and, if needed, slightly manoeuvring can be performed.
Specificity	Information	The satellites and the post-processing process can gather the specific data needed by the forestry company.
Customer link	**Pain relievers**	**Description**
Delayed	Revisit time	The satellite constellations located at VLEO can reduce the revisit time, allowing Earth data collection up to four daily revisits of a certain AOI.
	Constellation	Even though it is a small constellation, it improves the data transmission and the imagery collection capacity.

	DISCOVERER technologies	The application of these technologies, added to the use of constellations, improves the satellites' performance in terms of transmission and precision, among others.
Weather Conditions	SAROptic	The SAR camera can gather imagery regardless of the weather conditions or the day/night cycle.
Too expensive	Democratisation of EO	*Satellogic* offers competitive prices.
	DISCOVERER technologies	Thanks to the application of these technologies the mission's expenses are reduced.
Customer link	**Gain creators**	**Description**
Resolution	SAROptic	This combined camera ensures a great resolution (1 m).
	DISCOVERER technologies	Due to the use of new materials the sensor remains in good conditions for a longer period of time.
Success rate	SAROptic	This sensor allows to gather imagery even though it's a cloudy day or during no sunlight hours.
Risk prevention	SAROptic	Some of the applications of this sensor is flood mapping or testing inundation models.
Enhancement	Research	*Satellogic* continues to research and test new technologies.
	DISCOVERER programme	This programme researches to achieve new technologies that will improve the VLEO satellites.

VALUE PROPOSITION CANVAS

Therefore, the *figure 9.5* presents the filled CANVAS for the potential buyer of the imagery gathered by the *Satellogic* constellation (SAROptic) applying all the DISCOVERER technologies.

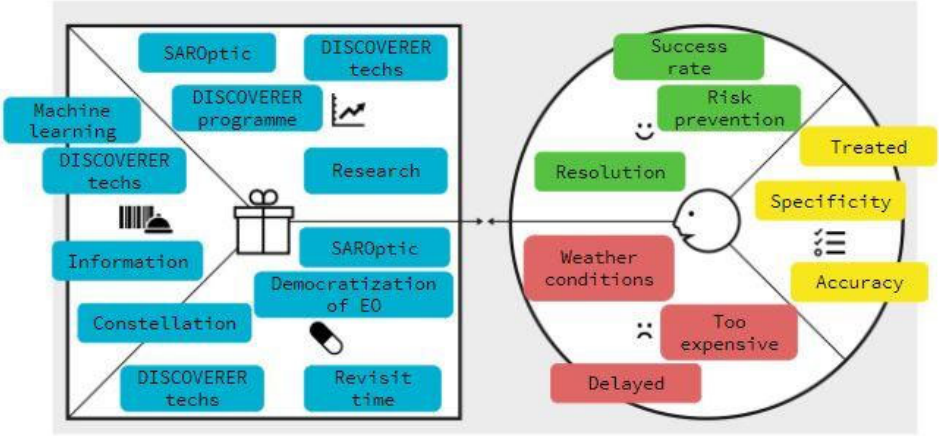


Figure 9.5: Value Proposition of SAROptic Constellation CANVAS

AD-LIB

The Value proposition CANVAS is summarised using the Ad-Lib template. In this case, the features in which the DISCOVERER technologies play an important role are highlighted in blue.

"Our SAROptic imagery helps commercial companies who want to acquire specific information by gathering the necessary data regardless the weather conditions and improving the risk prevention while maintaining competitive prices ".

ENHANCED CANVAS BUSINESS MODEL

Once the value proposition is defined, the summarised **enhanced CANVAS Business Model for Satellogic** is presented. It is important to outline that some of the information is obtained from [17], considering only the DISCOVERER technologies. Thus, the presented CANVAS differs from the one presented in figure 6.4.

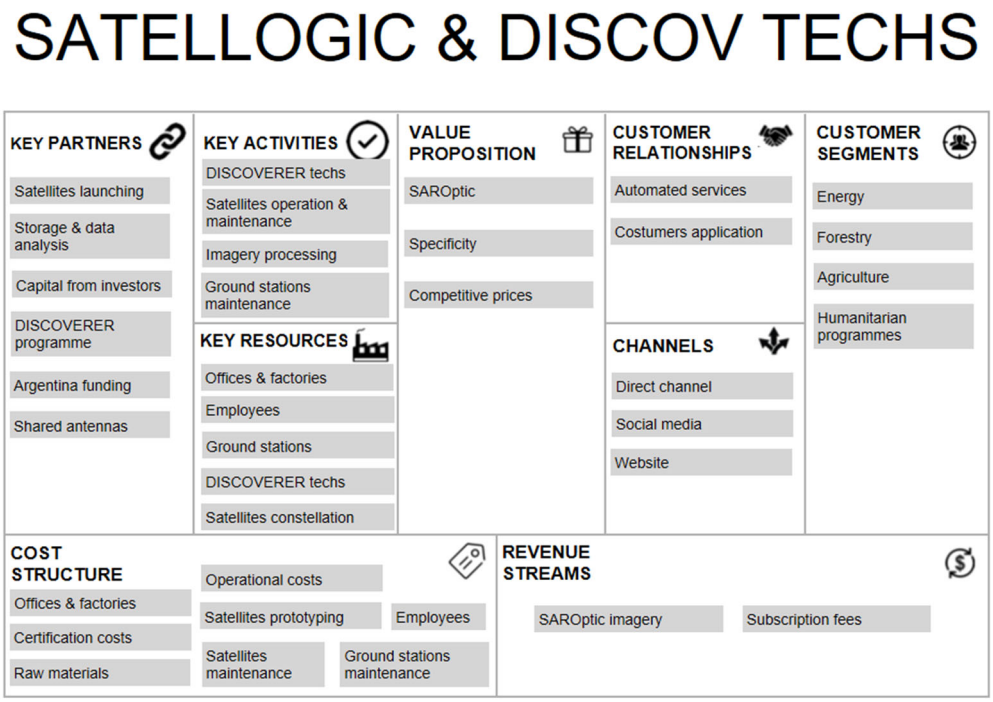


Figure 9.6: Business model of SAROptic CANVAS including DISCOVERER improvements

10 Conclusions/recommendations

This document deepens the work performed along the whole WorkPackage WP5, combining and enhancing the results of the previous Deliverables:

- D5.1 – EO market overview.
- D5.2 – Benefits and applications of VLEO for EO.
- D5.3 – EP market assessment.
- D5.4 – System models of VLEO platforms.

into a set of new Business Models plus some proposal of variation of other existing BM for EO applications.

The existing BM of some of the most representative companies in EO applications have been deeply analysed (*chapter 6*) in order to identify the success factors and patterns that can be extrapolated into the expected new BM. One of the findings after this analysis is a new common pattern “Democratizing Pattern” (*chapter 7*) that is also being implemented in the design of the new BM.

As a result of that, the following BM covering the whole range of identified opportunities of the EO market at VLEO can be found in *chapters 6 and 8*:

- BM for access to space companies.
- BM for new opportunities in the ground segment services.
- BM for space brokers.
- BM for new VHR-HP platforms.
- BM for VHR-LC constellations.
- BM for SAR platforms.

Besides that, in *chapter 9*, the BM for the space segment, are also analysed through the Value Proposition CANVAS (VPC) in order to identify how some of the existing BM can take advantage of the DISCOVERER findings:

- VPC for new VHR-HP platforms, plus DISCOVERER technologies.
- VPC for new VHR-LC constellations, plus DISCOVERER technologies.
- VPC for new SAR platforms, plus DISCOVERER technologies.

The obtained results, combined with the results of other Deliverables of the technological WorkPackages, will be exploited in order to produce two new deliverables:

- D5.6 → Roadmap for the implementation of the DISCOVERER technologies.
- D5.7 → Roadmap for the implementation of the new BM for EO at VLEO.

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11.2 Internal DISCOVERER reference documents.

Ref.	Document Title	Version, Date	Type of document
RD-5.1	DISCOVERER-D5.1 - EO Market Overview	11, 21/03/2018	Confidential
RD-5.2	DISCOVERER-D5.2 - Benefits and Applications of VLEO for EO	01, 30/01/2018	Public
RD-5.3	DISCOVERER-D5.3 - Analysis of New Stakeholders in the VLEO Market	06, 07/05/2020	Confidential
RD-5.4	DISCOVERER-D5.4 - System Models Description of	01, 21/07/2020	Confidential

	VLEO Platforms with Promising Opportunities in the EO Market		

11.3 Internal UPC reference documents

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