



UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH

Escola Superior d'Enginyeries Industrial,
Aeroespacial i Audiovisual de Terrassa



Study of Earth Observation Business Models by means of Business Model Methodologies

Polytechnic University of Catalunya.

Bachelor's Degree Thesis

Bachelor's degree in Aerospace Vehicles Engineering

REPORT

Miguel Ángel Bethencourt Arbelo

Director: Silvia Rodríguez Donaire

Co-Director: Miquel Sureda Anfres

15th January 2020

Polytechnic University of Catalunya.

Higher School of Industrial, Aerospace and Audiovisual Engineering of

Terrassa

Abstract

Higher School of Industrial, Aerospace and Audiovisual Engineering of Terrassa

Study of Earth Observation Business Models by means of Business Model

by Miguel Ángel Bethencourt Arbelo.

The emerging technologies are a reason of evolution. The usage of small satellites have marked the starting point where the Earth Observation sector needs to reconsider alternatives to create business. New trends come with new companies and perspectives, therefor business models need to be analyze to take, from those which remain with successful results, those characteristics that are the keys to ensure the success of a company. This thesis makes use of those tools necessities to analyze those companies and point out at them those characteristics that make them able to be outlined.

Contents

Abstract	2
Signed declaration	3
1. Introduction.	8
1.1. Aim.	8
1.2. Scope.	8
1.3. Requirements	9
1.4. Background	9
2. State of the art.	11
2.1. Earth observation with Small satellites	11
2.1.1. Earth Observation business.	11
2.1.2. Earth Observation forecasting.	12
2.1.3. Earth Observation at Low Earth Orbits and Very Low Earth Orbits.	12
2.2. Business Model	15
2.2.1. Definition of a business model.	15
2.2.2. Business' model composition.	16
2.2.3. Business modeling evolution.	17
3. Business Model methodologies.	20
3.1. The Canvas methodology.	20
3.1.1. How to apply the Canvas method.	21
3.1.2. Business model Patterns.	23
3.2. R. Casadesus methodology.	23
3.2.1. The Casual Loop Diagram.	24
4. Cases of Study.	26
4.1. Spire Global.	26
4.1.1. Spire Global Business Model by means of Canvas method.	27
4.1.2. Spire Global's casual loop diagram Business Model.	30
4.2. GomSpace.	34
4.2.1. GomSpace's Business Model by means of Canvas method.	36
4.2.2. GomSpace's casual loop diagram Business Model.	38
5. Discussion of the results.	42
5.1. Comparison between both companies	42
5.2. Business Models Patterns.	45
5.3. Business Models Key Factors.	46

6. Conclusions.	47
7. Environmental study.	48
8. Bibliography.	49

List of figures

Fig.1 Satellite launch history & Market forecast.[6]	9
Fig.2 Satellite application trends.[6]	10
Fig 3. ISRO Small Satellites [5].	11
Fig.4 Evolution of Spatial Density altitud profiles in LEO. [10]	13
Fig 5. Literature overview of the business model research field. extracted from [6].	18
Fig 6. The Business Model Canvas, Extracted from [1].	20
Fig 7. Canvas divided by groups, adapted from[1].	21
Fig 8. Competitive Process Framework, adapted from[11].	24
Fig.9 Small Satellite LEMUR Extracted from [7]	26
Fig. 10. Spire Global's Business Model Canvas adapted from [1].	27
Fig 11. Spire Global's Casual loop diagram, adapted from [11].	30
Fig 12. Virtuous cycles at Spire Global's casual loop diagram, adapted from [11].	33
Fig 13. NanoCam C1U. [8]	34
Fig 14. GomSpace's flight test program overview[8].	35
Fig 15. GomSpace's Business Model Canvas adapted from [1].	36
Fig 16. GomesSpace's Casual loop diagram, adapted from [11].	38
Fig 17. Virtuous cycles at GomSpace's casual loop diagram, adapted from [11].	41
Fig.18 Main characteristics of Spire Global's Pattern.	45
Fig.18 Main characteristics of GomSpace's Pattern.	46

List of tables.

Tab 1. Blocks addressed in business models. Extracted from [16].	16
Tab 2. Patterns overview and brief description, adapted from [1].	23
Tab 3. Categorization of the choices from Spire Global's diagram.	31
Tab 4. Categorization of the choices from GomSpaces's diagram.	39
Tab 5. Main characteristics of both companies shared in common.	44

1. Introduction.

1.1. Aim.

This study has as purpose to synthesize the theory of the Business Models of A. Ostelwalder [1] and the J.E Ricart & R. Casadesus [2], with the objective of applying those methodologies in two cases of study, the firms Spire Global and GomSpace. Both of them related with the Earth Observation Business. Finally, extracting the key factors from each firm and comparing them in order to find similarities with the Models' Success Factors.

1.2. Scope.

The scope of the study includes the following contents:

- Synthesis of the Business Models Definition.
- Comprehending the A. Ostelwalder's Canvas methodology.
- Comprehending the J.E Ricart & R. Casadesus methodology.
- Study of the Business Model of Spire Global by means of the Canvas methodology.
- Study of the Business Model of Spire Global by means of the J.E Ricart & R. Casadesus methodology.
- Study of the Business Model of GomSpace by means of the Canvas methodology.
- Study of the Business Model of GomSpace by means of the J.E Ricart & R. Casadesus methodology.
- Comparing the results from the models observed by both methodologies between the firms.
- Standing out the key success factors from the Business Models applied at each company, by means of J.E Ricart & R. Casadesus methodology.
- Standing out the patterns observed at the Business Models applied at each company, by means of Canvas methodology
- Proposing recommendations at the key factors for a Business Model if any firm is considerate in need of one.
- Proposing a new definition of a pattern for a Business Model if any firm does not match with an already defined one.
- Environmental impact of the study.

1.3. Requirements

In order to accomplish the scope, some requirements are taken into account:

- The firms chosen to be analyzed have to be into the activity of the Earth Observation.
- The satellites that will be included at this study will be only small- satellites, as nano/micro-satellites.
- The activity of the devices used by the companies must take plane between LEO (Low Earth Orbits) and VLEO (Very Low Earth Orbits).
- The analysis of the Business Models will be defined by the aspects treated at the Canvas and Casadesus methodologies.
- Only current Business Models of the firms are considered. Past and in development methodologies are not considered.

1.4. Background

Smallsats' industry is growing exponentially, since the ends of the seventies, when all started with some academic organizations interested in designing and building their own satellites. With the development of knowledge and innovation at engineering this trend reached the creation of the Cubesat standards in 2001^[2]. Besides, as this field was expanding, the market interests and business opportunities did it too. The use of low-weight satellites bring to the Earth Observation business a new possibility to increase its efficiency and the number of missions per year that it can afford.

It is obvious that, as the technology has been improved, the associations that build small satellites have been able to increment the number of devices launched per year, and also the amount of these firms is larger each year.

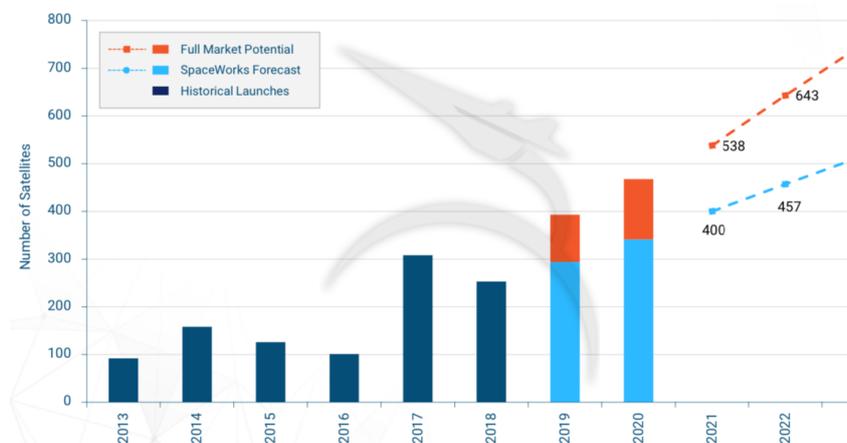


Fig.1 Satellite launch history & Market forecast.[6]

Any firm that actuates into this market will suffer the fluctuations caused by their own decisions and the interactions from the rest of the companies that are immersed in it. Besides as a growing sector, SpaceWorks' estimations indicate that around 2800 nano and micro satellites will be prepared to be launched in the next five years [4], and the majority of them will be purchased from Commercial Operators. A fact that indicates the wide variety of firms that can appear in these five years.

In addition, Earth Observation Business is predicted to continue being the major application of the cubists, as it can be observed in the next figure:

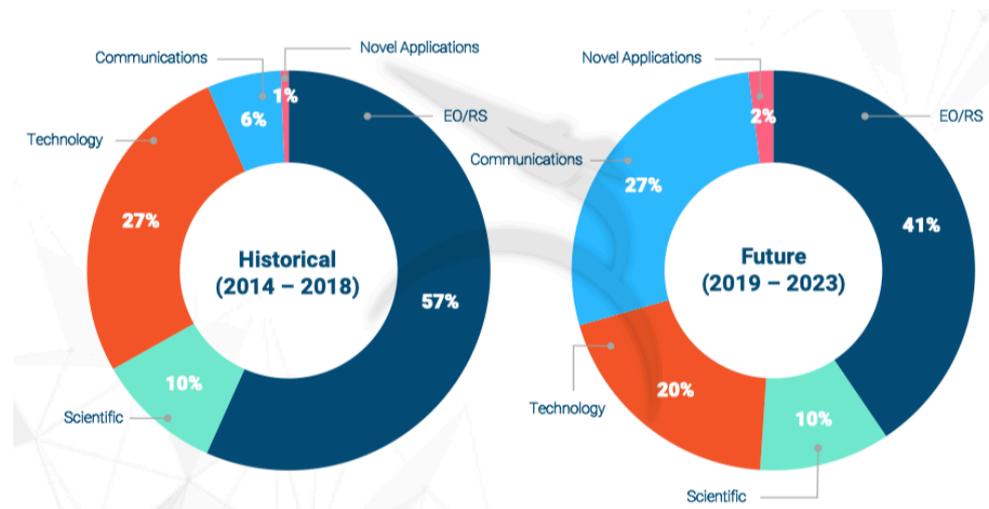


Fig.2 Satellite application trends.[6]

The overview shows a business that has been changing from its beginning, and it will be in a continuous fluctuation, so, every firm that actuates on it will need a business model that can adapt itself to this changes without modifying the basic strategy, only tactical choices will be done if it is necessary. On the other hand, the case of a complete change of perspective can be possible too, justifying the comparison between the business models of the firms, and their resultant key factors; and the theoretical business models treated in this study.

2. State of the art.

2.1. Earth observation with Small satellites

2.1.1. Earth Observation business.

Since the launch of the Sputnik in 1957, added to the situation given by the space race, the need of knowledge and exploration brought new challenges and opportunities, one of them, the observation of our own planet from a distant perspective. The fact is that satellites, as new technologies emerged, became multidisciplinary tools. Now satellites, besides earth observation, afford communications in a global scale, scientific testing and data collectors devices, military usage, etc. Small satellites have become such a sophisticated technology that a place into the space market, and now the expectations bring good news for them.

The Earth Observation business is about to change. Until now governments and private companies had to invest a large amount of money to put only one satellite in orbit. The principal reason to this cost is that this devices weight thousands of kilograms, and assume almost all the payload able in a rocket. So having in mind all the costs of an operation to send a device to a specific orbit and the fact that the weight limits the number of satellites to one per launch, now small satellites bring the solution. Their weight is between 1 and 10 kilograms and at one launch it is possible to send a constellation with hundreds of this devices. A constellation is a group of sats that usually work together to reach one mission, and furthermore this large number of satellites permit more opportunities to expand the number of missions and the success of this ones.

Now a days this technology is currently reaching missions with constellations of hundreds of smallsats. As an example extracted from “*The NewSpace Revolution : The emerging commercial space industry and new technologies*” (Reference [5])

*“...in February this year, the Indian Space Research Organization (ISRO), put a record 104 satellites into orbit from a single rocket, 88 of which were from Planet, each weighing just 5 kg
It packed in 48 doves on a Soyuz trip on July 14, making it the owner and operator of the largest fleet ever put in orbit — 197 in total, enabling it to photograph every inch of Earth’s surface every day.”*

At the following image we can see the dimensions of this devices.

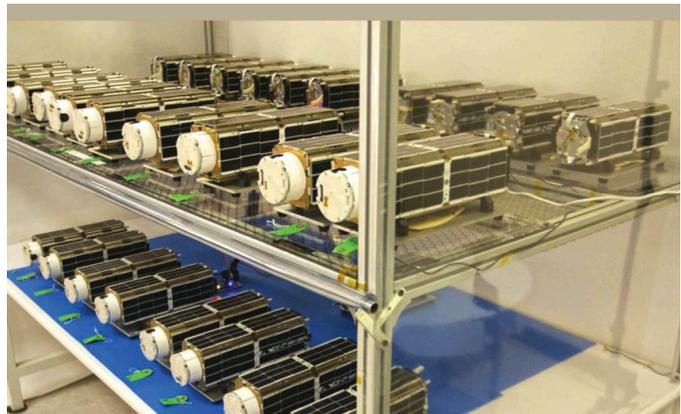


Fig 3. ISRO Small Satellites [5].

2.1.2. Earth Observation forecasting.

The Figure 2^[6] shows that in future trends, the major sector of application will still be the Earth observation business. In addition, as it is observed at the Figure 1, the number of small satellites will increase every year. Therefore, new firms are starting to appear at this sector, and so the governments and spacial agencies try to develop and invest in this new technologies. The article “*Status and trends of Smallsats and their launch vehicles*^[3] talks about a revolution:

“According to Naumann (1995), in 1995, Euroconsult identified 280 – 320 Smallsats for the following 12 years; the ELSA database revealed 417 Smallsats launched in that period. Only in 2014, 181 Smallsats were launched. Such an evolution may suggest a Smallsats revolution...”

The author insists that it has been possible thanks to some relevant aspects given by the utilization of smallsats, for example:

- Small satellites enable to do cheaper and faster testing for new technologies
- Their short life cycle and simple architecture leads to more frequent missions and a constantly upgrading technology
- The usage of standardization that simplifies the accessibility of this technology, as the Cubesats.

In consequence, the usage of small sats into the earth observation business has brought a large number of opportunities to innovate into this market, expanding it from only optical observation to expected future trends as hyper spectral, SAR, life video... diversifying the possible business targets of this market.

2.1.3. Earth Observation at Low Earth Orbits and Very Low Earth Orbits.

Potentially the Earth Observation business could increase the success of the firms immerse into it by lowering the altitude of operation. Lower orbits could bring some benefits as the missions would smaller and cheaper devices or simplifying the missions, leading to increase the number of them. In the other hand, new challenges will come.

Benefits.

• Increased Resolution.

Usually if it is wanted to increase the quality of the images obtained form an EO satellite it implicates a larger optic. The bigger optics suppose significant cost implications and a heavier payload.

Reducing the altitude of operation implies bigger resolution without changing the optic, because the subject of the image is closer, as simple as that.

- **Faster latency**

As the satellite is closer to its source, the radiometric performance is improved, as the power density of the signal is proportional to the distance from its source, it is showed at the following equation:

$$P\alpha[1/r^2] \qquad \text{Eq 1. Extracted from [10]}$$

As consequence, less sensible devices will be needed and the control of the device will be the same but implying lower costs.

- **Increased Payload mass**

To put in orbit a device in a LEO or VLEO requires less power allowing a major payload capability. Using simpler launchers and the low weight of the Smallsats increase the number of devices that can be sent, implying in just one mission a constellation of smallsats with the same PL in all of them.

- **No De-orbit required**

The lifetime of a device in an orbit between 600-700km could reach 78 years, but the operational time of itself could be shorter, ESA recommendations state that an inactive spacecraft should be deviated form its orbit within 25 years. In the case of VLEO missions the lifetime does not go further than three years and it will not be necessary to deviate because itself will suffer a reentrance into the lower atmosphere.

- **Geospatial position accuracy**

The mission would take place in a shorter distance from the objective, making it able to have more accuracy.

- **Lower Risk of collision with spacial residues.**

These orbits have not been used in the last 20 years as much as the ones comprehended into 700 and 1000 km, so predictions stipulate that residues from other space missions will not carry any problem. The population of residues in VLEO will not increase, meanwhile higher orbits will have big risks, making VLEO missions an optimum alternative, the next figure shows this forecasting.

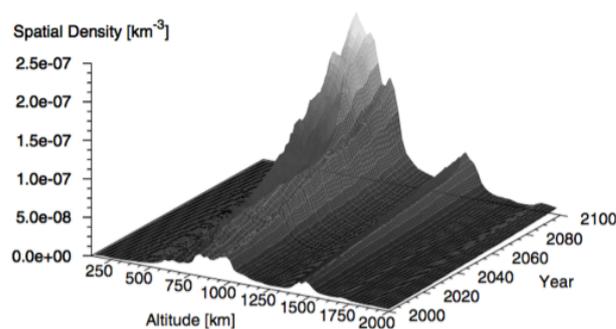


Fig.4 Evolution of Spatial Density altitud profiles in LEO. [10]

Challenges

- **Aerodynamics forces.**

The devices will be subjected to aerodynamics forces due to the final layer of the atmosphere in those orbits. The drag force will be the dominant one, decelerating the satellite and making it loose kinetic energy, reducing its lifetime. Usually, a propulsion system will relieve this effects, but this solution implies more weight. So the study of this forces leads to develop more efficient designs in order to reduce the propulsion requirements. Also aerodynamics forces creating torques, generating new problems to control and in the other hand a possible solution to study, using those torques to stabilize the satellite once it has been launched.

- **Reduced Communication Windows.**

As the altitude decreases, the time it passes above the ground station does too, so the time needed to download the data from the satellite is shorter than a common satellite's. This leads to different alternatives to study. Using higher bandwidth communications systems that allow a larger data transference in the same time. Cooperating with geosynchronous orbit spacecrafts transmitting the information through them.

- **Atomic oxygen erosion.**

Atomic oxygen is highly reactive and is the main constituent of the atmosphere in VLEO, it could be very corrosive and interacts with sensors and thermal coating. There is a need to develop new designs with different materials resistant to this species.

2.2. Business Model

2.2.1. Definition of a business model.

Answering the question *What is a business model?* is not possible to summarize in a paragraph with a simple idea. The meaning of that term depends on lots of aspects. The most relevant one is the field where it is being applied (marketing, engineering, science...). And also, the time when it is applied. Now a days the companies usually work in a worldwide market where the interactions between them have more influence than they did fifty years ago. As the market gets bigger and more companies are born every year, the meaning and the relevance of business models fluctuates.

At the book "*The business model: theoretical roots, recent developments and future research. C. Zott.*" Reference [11] there is a table at page number 6 (Table 2) that summarize different definitions of Business Model related to different articles from 1998 until 2010, were is possible to see how this concept has been treated from different perspectives but with some common ideas.

Therefore, the ambiguity of this concept could be a problem at the moment of developing a study of this nature, so it is considerate to give the definition of it by both methodologies that will be used at this study and extract from them the root idea.

Canvas Methodology:

"A business model describes the rationale of how an organization creates, delivers, and captures value."

A. Ostelwalder^[1]

Casadesus Methodology:

"Business Model refers to the logic of the firm, the way it operates and how it creates value for its stakeholders"

Ramon Casadesus-Masanell^[1]

The Ostelwalder method takes the concept of a business model to a structural field, taking as base the organization of the firm, creating the Canvas method with predefined concepts that will compose the model. Nevertheless, Casadesus proposed a strategic view of this concept with the intention to apply the Causal loop diagram in order to see how choices and interactions will take an important plane in this definition.

As a conclusion, independently from the moment, the way or the market where a business model, generally every methodologies conclude into a way to create values and get profit from them.

2.2.2. Business' model composition.

Creating a Business Model is not a task that follows a unique kind of instructions and so it develops a common methodology for a specific sector of firms. The large amount of methods, which intend to be the base of the creation of the strategy, jointly with the characteristic of the firms and the market where it actuates, help to develop a model that adjusts to the necessities of each firm.

Certainly, besides it exists such a big variety of models, there will always be some common terms and concepts that every model will have to deal with. For example the customers, resources, revenue, values... Both of the studies treated at this research make use of this concepts in their models but in different ways, as we will see in a deeper way at the section 3, the A. Ostelwalder methodology constructs the Canvas diagram using nine "blocks of construction"^[1] including these main elements as base. At the other hand, Casadesus, divides all these elements that build a business model in two big groups, the concrete choices and the consequences of this choices. And also subdivides this choices into three minor groups: policies, assets and governance structures. Designing a complete different vision from Ostelwalder's model, while this treats a more theoretical part of design and structure, Casadesus develops a practical strategy for each stage in which the firm could be immersed.

At the following table shows how different concepts were frequently used to describe a business model by different authors. Looking at the rows of the table below it can be seen how the different treatments of the same concept from each study are summed up at the blocks of the Canvas, giving a general idea of how to create business model.

Business model ontology	Stähler 2001	Weill and Vitale 2001	Petrovic, Kittl et al.	Gordijn 2002	Afuah and Tucci 2003	Tapscott, Ticoll et al. 2000	Linder and Cantrell 2000
Value Proposition	value proposition	Value Proposition, strategic objective	Value Model	Value offering	Customer Value		value proposition
Target Customer		Customer Segments		Market Segment	Scope		
Distribution Channel		Channels	Customer relations model				channel model
Customer Relationship			Customer relations model				commerce relationship
Value Configuration	Architecture		Production Mode	e3-value configuration	connected activities, value configuration	b-webs	commerce process model
Capability		Core competencies, CSF	Resource Model		capabilities		
Partnership	Architecture	e-business schematics		Actors	sustainability (team-up strategy)	b-webs	
Cost Structure				Value exchange	cost structure		
Revenue Model	Revenue Model	Source of revenue	Revenue Model	value exchange	pricing, revenue source		pricing model, revenue model

Tab 1. Blocks addressed in business models. Extracted from [16].

2.2.3. Business modeling evolution.

One thing is obvious, Business Models are essential to guarantee the success of a company, but when did the business models become such an indispensable resource?, and why did they do?

If we observe the concept of business model from the perspective of fifty years ago there was no need to develop a methodology, the medium size company reached a certain area, mostly locally, and there was only a few of competitors in it, but this all changed. With the growth of the market now firms can be affected by companies based at the other side of the world, and the customers are also change to a global scale. Looking back, there have been some agents or events that create such a need of renovation, as internet and the development of new technologies, the globalization or market deregulations[11]. These changes bring with them new needs to the companies immersed in them.

“Business model was one of the great buzzwords of the Internet boom... A company didn't need a strategy, or a special competence, or even any customers– all it needed was a Web-based business model that promised wild profits in some distant, ill-defined future. Many people–investors, entrepreneurs, and executives alike– bought the fantasy and got burned.”

Why Business Models Matter. J. Magretta [16]

And as the market was growing the companies had to compete into more difficult situations and with a larger number of competitors. Since 90s, when internet and the e-business started to emerge, a whole new perspective of business was born. At first new ideas to conform the companies and their operations try to answer the questions of Who are my clients? What do they value? and How can we generate revenue by offering what they expect at an appropriate cost for the company? (Adapted from [4]). But there was not a connection between these ideas until the concept of business model came out in the literature of management and strategy in order to give a standardization to all this concepts.

As an example of this trend:

“Since 1995 there have been 1,177 papers published in peer-reviewed academic journals in which the notion of a business model is addressed.”

The business model: theoretical roots, recent developments and future research.

C. Zott[12]

In this two decades the number of publications with studies of business models has increased, and changed their orientation. With the boom of internet the first decade since 1990, the business models focused their methodologies into the technological market, in this decade firms like IBM, Apple, Microsoft started a new trend, the electronic business tooked the first place at the global economy. Then from the early 2000s these publications try to understand how companies worked and tried to develop methods of organization and strategy, expanding this field of study.

The figure that follows, extracted from “*Business Models: Origin, Development and Future Research Perspectives Bernd w. Wirtz (2016) [6]*” shows in a time line how this trends were developed in this two decades.

	1975	1997	1999	2000	2001	2002	2003	2005	2007	2009	2011	2013		
Technology-oriented	<ul style="list-style-type: none"> Konczal Dotlore 	<ul style="list-style-type: none"> Shaw Timmers 	<ul style="list-style-type: none"> Bambury 	<ul style="list-style-type: none"> Amit/Zott Eriksson/ Penker Wirtz 	<ul style="list-style-type: none"> Amit/Zott Applegale Gordjin/ Ackermans Papakiria-kopoulos et al. Hawkins Petrovic et al. Rappa Rayport/ Jaworski Weill/Vitale 	<ul style="list-style-type: none"> Bienstock et al. Dubosson-Torbay et al. Eisenmann McGann/ Lytinen Osterwalder/ Pigneur 	<ul style="list-style-type: none"> Wirtz/ Lihotzky 	<ul style="list-style-type: none"> Afuah/ Tucci Wang/ Chang Hedman/ Kalling 	<ul style="list-style-type: none"> Pateli/ Gigalis Rajala/ Westerlund 	<ul style="list-style-type: none"> Haaker et al. Kallio et al. Rappa 	<ul style="list-style-type: none"> Eriksson et al. 	<ul style="list-style-type: none"> Andersson/ Johannesson/ Zdravkovic Björkdahl Clemons Tankhiwale Zott/ Amit 	<ul style="list-style-type: none"> Gambardella/ McGahan Sosna/Trevinyo-Rodriguez/Velamuri Wirtz/Schilke/ Ullrich 	<ul style="list-style-type: none"> Huang
Organisation theory-oriented		<ul style="list-style-type: none"> Treacy/ Wiersema 		<ul style="list-style-type: none"> Linder/ Cantrell 				<ul style="list-style-type: none"> Keen/ Qureshi Tikkanen et al. 	<ul style="list-style-type: none"> Zott/ Amit Al-Debei et al. Hurt 	<ul style="list-style-type: none"> Osterwalder/ Pigneur 	<ul style="list-style-type: none"> Baden-Fuller/ Morgan 			
Strategy-oriented			<ul style="list-style-type: none"> Hamel Wirtz Mahadevan Afuah/Tucci 	<ul style="list-style-type: none"> Hamel 	<ul style="list-style-type: none"> Betz Chesbrough/ Rosenbloom Magretta 	<ul style="list-style-type: none"> Winter Mansfield 	<ul style="list-style-type: none"> Afuah Lehman/ Orlega Schafer Moris Schweizer 	<ul style="list-style-type: none"> Chesbrough Debelak Lai/Weill 	<ul style="list-style-type: none"> Johnson et al. McPhillips/ Merlo Richardson Zott/Amit 	<ul style="list-style-type: none"> Kind/ Nissen/ Sergard 	<ul style="list-style-type: none"> Casadesus-Masanell/ Ricart Smith/Binns/ Tushman Teece Casadesus-Masanell/ Ricart Demi/Lecocq 	<ul style="list-style-type: none"> Desyllas/Sako Keen/Williams 		
	<i>Early phase</i>	<i>Formation phase of first overall concepts</i>					<i>Differentiation phase</i>							

Fig 5. Literature overview of the business model research field. extracted from [6].

3. Business Model methodologies.

In this section is about giving to know in depth both methodologies selected for the study of the firms. For that, a similar structure will be followed: at first giving an overview of the general idea of the theory and its intention, then explaining how it is developed and how does it work and at the end clarifying the terminology and the concepts used at each one.

3.1. The Canvas methodology.

Alexander Ostelwalder by the development of this methodology wanted to condense all the concepts used until the moment into nine building blocks, simple concepts that will structure a firm’s business model. As objective, this method tries to give a shared language in order to make easier to understand how a company creates value and get profit from it. The idea is reflected at the following extract from *Business model generation* [1].

“The business model is like a blueprint for a strategy to be implemented through organizational structures, processes, and systems.”
A. Ostelwalder.

At the following figure its showed the Canvas Template and the nine building blocks:

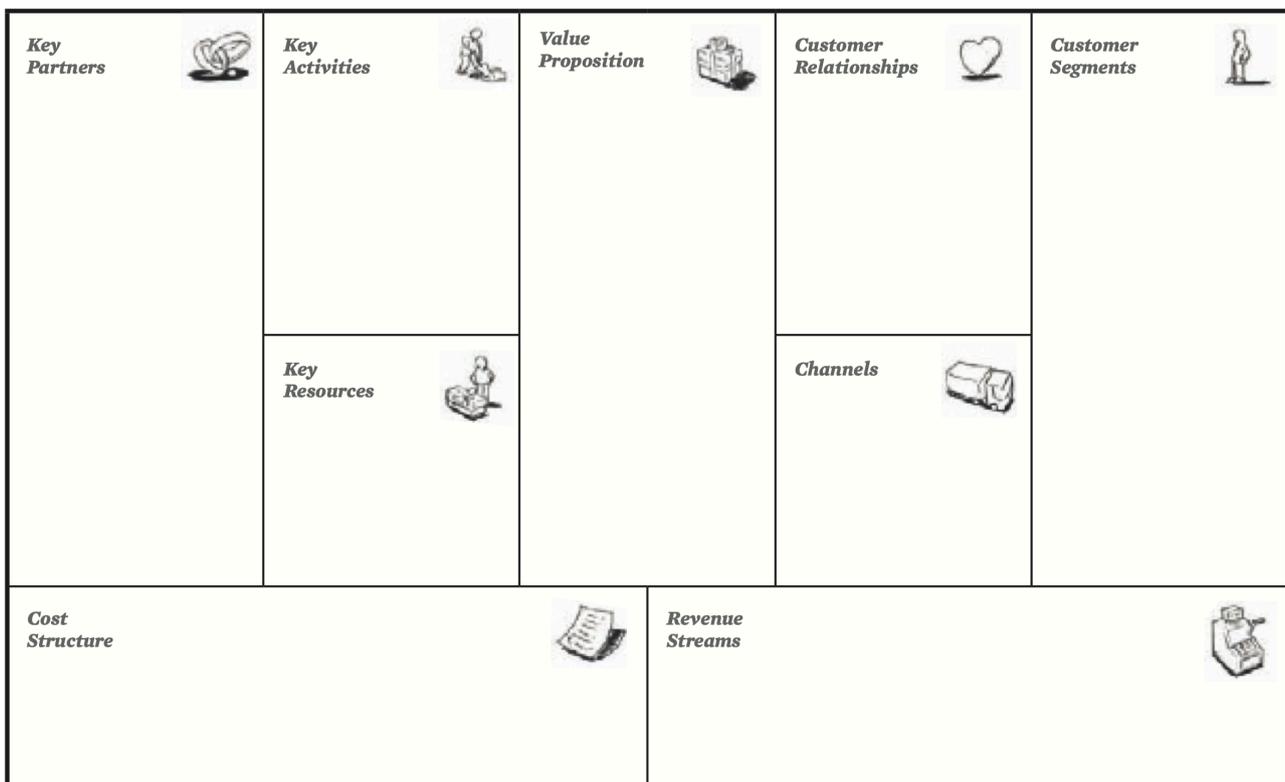


Fig 6. The Business Model Canvas, Extracted from [1].

3.1.1. How to apply the Canvas method.

In order to make use of this template it is need to know what all its components mean and how they work together. The construction block can be separated into two groups, related at the figure 7. The yellow part makes reference to the efficiency side, the blocks included in this side affect to the internal functionality of the firms and usually the activity related to this blocks is not visible from the outer environment of the company. The blue one is the Value side and includes the blocks with their activities might have a clear effect in the value that the firm is offering and develops visual activities. Then, knowing how are relate those blocks with the company, let's focus on describe them.

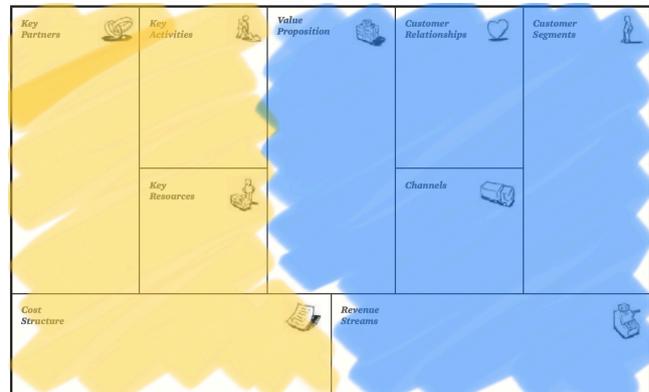


Fig 7. Canvas divided by groups, adapted from[1].

• Customer Segments

The customers are the main reason of the feasibility and sustainability. This block collects all the different types of customers segments that a firm may consider, a brief description of them follows:

- Mass market: Focused in a large group of customer that share the same needs and there is not a clear distinction between them.
- Niche Market: the target of a firm with this customer segment is very specific, their values are oriented into the needs of a specialized sector.
- Segmented: This types of Business Models treat with divided groups of customers. Into this groups the customers share the same needs, but between groups they can have the same needs too, but in different scale, and that is a reason for this diversity.
- Diversified: This type of Business models deal with a big diversity of needs and problems, and try to reach as many different types of needs as they can afford.
- Multi-sided platforms: At this type of Business Model, a certain firm have to deal with different segment of customer that do not share any common need, they have to supply them with different values made specifically for them

Also firms in order to define their products could reach three types of development of the values that they offer, this is called: Alternative Competitive Advantage. Depending on the way they focus their products they are differentiated in this three categories:

- Focused on the process: These firms are constantly pushing the limits the optimization of the way they create value, leading to lower prices affording customers who want to save.
- Focused on the product: This type of focusing tries to reach a very specific segment of customers, the firms develop a product that usually offers the best quality or services to differentiate from their competitors.
- Focused on the customer: In this case, the company offers a special product made specially to reach the specifications from the customer.

- **Customer Relationships**

Defines the firm and its customers are linked and how is the interaction between them, usually the general desire is to attract the attention of new possible customers and engage them to ensure possible future purchases.

- **Channels**

Conformed by the ways how the firm is going to get their products and services to the customers and also use them to establish a communication to aware customers of the existence of this products, persuade the to purchase and also remind the customer why an offer is better than the ones from the competence.

- **Value proposition**

It is a description of the products and services that create value for a customer segment, the value proposition might give reasons why this segment choose the product of the company in front of the competence. This block has also a relation with the Alternative Competitive Advantage explained at the Customer Segment, the reason is that the value proposition of a firm usually is diversified in 3 three categories depending on the focus given at the customer segment:

- Process: Quantitative value proposition
- Product: Qualitative value proposition
- Customer: Game-changing value proposition

- **Revenue Streams**

The block explains how the company will make profit from the value creation, and the price that customers will have to pay to get it. There are many types of revenue streams: asset fee, usage fee, subscription fee, renting, licensing, intermediation fee, advertising...

- **Key resources**

This block includes the main assets that a firm may have to develop the necessary activities to create values.

- **Key activities**

A description of the operations that the firm might do to make the business model work.

- **Key Partners**

Partnerships that may supply the firm with different products or services necessities to make the business model work and finally create value.

- **Cost structure**

In this block are included all the costs and investments with the firm might do to make the business model work.

3.1.2. Business model Patterns.

In the Canvas Methodology A. Osterwalder makes a further step and categorize some business models that have similar characteristics or behaviors into five different patterns. Observing these similarities between business models of different firms these patterns give them a common language and a way of standardization. The following table adapted from the information from *Business model generation* [1] gives the basic definition and characteristics of these patterns, a deeper study can be found at the reference.

Pattern	Description
Unbundling	These types of Business Models take one type of alternative competitive advantage and ideally do not mix with the notions of the other two categories in order to avoid conflicts.
The long tail	This type of Firms tries to avoid the general trend, selling a famous and trending product in a large quantity, and focus into selling a large amount of types of products in low volumes.
Multi-sided platforms	In this pattern the trend is to bring together various customer segments, each one independent from each other, and tries to establish interactions between these groups in order to create value.
Free as a Business Model	The business models have at least one group of customers that is able to get the product for free, and still having revenues by another part of the business model.
Open	Open business models allow to create values by collaborating with outside partners.

Tab 2. Patterns overview and brief description, adapted from [1].

3.2. R. Casadesus methodology.

Joan Enric Ricart and Ramon Casadesus-Masanell give a new perspective from the business models, taking this concept to a practical level and making a visual representation of the business models, the Casual Loop Diagram. Also, this point of view gives a distinction between Business Model and the concept of strategy, where the strategy is one of the stages of the process of the business model framework.

3.2.1. The Casual Loop Diagram.

In order to comprehend the diagram used in the Casadesus method first let's state the basic notions of the concepts that compose this theory. The business models from the authors perspective are immersed in a competitive environment, therefore they follow a process framework differentiated in two stages

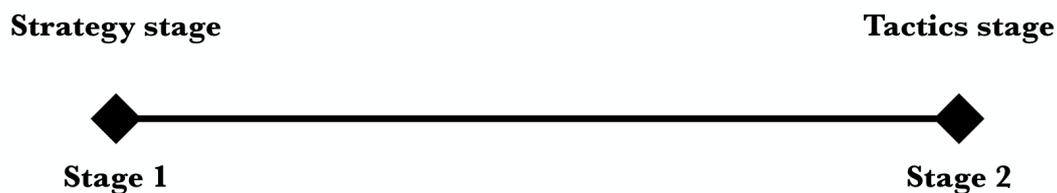


Fig 8. Competitive Process Framework, adapted from[11].

The concepts of this idea are described:

- Business Model: describes the way that the firm operates in order to create value and get profit from it.
- Strategy: The choices in the business model that would make able to the firm to compete in the marketplace.
- Tactics: The residual choices that the firm is going to make by virtue of the business model chosen at the first stage.

Casadesus' methodology answers the question of "What are Business Models made of?" with two general concepts: choices and consequences of this choices. Then differentiate the nature of this choices and consequences in order to point the kind of impact they had over the casual loop diagram. The categorization follows:

- **Choices:** Manage the operations of the firm.
 - Policies: This kind of choices relate to the stance of the firm for all the aspects of its operations.
 - Assets: Resume all the choices that are dealing with tangible resources.
 - Governance structures: Makes reference to the choices that may have decisions over the policies or assets choices.
- **Consequences:**
 - Flexible: Very sensible to the choices. A change in this consequence will be rapidly noticed.
 - Rigid: Not sensible to the choices. This kind of consequences only experiment noticeable changes in a slowly way.

In the representation of the Casual loop diagram is possible to see some cycles, loops that can have different effects in the business model, they are called virtuous and vicious cycles.

- **Virtuous cycles:** Part of the diagram that describes a feedback loop that reinforce consequences with every iteration, They are not usually use to define and describe the business models but they can be elements that ensure the success of the model.
- **Vicious cycles:** Refers to the situation when the virtuous cycle gets interrupted or reversed, this situations could suppose a high risk because with every iteration the reinforcement will decrease exponentially.

In order to simplify the representation of the business model, the Diagram method contemplates two options to summarize the complete and detailed map, the aggregation and the decomposition.

The first one consists into analyze the full map and select from it the **key choices**, and see what choices derivate from them. Then the final representation of the map will include this choices and consequences, “zooming out” from the detailed one and making the analyst able to see the key interactions in the business model.

On the other hand, the decomposition option make reference to subdivide the general diagram into different groups, “sub-diagrams”, that include those choices and consequences that do not interact between them. The choices and consequences included in the diagram of one group do not interfere with the process of the other ones.

4. Cases of Study.

Continuing with the application of the methodologies explained at the theoretical part of this thesis it is time to present and analyze both companies selected, Spire Global and GOMspace. The treatment of this firms will be equal for each one, first there is going to be an overview of the firm, its principal activity, localization, market area and the basic structure of itself. Then the analysis will take both Business Models methodologies and apply them in those firms in order to extract the necessary information from each firm to represent their business models by the canvas and casual loop diagram and then getting conclusions.

4.1. Spire Global.

Spire Global was founded in 2012 in San Francisco, based on the activity of recollection and analysis of data by the Earth observation with smallsats. Now a days the company have 6 headquarters around the world and the larger constellation of small satellites, composed with 84 operative satellites and more than 30 ground stations. The company uses the Earth observation to compile maritime, aviation and weather data and deal with this information to offer some different type of services. In the maritime field Spire Global uses Satellites AIS (Automatic Identification System) data in order to improve shipment localization, collision avoidance, make easier the search and rescue operations and all this data gives the possibility of a historic AIS data to predict shipment positioning. This technology is also the main objective at The Developer Portal, a reserved space at Spire Global's web site that offers the possibility to the customer of develop their own AIS project, trying to expand the usage of this tree to the rest of the fields that they deal with. Talking about aviation, the firm tries to cover unmonitored areas and provide with precise position data over this fields. The data collection is ADS-B (Automatic Dependent Surveillance-Broadcast) it uses GPS information to determine the localization, airspeed and more information that is ended to the orbit where the satellites receive it and broadcast it to the ground stations. All this information is enhanced with the already existing flights schedules, air controllers information, etc. And the weather sector is the first one which the company started with, this is the major field of application, it also is part of the other two. *[ref. enlace spire global]*

As interesting additional information, Spire Global uses a standardized small satellite the LEMUR (Low Earth Multi-use Receiver), designed and built in the firm itself. The next figure shows a picture of this Cubesat.



Fig.9 Small Satellite LEMUR Extracted from [7]

4.1.1. Spire Global Business Model by means of Canvas method.

Using a Canvas template adapted from the A. Osterwalder's book [1] and with all the information from the web page of the firm [7], the following figure shows this visual conceptualization of Spire Global's Business Model. The nine building block will be explained in detail further in this script.

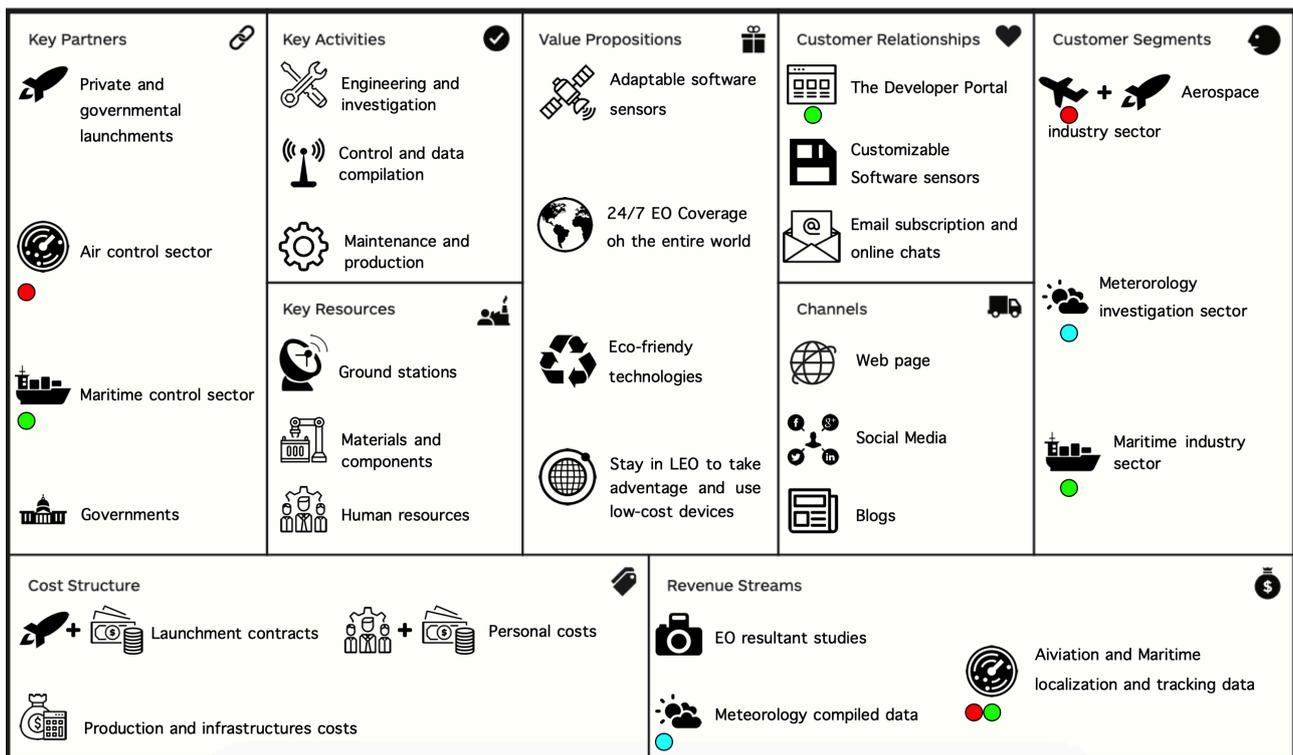


Fig. 10. Spire Global's Business Model Canvas adapted from [1].

Observing the Canvas it is possible to notice three types of dots, red, green and a blue one. Each one of this dots is related to a customer segment, and indicates with elements of the building block are exclusively related to this customers, the rest of elements without an indication are common elements for all the segments. The red dot is for those elements related to aerospace industry, the blue one is for meteorology investigation and the green one refers to maritime industry.

Now, in order to give an explanation of the Canvas, each building block will be detailed.

Value proposition. This Company has three main pillars, improving the Earth Observation by using software customizable and multifunctional sensors in order to adapt to the customer requests and choosing quantity over size; offering 24/7 coverage of any place of the entire world by their large constellation and taking the advantages of staying at LEO leading them to use low cost devices and having a responsible treatment of spacial debris by using these smallsats. Also Spire Global wants to inspire and be a leader in the Earth Observation business by using LEO orbits developing new technologies and solutions to explore further in this new emerging sector.

Customer Segments. Is reasonable to think that the offer of the kind of information that this company deals with brings with it a very specific type of customers. For example, the aerospace industry sector gives to this company as many information to complete the treatment of the air control localization using the smallsats, and the air control industry itself is the principal and ending customer that purchase this offer. The same thing occurs with maritime and weather studies. In addition, putting aside the private use of this information of each sector, this company sells this studies to governments that work as partners to deliver this information to the correspondent sectors in order to offer accurate information as it is said in their web site *“Spire Global identifies, tracks, and predicts the movement of the world's resources and weather systems so that businesses and governments can make smart decisions.”* [7]

Customer Relationship. Spire Global tries to give an image of total transparency offering as much information to their customers as they can, trying to give a close relation through news, online chats, etc. Moreover they had the offer (for the moment only applicable at maritime industry but the trend is to expand this technology to the rest of the sectors) in their website of *“The Developer portal”* A place where the customers can develop their own AIS projects with cloud based APIs (Application Programming Interface).

Channels. The firm ways to get in touch with their customers are mainly online based, they have the webpage where anyone can get information about the values and services that they offer, they also do broadcasting through social media and also for the ones most interested in the firm and its progresses they can request news by an email subscription to their blog.

Revenue Streams. As a result, the information collected and the subsequent study is offered to the mainly interested sectors.

Key Partners. In order to complete the information treatment is indispensable to collaborate with the sectors specified in this block to request the rest of the data to complete studies such as the localization and tracking of ships and flights. This three main sectors are also the principal customer segments, that give to Spire Global the necessary information to accomplish the studies added to the information collected from the orbit. Usually, the relation between these customers and the firm is managed from governments that comprehend these three sectors in a certain country, so they are considered as partners as well.

Key Activities. This company tries to be a leader into this innovating technology, so the development and investigation that concerns the small sats is an imperative activity in order to improve the efficiency of their operations and services. Also the maintenance of this devices and the servers to keep safe data storage. And finally, the study of this information to create value.

Key Resources. Human resources and supplies to assembly the small sats and keep a certain level of production are essential. As the life time of this mission are short in comparison with larger orbits ones, more satellites are need to keep a continuous number of this devices in this missions. And also ground stations that allows to keep tracking and collecting information from this devices, as the area covered of the Earth gets larger more stations are need to cover it without losing connection.

Cost Structure. The mainly cost of this kind of industry are the contracts that allow to include this smallsats in larger launches, and also the cost of human resources and infrastructures in order to complete the activity of the firm.

Choice	Type	Consequences																		
		Reducing env. impact.	Leader of this field	Vanguardist technology	Efficient Services	24/7 coverage	Constantly innovation	Low cost services	Quick manufacture	Reinvest	Larger revenues	Increased n°. of customers	Global range market	Image of closeness	Accurate localization and info	Share information	Specialized Services	Improvement of AIS Tech.	Enhanced services	Non debit mission needed
Data management post selling services	Governance		✓	✓	✓												✓			
Use Small Satellites	Assets	✓			✓		✓	✓												✓
Constellation of large number of sats	Policies					✓		✓												
Large quantity of ground stations	Policies																			
Headquarters located around the world	Policies							✓	✓	✓	✓	✓	✓							
Partnerships with the principal customers	Governance														✓	✓	✓	✓	✓	
Usage of adaptable software sensors	Assets		✓	✓														✓	✓	
The usage of the developer portal	Assets		✓															✓		

Tab 3. Categorization of the choices from Spire Global’s diagram.

The principal objective of the firm is to be a leader and inspire the creation of new technologies and the constant improvement of the usage of small satellites to the earth observation business. Also they try to offer the most accurate information, therefore there is a need to compile as much data as they can and use it to complete the one that comes from EO, the partnership with their most common customers allows to reach that information. For example, in order to enhance the localization of flights in areas where the communications are limited or land gaps in remote areas, Spire global takes the schedule of flight and more air control data to fill those unmonitored areas with EO data. In addition new ways to use and collect this information are proposed by the firm, in the case of the maritime sector Automatic Identification Systems (AIS) a global used way to communicate between ships and shores and between different ships to avoid collisions. Applying this concept to the Spire Global's constellation will make the maritime sector able to communicate in remote areas of the ocean where the distance between ships and shores could suppose the loss of the signal. This application leads the company to stay at the vanguard of this technology. Moreover Spire Global estimates to offer 24/7 coverage of the entire Earth added to the localization of the headquarter makes the firm able to reach a global market expectations more revenues that carry with them a reinvest into this technology ensuring the growth of the constellation and this coverage.

Talking about the technology, the usage of small sats and stay in LEO are standards of innovation, because this low-cost devices do not suppose a large time to manufacture, so Spire Global is able to investigate and improve its devices in a faster way than companies that work with larger satellites. Also, due to the the estimated life time of the small sats and the fact of being in LEO orbits reduce the environmental impact of this activity as it was explained at the state of the art.

In conclusion the activity of this firm and the nature of its decisions make it a very competitive subject into the EO market.

Analyzing the casual loop diagram it is seen three virtuous cycles, each of them pointed out at the following figure.

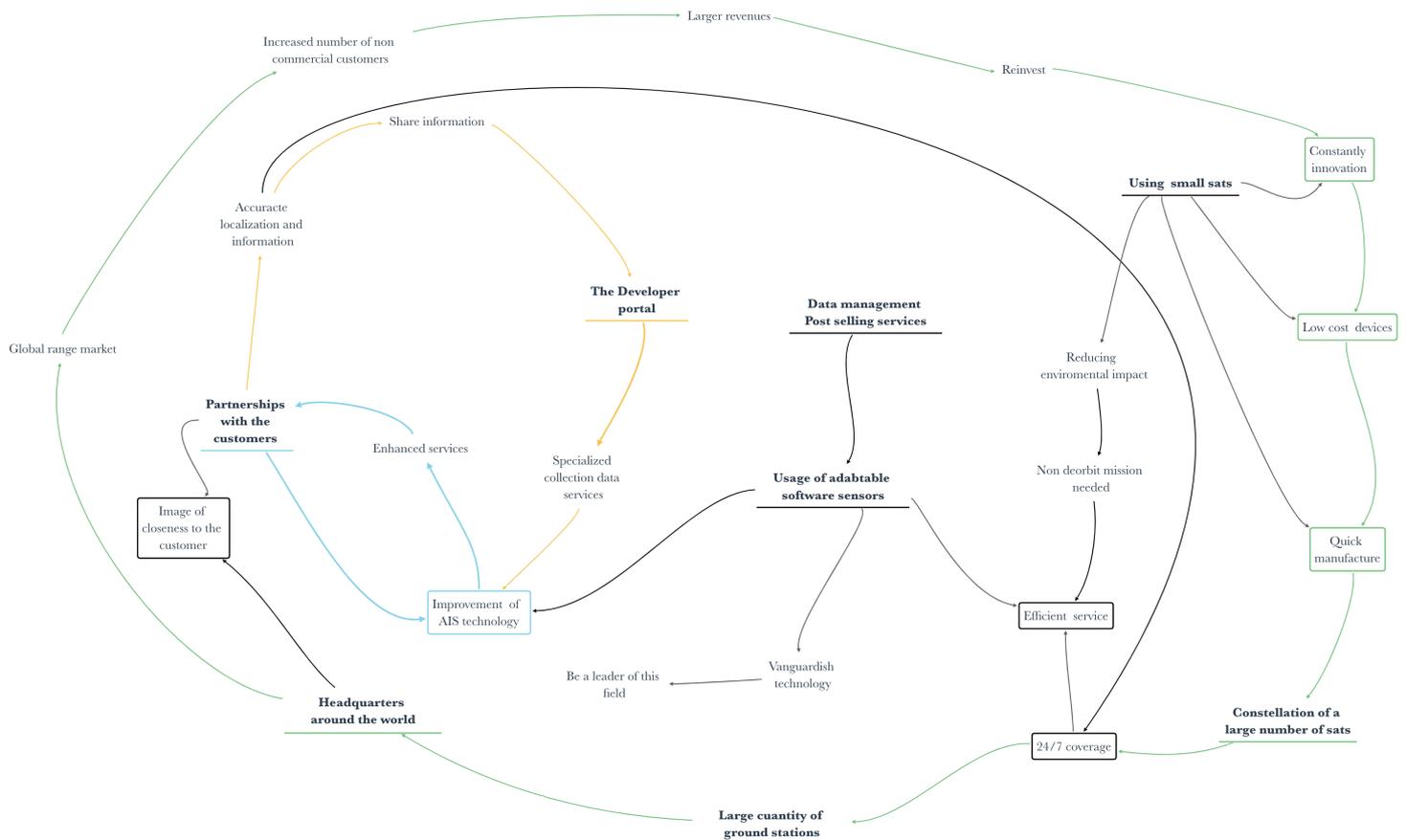


Fig 12. Virtuous cycles at Spire Global's casual loop diagram, adapted from [11].

The green one reflects how the firm's expectation to reach a 24/7 coverage will have as a result the expansion of the market that they may be able to offer this service, enhanced the revenues stream and in addition as the small sats are low-cost devices and do not suppose a large amount of time to manufacture the number of devices at the constellation would be constantly growing and replacing that ones that end their life time, ensuring this ability of a continuous EO coverage and in a worldwide coverage. As principal result the activity of this loop leads to increase the investments and enhance the EO coverage.

Then the yellow one represents how the partnership with the customers sharing information leads them to improve their projects with the Developer Portal and then treating this data and with the new AIS projects the firm will improve this technology and getting from it more, and better information to their own profit, and the whole scope of customers sectors.

Finally the third loop, the blue one reflect the same effect of the yellow one but taking into account only one customer segment and for instance this specific partner.

4.2. GomSpace.

GomSpace starts with the enthusiasm of the original founders of sending devices to the space, when they were students at Aalborg University back in 2001. Their ideas and efforts lead the to establish the firm GomSpace at Novi Science Park, Denmark in 2007 and have their first experimental launch in 2013. Since then the firm have establish several partnership and in order to grown their commercial offers GomSpace had to shift their strategy and develop a certain business model to survive and expand at the nano satellite market. Now the company offers the fabrication of cubesats and nanosatellites that integrate a plugs-and-play solutions, in other word, customizable devices in order to accomplish a certain kind of objectives depending on what the customer desires. For example different mission payloads as ship tracking AIS receiver, aircraft tracking ADS-B patch antennas or optics to conduct Earth Observation as the NanoCam C1U showed at the figure 13.



Fig 13. NanoCam C1U. [8]

Also GomSpace, a part from the devices, offers a certain number of services to their customers related with constellation management. The firm wants to stay in LEO because as they consider: “*Future high value data and communication services will be delivered by LEO satellite constellations networks.*” [ref. web Gomspace]. And in order to keep under control all the devices the company offers the first service, a unique mega-constellation operations platform, denoted as MCOP. Developed under contract with ESA and based on the GOMX flight test program’s devices, the ones that are showed and detailed at figure 14, extracted from GomSpace’s website. This program wants to keep a fully automated system of control of the constellations of their customers.

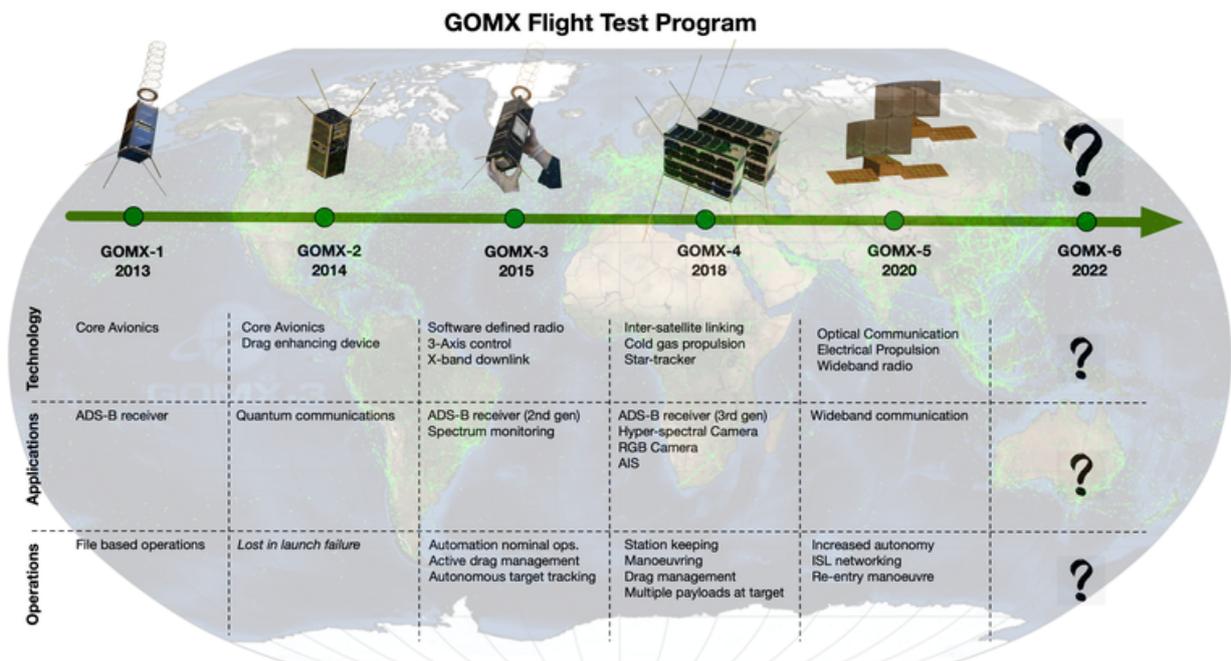


Fig 14. GomSpace’s flight test program overview[8].

Mega-Constellations Operations Platform also offers network-management, often this constellations are composed of tens or hundreds of satellites so to ensure the accomplish of their operations the MCOP deliver features as:

- End-to-end monitoring of all assets.
- Services Layer to monitories the quality of the device’s services.
- Compatibility with a large number of usual commercial ground station networks
- Centralized configuration, to minimize down-time and single-points of failure.
- Automatic network functionality and fault recovery

And finally if the customer requires the company also offers projects of mission exploitation to help with data collection and treatment.

4.2.1. GomSpace's Business Model by means of Canvas method.

As it was done with the case of Spire Global now the Canvas method by A.Ostelwalder [1] is applied on the GomSpace's business model in order to see how it works from an operational point of view. The same codification of dots is used to indicate those elements that are exclusively related with certain customer segments. The red one refers to National and Private aerospace agencies, Military industries are indicated with a green dot and those elements related to the universities are indicated with a yellow one. The reasons of this relations an the building blocks will be explained further in this script.

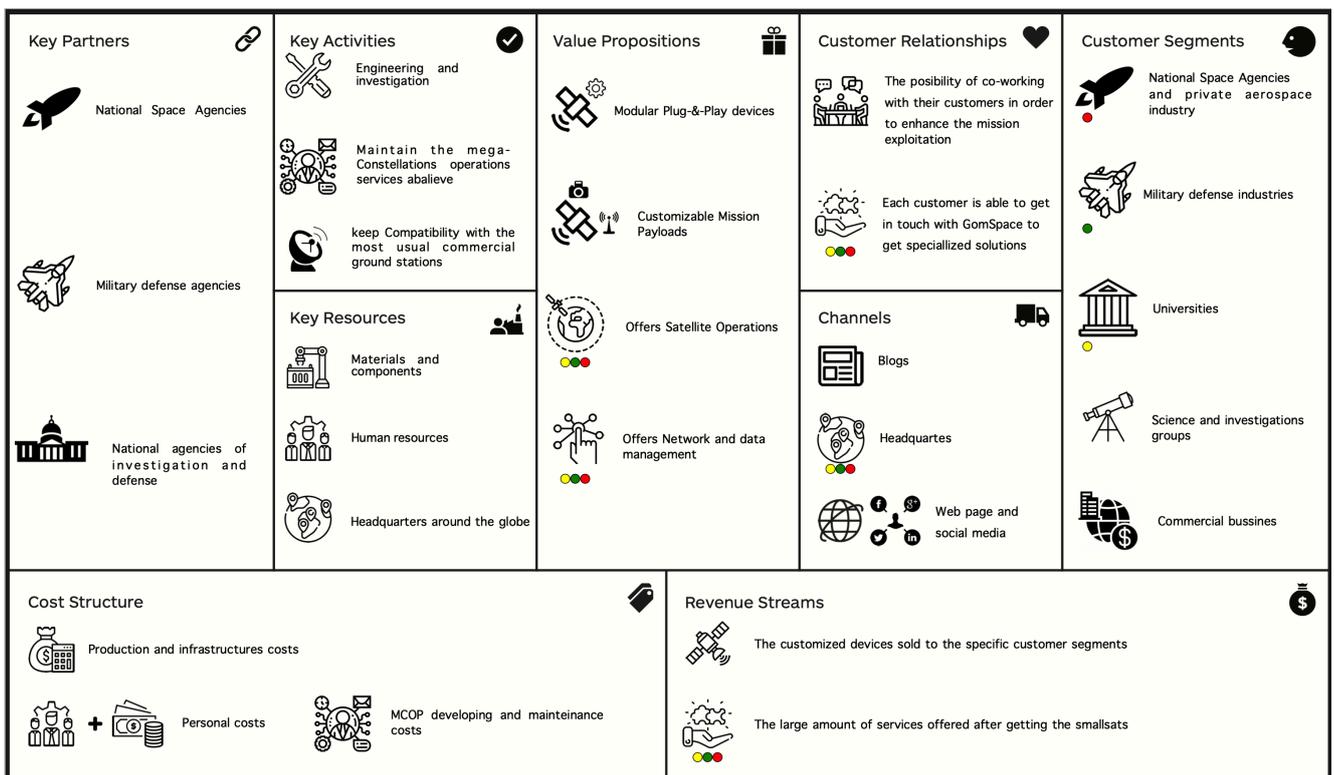


Fig 15. GomSpace's Business Model Canvas adapted from [1].

As it was done at the other canvas the characteristics of the nine building block will be detailed.

Value proposition. GomSpace offers devices and services too, their devices have multiple options of modular plug-&-play accessories as propulsion, communication and control systems from an operational point of view and also the possibility of select the mission payload with is modular too. Basically they offer custom-made devices and also services to enhance the exploitation and the endurance of the mission, these services are oriented to take place in large operations, therefor they are considerate to be related to three of the five main customer segments.

Customer Segments. As large Segments there are National and Private space agencies, the military defense industries from certain countries for example the SAS (Specia Air Service) from the United Kingdom. Also there is a sector oriented to University investigation and as the smaller groups there are considerate private investigation scientific groups and commercial business that want to use ore sell the assets from GomSpace.

Customer Relationship. Very related with what is offered in the value propositions, the customers of GomSpace are able to ask for help in order to get specialized devices as solutions or request of their missions. And also require services that help the customer with data treatment and acquisition or network facilities.

Channels. As it was seen at Spire Global's case, with the blog, web page and social media the customers can be aware of the news, developments and announcements of the firm. Also in order to cover the larger and more important missions, GomSpace has a net of headquarters around the world that give fully coverage and assistance to this kind of customers.

Revenue Streams. Mainly, the custom-made devices and the services offered after the selling of them, are the principal channels of revenues that this firm has.

Key Partners. As GomSpace wants to reach missions that lead the firm to innovate and improve the services that they offer since the beginning the firm wanted to establish relations with agencies and large sectors of investigation that as partners wanted to apply the technology of the nanosatellites collaborate to reach the success of this missions, for example the GOMX-3 a satellite launched the first of October from 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, 2nd gen. air traffic receiver and advanced software defined radio techniques. Form this moment the firm continuous getting new partnerships, in other to achieve more knowledge of the nanosatellites and apply it at the firms activity. An other example of this partnerships is the one with the The Ministry of Economy in Luxembourg in order to develop a business unit that concentrate the activity of it in offer data processing form a satellites constellation. this partnership was established the 30th of December in 2017.

Key Activities. As the firm offers the crafting of the nanosatellites, engineering and investigation is primordial. Then talking about the services of the MCOP, the constantly maintenance of this networks and enhance this services is vital to keep this service as a differentiation of the firm, then related to this, as the firm uses the common commercial ground stations to establish this connection, keep this compatibility is essential, if not the whole MCOP device would need an other solution.

Key Resources. To get the key activities done this company has to keep a certain level of material resources and qualified personnel to craft the nanosatellites and also more workers specialized into the activity of the MCOP to keep this service actualized. Also at the history of this firm it had to establish more headquarters in more countries to reach the global demand, opening offices in Asia in 2017 and in the same year in North America

Cost Structure. Related to the key activities, the maintenance and improvement of the MCOP would have a cost associated, and also the crafting of their devices. As the company have become bigger it workforce had do it too and also it had to getting the establishment of more headquarters around the world, increasing personal and infrastructural costs.

4.2.2. GomSpace’s casual loop diagram Business Model.

Following the structure of the other case of analysis now applying the theory of R. Casadesus, the casual loop diagram [11] is adapted to the business model of GomSpace. In addition is presented as an overview a table with the choices of the diagram and specifying what are their nature.

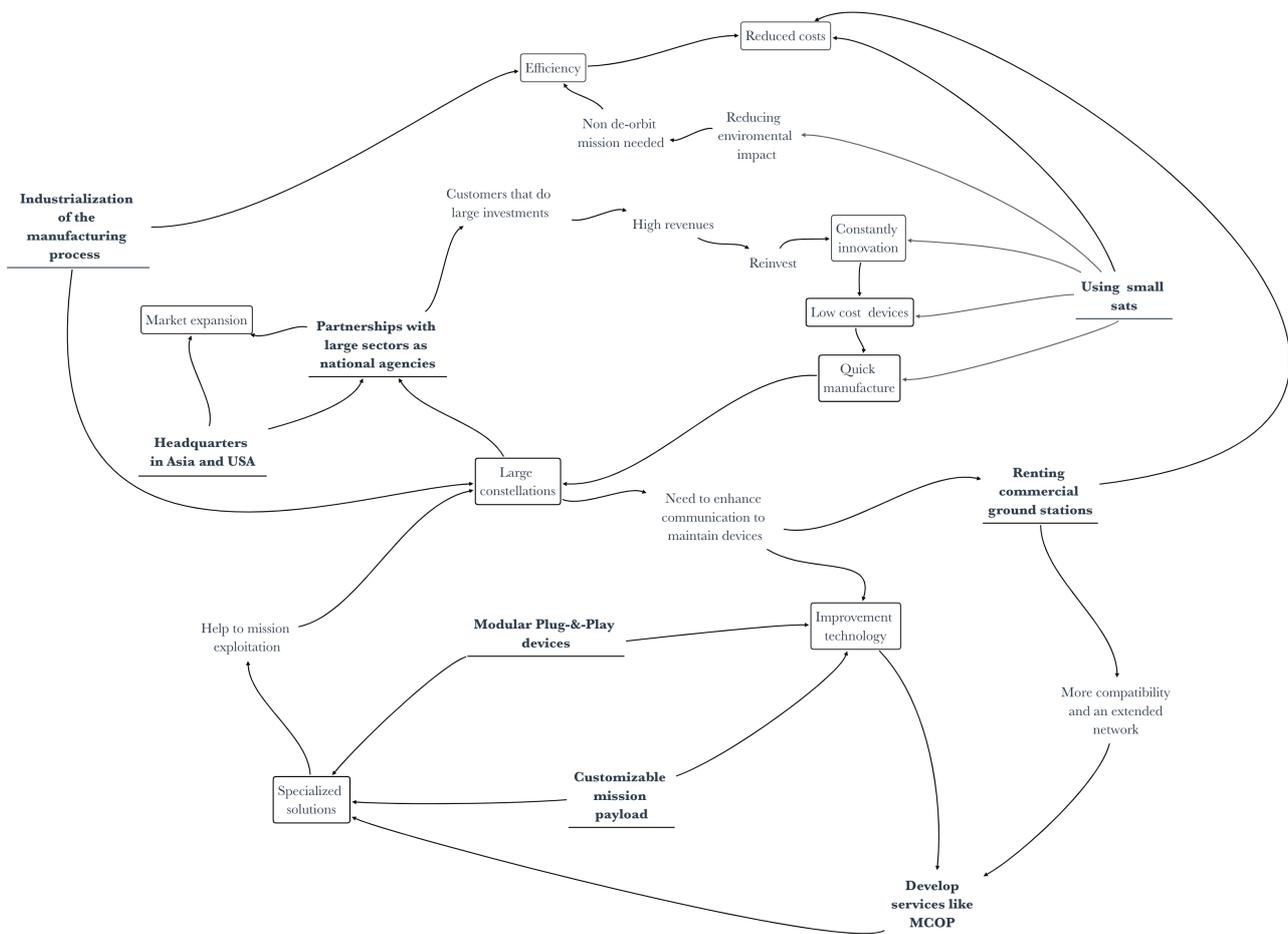


Fig 16. GomesSpace’s Casual loop diagram, adapted from [11].

Choice	Type	Consequences																
		Reduce environmental impact	Better communications	Help to mission exploitation	More compatibility and a large network	Large constellations	Constantly innovation	Low cost services	Quick manufacture	Reinvest	High revenues	Customers do larger investment	Market expansion	Improvement technology	Specialized solutions	Reduced costs	Efficiency	Non deorbit mission needed
Customizable Mission Payload	Assets			✓	✓		✓											
Develop services like MCOP	Assets			✓	✓	✓									✓	✓		
Plug-&-Play devices	Assets			✓	✓		✓								✓	✓		
Renting ground stations	Governance			✓		✓										✓		
Headquarters at Asia and USA	Governances														✓			
Partnerships with large sectors	Governance													✓				
Using Small Sats	Assets		✓										✓				✓	✓
Industrialization of the process	Policies		✓															✓

- Legend**
- ✓ Directly related concepts
 - ✓ Indirectly related concepts
 - Choices related between them

Tab 4. Categorization of the choices from GomSpaces's diagram.

Since the beginning of the firm its main objective is to reach a successful nano satellites mission, focusing their efforts on develop the technology that they were applying and develop new methods to built and exploit this devices. And then in 2014 the firm turns turns to focus into commercial market of this devices, the industrialization of the process of building this devices was essential to cover the demand of large customer sectors interested in this new up-coming technology. For this a new standardization need to be included at this building process, the Plug-&-Play modular devices, different set up options that the firm offers to their customers in order to give an specialized solution to which ever kind of mission that they want to develop, this modular units include propulsion systems, control systems and also communication and data collection devices. A part from that, the mission payload is also customizable depending on the customer necessities. So until this point the firm had multiple solutions and a quick manufacture process, this lead to the possibility of offering large constellations minions, something very attractive to sectors as military and national agencies, for example the SAS (from UK), this relation with national agencies was an incentive to establish headquarters in two more continents, USA and Asia in order to cover this market demand and expanding the company. But all this activity of the firm is the one that is possible to see from the surface, basically specialized nano-satellites constellations. To understand how this product was so attractive to this type of customers it is need to go deeper and analyze the operations that GomSpace do in order to ensure the success of the missions that they encompass. GomSpace has develop services that offer to their customers constellation management, renting commercial group stations, the communication network that GomSpaces uses makes it able to control large constellations, collect and send information and then exploit this data in collaboration with their customers.

Analyzing this diagram it is possible to see two virtuous cycles, these are pointed out at the following figure and will be explained after it.

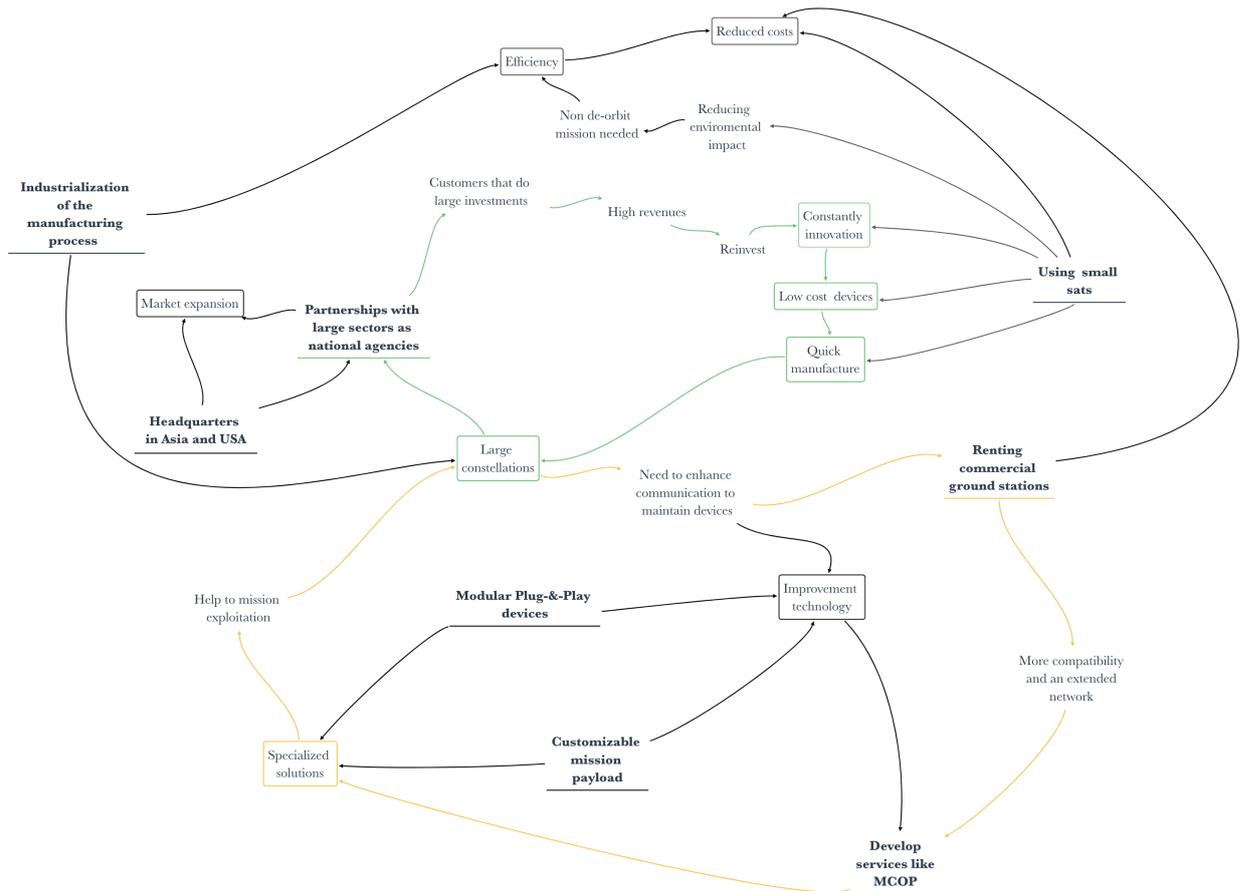


Fig 17. Virtuous cycles at GomSpace’s casual loop diagram, adapted from [11].

Differentiated in colors it is possible to see two virtuous cycles, the green one is directly related with how this company gets profit and uses it to reinvest into the innovation and manufacture of this devices offering the maintenance of this large constellations to keep them operative and by a doing so customers will still requesting for this products. In the other hand, these large constellations and their constant growth lead to a necessary better communication network by renting ground stations and enhancing the services of constellation management, as this services help to ensure the success of this missions more constellation would be request based on their reliability.

5. Discussion of the results.

As a final objective of this study, taking profit from both analysis applied on the companies, this section tries to give a connection between both firms in order to look for similarities that they had developed immersed in the Earth Observation business and which aspects make each company able to differentiate and stand out in this market. After that, as a final statement of this study, the key factors and patterns observed by both Business Models methodologies will be pointed out.

5.1. Comparison between both companies

The starting point for both companies is the same, to improve and design small and nano satellites in order to reach successful LEO and VLEO missions. Spire Global and GomSpace in the beginning where enthusiastic groups of academics interested in an emerging technology, a new branch of knowledge, investigation and opportunities. But a part from the fact that these companies share the same principal product each company had develop different strategies on how to focus what they offer and the services added to their satellites, reaching deferents kind of projects and customers. Also talking about their operational they have despairing key factors that reinforce the position of these firms into the EO market.

First case, Spire Global, has a strategy focused on use their constellation to reach what their customers demand, information. For this company, the usage of small satellites is a way the make them able to do Earth observation and data collection form the orbit with a low-cost and versatile technology. Also the re-programable software sensor provide more possibilities to the scope that they offer. As it was explained at section 4.1. Spire Global's partnerships are also their principal customer segments, as the information that the firm collects needs more data to be treated and then sealed to this sectors. It is remarkable that in the case of GomSpace their principal customers are also their key partners, but in this case it is not about information. This firm offers to their customers constellations of nano satellites and the post selling services of constellation management and mission exploitation, so their customers must be sectors that can deal with large satellite operations and reach such kind of investments, therefor space agencies and military industries are interested in be associated with this firm, because GomSpace give them the opportunity to reach this technology an enhance the success of they investment by the services that if offers. Furthermore both companies are immersed in partnerships with governments, that work as intermediaries to national aerospace sectors in the case of both firms or military sector in the case of GomSpace and maritime industry and weather investigation at Spire Global's case. Summarizing both companies' strategies include their principal customer segments as their key partnerships in other to get profit in different aspects as they offers different products and services with the same technology involved.

It is important to point out these post selling services offered by each company which are totally different one from each other. Starting with GomSpace's case a part from the modular devices that offer specialized devices for each mission this firm could manage a whole constellation for a

customer if it requires to, helping it to exploit its mission by using the large network of rented commercial ground stations and the Mega-Constellations Operations Platform, explained at the section 4.2. But this doesn't mean that the customer is a passive factor in this process, there is the possibility to make the customer and GomSpace to collaborate in order to ensure the success of this operation. Mean while, Spire Global manages their own constellation in order to reach the customer's demands. Finally they get all the information and treat it so it can be sell but the customers can take place in this process the developer portal, working as collaborators that develop a certain AIS project that they are interested in and by doing so the firm could use its constellation and the information collected in order to reach the objective of this project.

Talking about their activity that it has been see at the casual loops diagrams where it is possible to see that each one has two virtuoso cycles, at each firm one of those cycles is related with how they create value and get a reinvest that feeds this activity. The others cycles are related with the services that each company offers but they differ on what they apply this resultant feedback. In Spire Global's loop , the yellow cycle is related with the information it self and how the developer portal and the partnerships bring more accurate information. on the other hand, GomSpace's diagram shows that this cycle is related with how the large number of big constellations creates the need of enhance their communications and by doing so improving their network services (MCOP), making them able to reach the control of bigger constellations, summarizing this process expands the offer of devices and services that this firm could reach.

The following table gives an over view of what main characteristic do this firms share in common:

Shared and not shared characteristics from each firms		
characteristic	Spire Global	GomSpace
Using Small Satellites	✔	✔
Large constellations management	✔	✔
Selling Data	✔	
Selling Devices		✔
Post Selling services	✔	✔
Customers are also key partners	✔	✔
Industrialization of manufacture process		✔
Devices could be specialized to specific kind of missions	✔	✔
Using adaptable software sensors	✔	
Using Modular devices and customizable payloads		✔
Co-working directly with customers	✔	✔
Partnerships with Governments and agencies.	✔	✔
Reinvest directly related with the enhancing and investigation of small satellites	✔	✔
Operating in LEO and VLEO	✔	✔

Tab 5. Main characteristics of both companies shared in common.

5.2. Business Models Patterns.

Making use of what was explained at the section 3.1.2 about Patterns, the theory of *Business Model Generation*. by A. Ostelwalder [1] and the results observed at both Canvas method analysis; at this section is given a general idea of what common aspects do define the construction blocks of these firms. Showing similarities with that (or those) pattern(s) which clearly define the operational behavior and characteristics of this companies.

This firms mainly work with the same product, smallsats. One of them, Spire Global, using them in order to collect information and create value with it. And the other one, GomSpace, making profit directly with the selling of this devices.

As it was explained at the comparison, section 5.1; this companies share the trend of having their main customers segments included as key partnerships too in order to accomplish one of their most important value proposition of giving an specialized solution. This aspect is clearly related with a Open business pattern. Nevertheless this is not the only pattern which both companies share aspects in common. Also if the definition given for a Multi-sided Platform pattern is taken: “*In this pattern the trend is to bring together various customer segments, each one independent from each other, and tries to establish interactions between this groups in order to create value.*” (section 3.1.2, adapted from [1]) it is possible to see that also these customers at both companies are based in very different fields.

Until this moment it is possible to stipulate that the pattern that defines both companies are composed by the characteristics of more than one defined patter. In addition, focusing on GomSpace, this firm also makes reference to a Long-tail patter, due to the different possible configurations and solutions that this firm can deal with and also the volume of different constellations that it can manage.

In conclusion, Spire Global’s pattern can be defined of a composition of Open and Multi-sided Platforms patterns, taking profit of the relation ships established with the different customers segments and enhancing the services that this firm offers. Every interaction with a single customer segment will get more information and experience from it due to their define partnership. Then this improvement will have an affect on the rest of customers in future operations.

For summing up:

Spire global’s pattern: **Open Multi-sided Platforms**

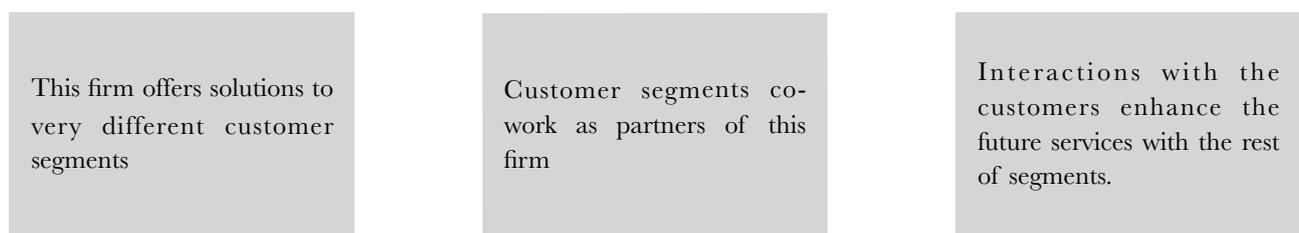


Fig.18 Main characteristics of Spire Global’s Pattern.

Then for GomSpace it can be considered that its business model pattern is a composition of Open, Multi-sided Platforms and Long-tail patterns. In this case interactions may not have a direct impact on the different segments, but every operation will carry an improvement at the technology used enhancing firm's offer. In addition this company tries to give the possibility to customize the devices demanded for each mission, creating a huge arc of possibilities as different kind of missions that their customers could have.

GomSpace's pattern: **Open Multi-sided Platforms**

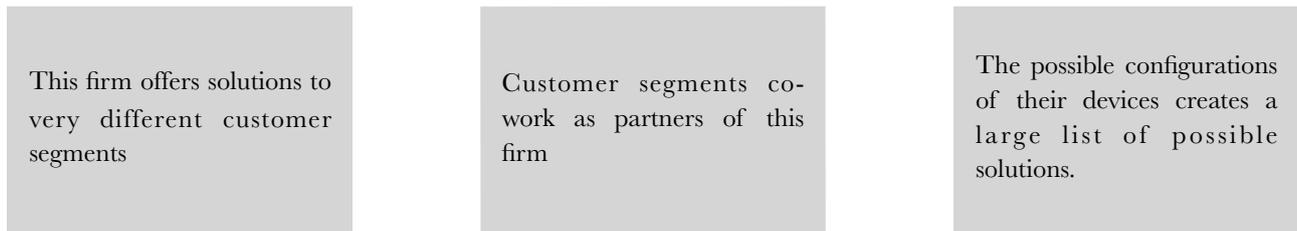


Fig.18 Main characteristics of GomSpace's Pattern.

5.3. Business Models Key Factors.

Now taking place at the different strategies of these companies, there are some aspects that remain as pillars of their activity. Reinforcing the place of this firm into the market and also their business models, aspects like **using small satellites** that make them able to deal with a vanguardist technology taking the advantage of this growing sector. Then this factor is related with both economic virtuous cycles seen at the sections 4.1.2 and 4.2.1 from each company, the usage of this technology carries with a viable and necessary **constant innovation**, in order to keep their constellations and ensure the success of every future operation.

Focusing at Spire global, it is possible to see that **information treatment** is the engine that promotes the rest of activities of this company. In order to give the most accurate information to these customers and declare as leaders of this field, the firm must keep improving the services that makes them able to collect, treat and sell this information.

At the other hand, GomSpace is clearly defined by their **specialized solutions** and **MCOP services**. Every interaction of this firm focuses in giving to their customer a constellation that has all the requirements needed to accomplish a mission, and also ways to manage these constellations and obtain successful results from it.

6. Conclusions.

Cubesats, small and nano satellites have supposed a revolution at many space related sectors, Earth Observation , communications, scientific investigation, etc. All business that are immersed at the usage of satellites should reconsider the possibilities, advantages and challenges that this rising technology comes with.

As the Earth Observation business is the one which these study focus on, following the steps from other previous thesis from Discoverer's group; two new firms of this field are selected to study, Spire global and GomSpace. Both of them analyzed in a very visual way with the Canvas and Casual loop diagram.

To understand and point out the activity and key factors of this firms it is necessary to comprehend what a business model is, and how it operates. From the section 2.2. Business models, located at the State of the Art, it can be extracted a principal and basic idea: A business model is the way how a firm creates value and gets profit from it. In order to apply this concept and understand a company business models theories are mainly tools that give the necessary information to do this analysis. In the case of A.Ostelwalder's theory looks the company from an operational perspective, sketching the main behaviors of it at the Canvas template, where each block has a ruction and relation with the others that compose this figure. Seeing a Canvas is easy to know what a firm needs to create value, what does this value carries with and also how customers get it.

At the other hand, Casadesus' method centers its efforts at the strategy of this firm and its behavior at the market. Casual loop diagrams relay what choices and consequences are related and how this affects to the firm, the values and the interactions with the market.

Observing this two firms is possible to identify how at the Earth observation Business could exist some hints that can make a company able to differentiate and point out from the rest. Starting with Spire Global, this firms does not commerce with its devices, Spire uses its constellation in order to create value, the data acquisition. Then the treatment of this information and posterior selling is the principal revenue stream of this firm, which allows it to reinvest at this technology and the services that it offers enhancing the firm's operations. Nevertheless, GomSpace creates values with the customizable small satellites, offering specializing solutions for certain kind of missions. Moreover both firms are in need to establish partnerships with their principal customer segments, which in the case of Spire Global supply with the necessary information to ensure the accuracy of the information request. And talking about GomSpace, this partnerships allows to the firm to work with large sectors as defense, national space agencies or universities that collaborate with GomSpace allowing the firm to deal with a large number of constellations and missions.

7. Environmental study.

As this study is based on the research, analysis and investigation of Earth Observation Business Models, the usage of small satellites and the theory of Business Models by A. Ostelwalder[1] and R. Casadesus [11], the development of this thesis does not imply any remarkable environmental impact

8. Bibliography.

1. OSTERWALDER, Alexander and PIGNEUR, Yves. *Business Model Generation*. 2010.
2. WEKERLE, Timo, FILHO, José Bezerra Pessoa, DA COSTA, Luís Eduardo Vergueiro Loures and TRABASSO, Luís Gonzaga. *Status and trends of smallsats and their launch vehicles - An up-to-date review*. 2017. *Journal of Aerospace Technology and Management*.
3. BOTHAM, Crystal M. and EVANS, Tanya M. How to design a winning fellowship proposal. *Nature*. 2018. Vol. 563, no. 7730, p. 283. DOI 10.1038/d41586-018-07297-x.
4. OSTERWALDER, Alexander, PIGNEUR, Yves and TUCCI, Christopher L. Clarifying Business Models: Origins, Present, and Future of the Concept. *Communications of the Association for Information Systems*. 2005. Vol. 16, no. July. DOI 10.17705/1cais.01601.
5. PROGRAMME, Chief International. *Small satellites : The NewSpace*. . 2018.
6. WIRTZ, Bernd W., PISTOIA, Adriano, ULLRICH, Sebastian and GÖTTEL, Vincent. Business Models: Origin, Development and Future Research Perspectives. *Long Range Planning*. 2016. Vol. 49, no. 1, p. 36–54. DOI 10.1016/j.lrp.2015.04.001.
7. *Space to Cloud Data & Analytics — Spire* [online]. [Accessed 9 November 2019]. Available from: <https://spire.com/en>
8. GOMSPACE. *GOMspace | Home*. [online]. [Accessed 23 November 2019]. Available from: <https://gomspace.com/home.aspx>
9. *GomSpace's company brochure*. GomSpace. 2019.
10. CHEREAU, Philippe and MESCHI, Pierre Xavier. *Strategic consulting: Tools and methods for successful strategy missions*. 2017. ISBN 9783319644226.
11. CASADESUS-MASANELL, Ramon and RICART, Joan Enric. From strategy to business models and onto tactics. *Long Range Planning* [online]. 2010. Vol. 43, no. 2–3, p. 195–215. DOI 10.1016/j.lrp.2010.01.004. Available from: <http://dx.doi.org/10.1016/j.lrp.2010.01.004>
12. MASSA, Lorenzo, ZOTT, Christoph and AMIT, Raphael. The Business Model: theoretical roots, recent developments, and future research. . 2010. Vol. 3, no. September.
13. ANNE, As and MIGLARESE, Hale. *The NewSpace Revolution : The emerging commercial space industry and new technologies What are the drivers*. . 2018.
14. NAGENDRA, Narayan Prasad and SEGERT, Tom. Challenges for NewSpace Commercial Earth Observation Small Satellites. *New Space*. 2017. Vol. 5, no. 4, p. 238–243. DOI 10.1089/space.2017.0014.

15. VIRGILI LLOP, Josep, ROBERTS, Peter C.E., HAO, Zhou, RAMIO TOMAS, Laia and BEAUPLET, Valentin. Very Low Earth Orbit mission concepts for Earth Observation: Benefits and challenges. *12th Reinventing Space Conference*. 2014. No. January 2016, p. 1–18.
16. DELPOZZO, Stephanie, WILLIAMS, Caleb and DONCASTER, Bill. *Nano/ MicroSatellite Market Forecas*. 2018.
17. MAGRETTA, Joan. Why business models matter. *Getting to Scale: How to Bring Development Solutions to Millions of Poor People*. 2013. No. 1. MAGRETTA, Joan. Why business models matter. *Getting to Scale: How to Bring Development Solutions to Millions of Poor People*. 2013. P. 33–68., p. 33–68.