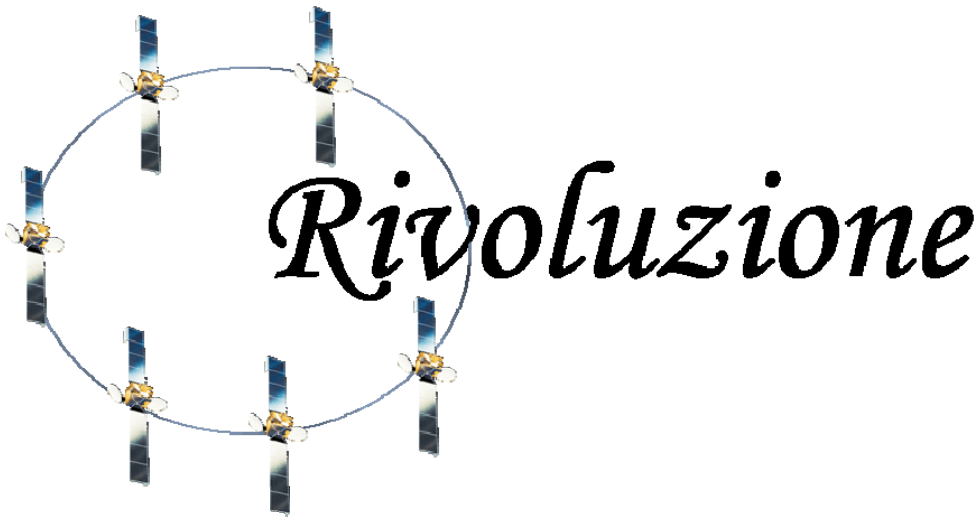
Enabling a more profitable business for commercial communication satellite manufacturers



Executive Summary

SpaceTech 11
Delft University of Technology
Delft, The Netherlands
July 2009

"Rivoluzione"
Enabling a more profitable business for commercial communication satellite manufacturers

Executive Summary

The competitive and evolving nature of the commercial communications satellite market, combined with the limited number of allocations in geostationary orbit, have led to a steady increase of the complexity, size, and weight of satellites over the years. Satellite manufacturers have suffered from increased non-recurring engineering costs and low rate production, leading to insufficient profit margins.

"Rivoluzione" recognizes an opportunity to capitalize on the overcrowding of prime geostationary orbit slots and provide satellite service providers with a scalable space system solution fulfilling their need to follow market evolution.

The proposed space system, FormSat, is based on standardized medium power satellites flying in formation in the geosynchronous orbit. The system will consist of transparent communication satellites connected via inter-satellite links to a hub satellite, which carries the processing and routing functionality of the communication satellites in the formation, allowing management and optimization of in-orbit resources. This system architecture is integrated with attractive services into a new payload hosting business model. Satellite service providers enjoy reduced upfront investments, and are able to gradually deploy and expand to new applications or commercial markets with reduced risk.

In summary, *"Rivoluzione"* will provide a profitable and sustainable business for satellite manufacturers with reduced upfront investment and additional new value added for satellite service providers.

Final Proposal Contents

Executive Summary Contents

The executive summary covers the following subject areas:

Overview

The need

In the last twenty years, satellite manufacturers in the commercial communications satellite market have seen a steady increase in satellite size and complexity, highly evolving customer requirements leading to unique product designs, and low rate production. This has resulted in inadequate profit margins to justify sustained long term business in the commercial communication satellite manufacturing business.

"Rivoluzione" is a subsidiary of an existing Satellite Manufacturing Company, hereafter referred to as "The Company", with the mission to improve sales and profit margins for satellite manufacturers while meeting evolving and challenging needs of satellite service providers.

"Rivoluzione" assessed the market to understand the customer, satellite service providers (SSP). Satellite service providers face a high financial barrier to entering the market, replacing or increasing service capacity. Satellite service providers require a shorter time to market in order to fully capitalize on market trends in services and growth over geographical areas. Their business is also restricted by the limited number of allocations in geostationary orbit and therefore access to desirable orbital slots is of premium value. Given the evolving nature of the market, there is also a need for risk reduction, quick responsiveness to introduce new services and applications, and overall service flexibility over the satellite lifetime.

"Rivoluzione" will address these customer needs by means of an innovative, flexible and scalable system solution integrated with attractive new payload hosting business model which will enable improving manufacturers' profitability.

Opportunity and Objectives

Current satellite system designs do not provide a common system solution and are unique products customized for each SSP's current needs. Furthermore, there is a tendency toward larger and more complex satellites, with higher cost and centralized risk, to make resourceful usage of prime geostationary orbit slots. "Rivoluzione" will set a new direction and develop an innovative system concept integrated with multiple attractive services to provide an encompassing scalable and flexible solution to satellite service providers.

"Rivoluzione" recognizes a profitable business opportunity to capitalize on the overcrowding of the geostationary orbit and provide satellite service providers with a flexible and scalable system solution fulfilling their need to follow rapid market evolution.

Systems and Business Engineering

Various systems concepts and business models were developed through a combined systems and business engineering evaluation process. The joint systems and business engineering approach allows bringing together technology and engineering perspectives with market and business perspectives.

As a result, the solution proposed by "Rivoluzione" consists of a compatible and profitable system concept and business model.

The Solution

The space system concept, FormSat, consists of medium size standardized satellites flying in a formation in geosynchronous orbit. Payload distribution allows for gradual deployment and scalability of the system exceeding the performances of the current generation of large commercial platforms. It allows for manufacturing of simpler, smaller and standardized satellites. The FormSat system is composed of bent-pipe satellites, AntSats connected via inter-satellite link with a HubSat satellite, which carries on board processing and routing capability.

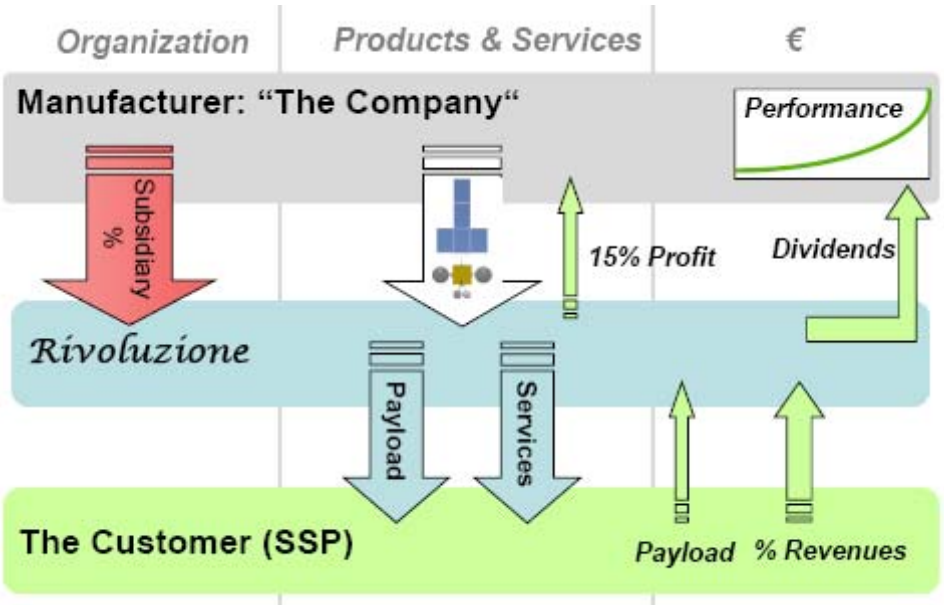
This new end-to-end technical solution provides the ability to address multiple markets with one space system. This is coupled with a new payload hosting business model based on a split ownership of payload and platform by satellite service providers and "Rivoluzione". Additionally, it incorporates the offering of operations services by "Rivoluzione" over the satellite lifetime in exchange for satellite service providers' revenues sharing.

Products and Services

"Rivoluzione" is a subsidiary of "The Company" acting as brokerage interface with satellite service providers offering payloads, launch, insurance and operations services. A new payload hosting based business model is introduced as an evolving strategy from manufacturer traditional business model to a more profitable model through the integration of the sale of satellite products with operational services during the satellite lifetime.

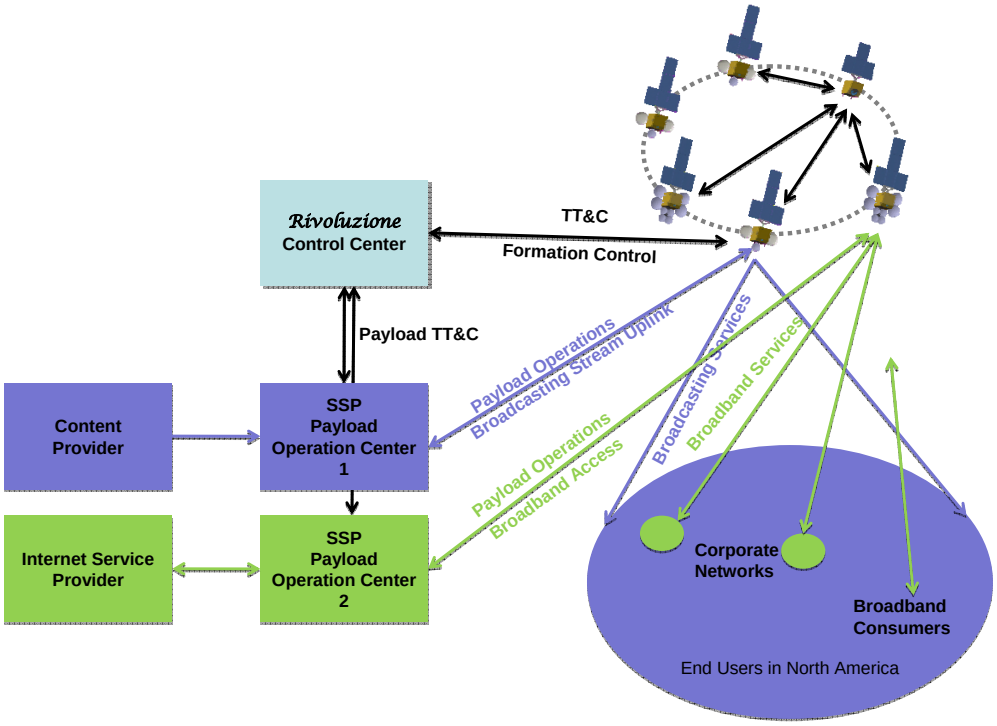
"Rivoluzione" offers an a-là-carte menu of selected products and services with attractive options to respond to satellite service providers needs. Products will include three types of flexible communication payloads in C/Ku/Ka-Band to support the market demand for broadcast and broadband satellite services. The "Rivoluzione" payload hosting business model includes platform and formation keeping operations as included baseline services in the a-là-carte menu. This model sells service providers only what they need – the payload – and handles all infrastructure and operations needs though "Rivoluzione".

The payloads will be hosted by a standardized platform which will be a new product line for "The Company". The platforms will be owned and operated by "Rivoluzione" as part of the FormSat infrastructure and payload hosting business model. Additionally, launch and insurance interface and brokerage services are offered as optional services at a split cost between "Rivoluzione" and the service provider.



The Functional Architecture

"Rivoluzione" has designed an integrated architecture of products and services with widely addressable applications in the satellite communications market sector. As a result of the "Rivoluzione" market analysis, emphasis is given to broadcast, consumer broadband and corporate networks applications.



Services extension to different market sectors is eventually anticipated. These include integrated navigation and multimedia services, data relay services, mobile satellite aeronautical service, earth observation, rescue and safety services, and navigation augmentation.

Market

Current and Future Trends in the Commercial Satellite Market

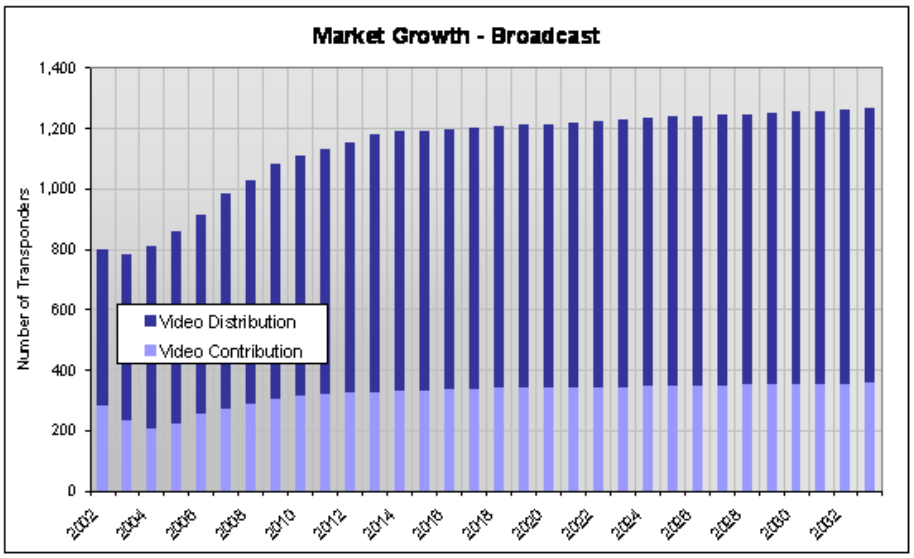
"Rivoluzione" performed an analysis of the commercial communication satellite market through a systematic approach of combining traditional market analysis techniques with original market research conducted through surveys and interviews with key industry stakeholders.

"Rivoluzione" will begin by focusing on the most commercially attractive market services and applications, with provision of integrated services and applications from a single geostationary orbital position. Growth potential is further foreseen by addressing newly developed attractive market sectors.

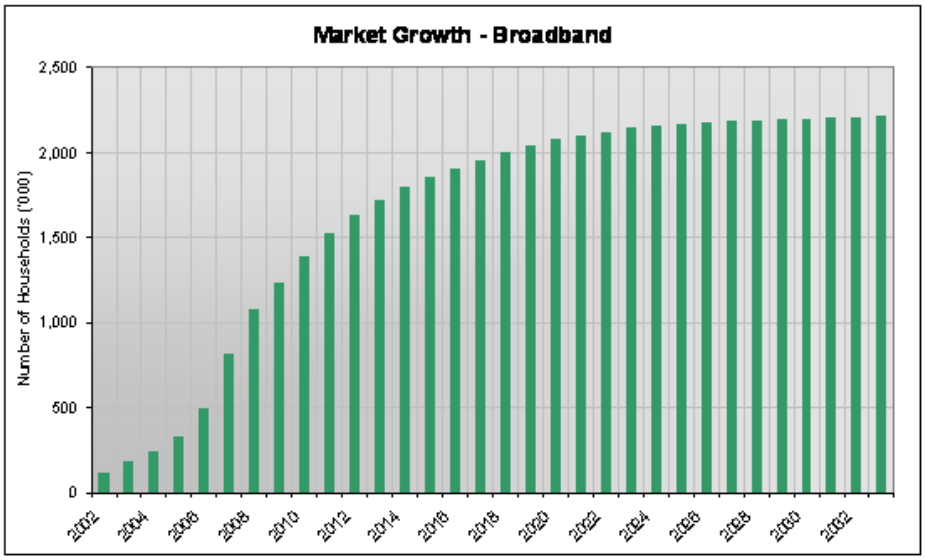
A summary of the "Rivoluzione" market analysis and trends findings are listed here:

Market Segments: "Rivoluzione" focuses on the fastest growing market segments of broadcast and broadband services as a strategy to capture the fastest growing service applications: broadcast, consumer broadband and corporate networks. Addressing the broadcast market (video contribution and video distribution) provides service application capabilities such as content management, satellite news gathering, IPTV networks, mobile TV, direct to home, standard definition TV, high definition TV, digital cinema, business TV and tele-education. Addressing the consumer broadband market provides service application for IP direct access. Corporate networks services provide capabilities such as public and private networks, rural communications, and telemedicine.

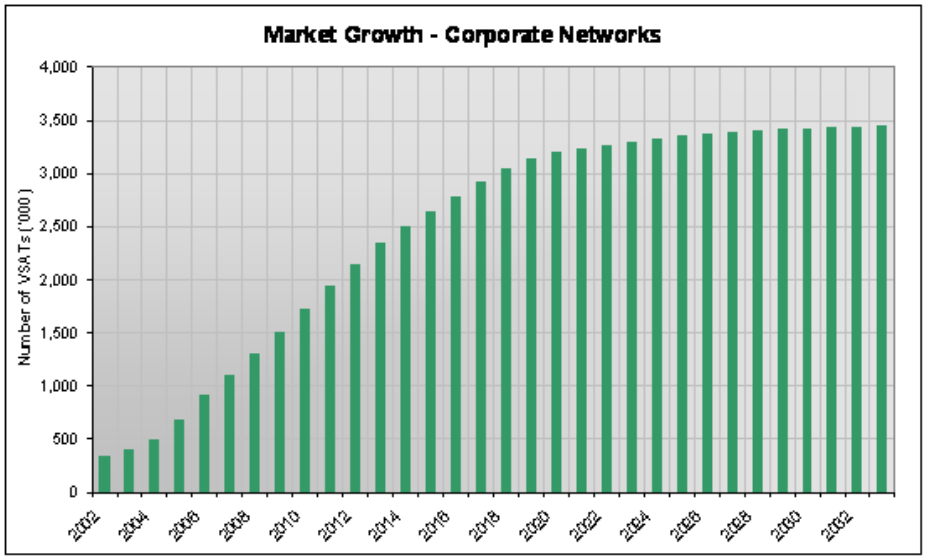
The expected growth for the selected segments is presented in the following figures. These are based on consultant agency forecasts through 2016 and on conservative estimates thereafter.



In particular, the market of broadcast services will keep progressively growing until year 2014 and will remain relatively stable during the rest of the period considered.



The market of broadband and corporate network services will experience a considerable increase in the next decade.



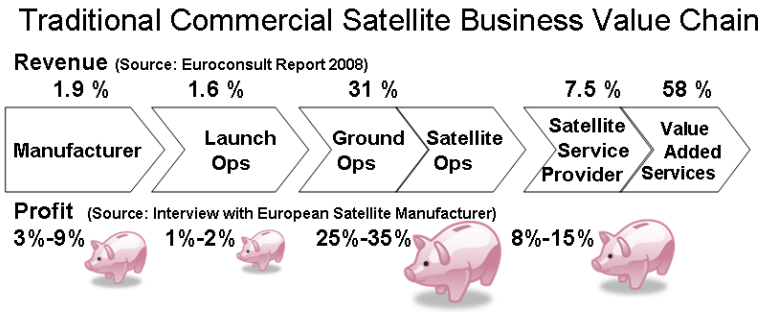
Geographic Areas: "Rivoluzione" expects the highest new growth in geographical regions of North America, China and Southern Asia and moderate growth in Latin America and Central Europe.

Satellites: Sales in the 6- 12 kW range will dominate near term sales for the next decade, largely driven by the need to replace capacity in existing systems.

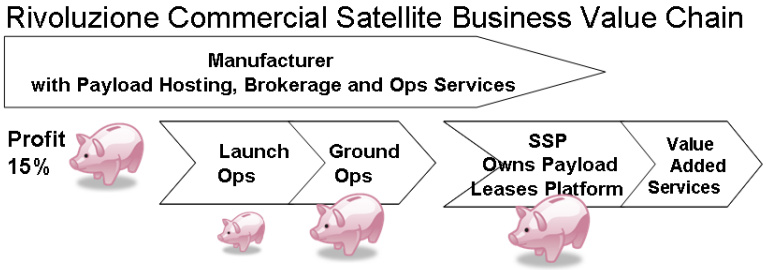
Horizontal and Vertical Integration Trends: The industry is experiencing a continuing increase in business horizontal and vertical integration, through both mergers and acquisitions. In addition, there is a growing consumer demand for integrated service and applications.

Value Chain

In the traditional commercial satellite value chain, key stakeholders have held unique roles, each with highly specific domain knowledge.



The traditional satellite value chain model has not historically provided manufacturers the ability to achieve a profit margin that will sustain a long term business. The unsteadiness of the commercial satellite market and the unique requirements from each satellite service provider have caused satellite manufacturers to suffer from increased non recurring engineering costs and low rate production. There is fierce competition between several large manufacturers and cost reduction is necessary for their survival. The future holds a likely consolidation or reduction of existing manufacturers unless new solutions and breakthrough thinking can increase profits to a sustainable level.

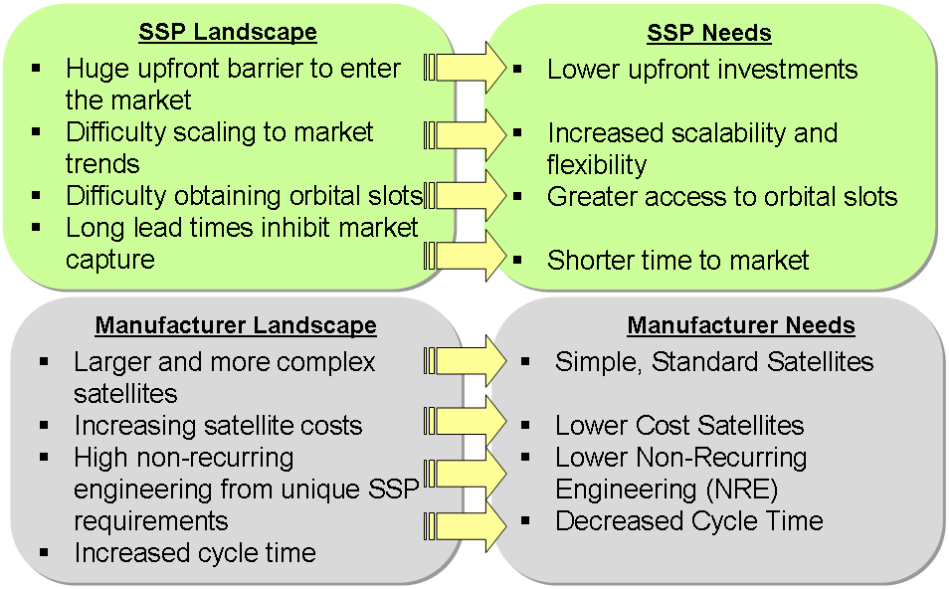


"Rivoluzione" proposes a new business model that allows satellite manufacturers to move up in the value chain by using a Payload Hosting based business model and offering operations services, while also providing a win-win situation to service providers with a solution that offers lower upfront investment, and the capability to gracefully expand services over time.

Customer Landscape and Needs

Only a handful of satellite service providers dominate the current market. This is attributed to the very high financial barrier to entering the market as well as the scarcity of satellite service provider domain knowledge.

In personal interviews conducted by "Rivoluzione" personnel, satellite service providers expressed the following trends in the landscape of their industry and their resulting needs, as well as the following challenges they see their manufacturers facing.



Service providers struggle with the enormous upfront investment required to enter the market or expand service. The "Rivoluzione" business model lowers this upfront investment by about half of the traditional requirement which allows emerging service providers to enter the business and established service providers to expand coverage.

Established service providers have the same financial challenge with expanding their coverage area and entering new markets. Using the "Rivoluzione" business model their risk and upfront investment is cut in half.

Obtaining desirable orbital slots from the International Telecommunications Union is becoming increasingly difficult. The "Rivoluzione" technical solution allows efficient use of the space in space.

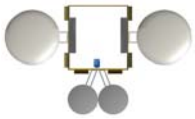
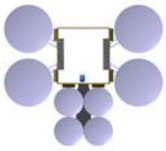
In addition, the time to market for providing service by satellite is increasingly demanding the ability to forecast trends years in advance. The ability to augment service markets incrementally over time is extremely attractive to satellite service providers as it allows them to more effectively follow market trends.

Products and services

Overview

Based on the market analysis results and recommendations, "Rivoluzione" provides a selection of payload products to cover the forecasted market demand in the broadcast, consumer broadband and corporate networks applications.

In the "Rivoluzione" new Payload Hosting business model "Rivoluzione" provides its customers the use of the satellite platform and operations. Launch and insurance services are also offered at a split cost between "Rivoluzione" and the SSP customer. This portfolio provides attractive services to satellite services providers which exploit the major advantages of the system concept in terms of gradual deployment and scalability, on-board processing and data management, and graceful depreciation.

AntSat Payload	Price* (M€, $M)			Revenue Sharing
	**C/Ku**	37 (51.8)	+	25% p.a.
	Launch (SSP share)	20 (28)		
	Insurance (SSP share)	7.5 (10.5)		
	In Orbit Payload PRICE	**64.5 (90.4)**		
	**Ka**	44 (61.6)	+	25% p.a.
	Launch (SSP share)	20 (28)		
	Insurance (SSP share)	7.5 (10.5)		
	In Orbit Payload PRICE	**71.5 (100.1)**		

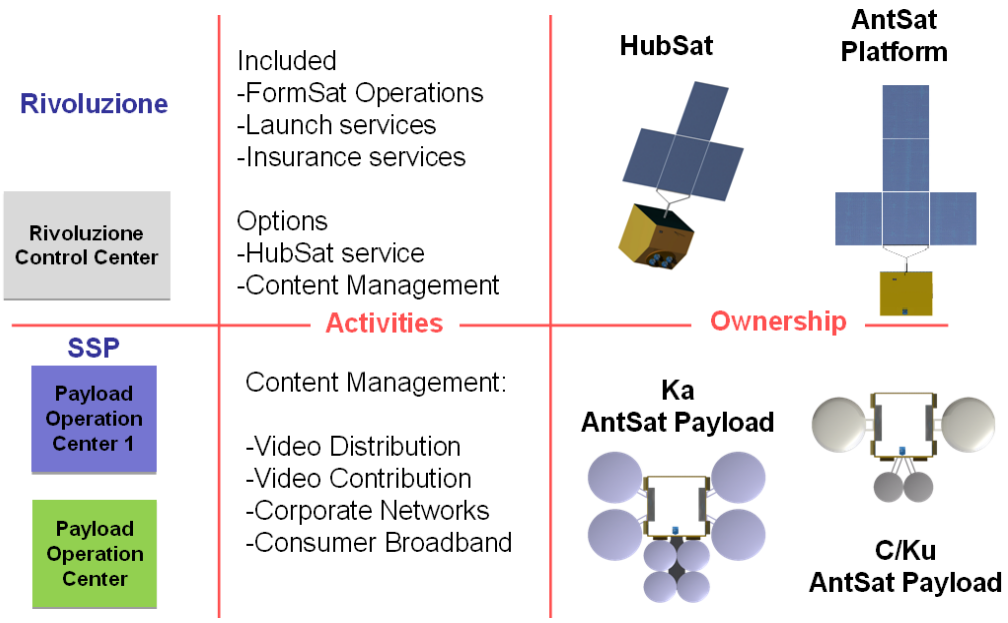
*Example: configuration Land Launch + 1 AntSat, 50% share for launch and insurance

Payload Hosting

"Rivoluzione" new payload hosting model is based on an split ownership of the AntSat between satellite service providers and "Rivoluzione". The satellite service provider purchases the AntSat communication payload, while "Rivoluzione" maintains ownership of the platform. Procurement of only the communication payload products, without the cost of a platform and operations, considerably reduces the upfront investment and entry barriers for satellite service providers by approximately 50% of the current market price.

Baseline services included with the purchase of a payload in the payload hosting model include use of the satellite platform, data processing, housekeeping and formation keeping services. Service providers can receive these benefits at a cost of 25% of their future revenues, which results in an attractive and low cost solution for "Rivoluzione's" customer. Additional services include brokerage for launch service agreements and insurance shared risk and costs.

This model allows a partnership in which "Rivoluzione" and the satellite service provider to master their respective core businesses.



FormSat operations

"Rivoluzione's" ground segment is the heart of the in-orbit operations service provision. A multi-mission control centre allows operating multiple FormSat segments, with dedicated ground stations per geographical area for direct uplinking and downlinking of telemetry, telecommand and tracking data to the FormSat. The ground segment provides the network connectivity with the customers' control centre for the provision of payload operations to the customer payloads. The FormSat 24/7 operational service is provided at 25% of the satellite service providers' future revenues and at no initial cost.

Launch and Insurance Brokerage

"Rivoluzione" provides the brokerage of launch and insurance services through case-by-case contractual arrangements. The baseline proposal is that costs for launch and insurance for AntSats are shared equally between "Rivoluzione" and the satellite service provider due to the split ownership of the satellite. This is a simple interface solution for the satellite service provider, and "Rivoluzione" has more domain expertise in brokering these services.

FormSat design has been optimized for flexible launcher opportunities from one to three satellites per launch. Insurance sharing covers Launch, LEOP, LEOP plus one year or LEOP plus full lifetime.

System description

The concept

FormSat concept distributes the functionality and payload typically carried by a large multi-service satellite into smaller and simpler satellites. The system multi-service functionally is integrated by means of inter-satellite links.

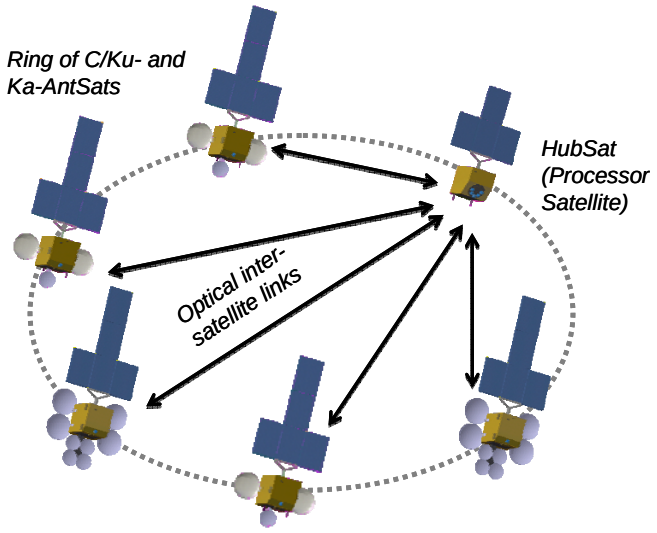
Payload distribution allows for gradual deployment and scalability of the system exceeding the performances of the current generation of platforms while allowing manufacturing of simpler, smaller and standardized satellites.

System Architecture

The system architecture consists of:

- The space segment, FormSat, is a geosynchronous formation flying of satellites that performs an integrated function by means of inter-satellite communication links. The FormSat satellites are classified in two types:
  - AntSats, payload hosting satellites, carrying reception and transmission functionalities such as a bent-pipe satellites, or processed on board by
  - HubSat, a regenerative processor satellite that conditions, processes and routes the data streams via the AntSats down to ground

The formation is interlinked with high data rate analog optical inter-satellite links (ISLs) to route the data streams via the regenerative processor. The ISLs are also used to collect and distribute telemetry and telecommands to the different satellites in the formation.

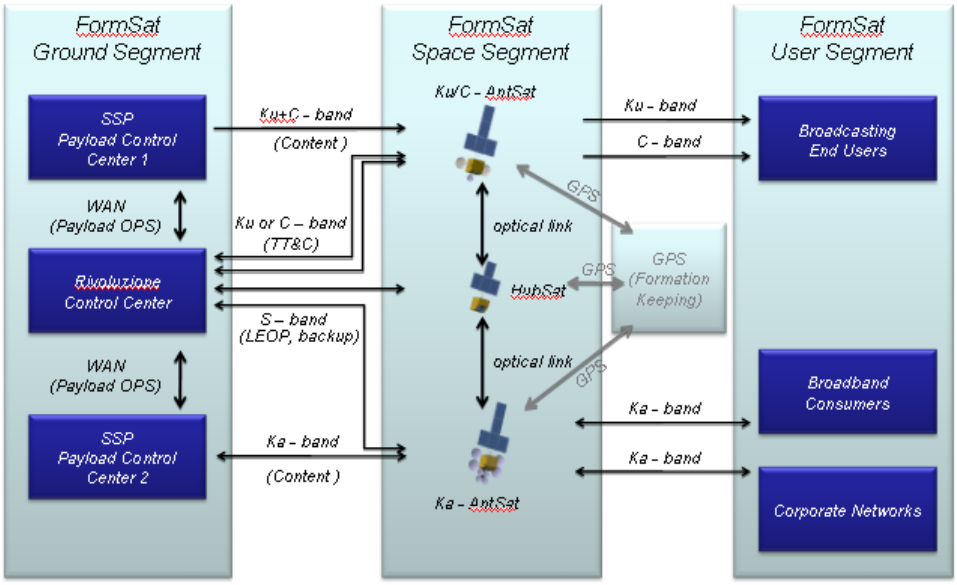


- The Ground Segment is the backbone of the "Rivoluzione" payload hosting model, and is decomposed in three main parts:
  - "Rivoluzione" ground segment, which provides satellite telemetry, telecommand and tracking (TT&C) control of the autonomous FormSat and satellites, and the infrastructure required to connect to the SSP ground segment
  - The SSP ground segment with monitoring and controlling capabilities for hosted payloads operations, as well as upload of data content and access. As a baseline, payload TT&C operations are uplinked from the "Rivoluzione" control centre as part of the overall TT&C operations.
  - The infrastructure segment, which connects "Rivoluzione" and satellite service provider ground segments and allows for business expandability to

acquire new customers.

- End users access FormSat via off-the-shelf end user terminals provided by satellite service providers. FormSat allows for the provision of multiple services from a single geostationary orbital position, which constitutes an attractive feature for end users.

The high level physical architecture is represented below.

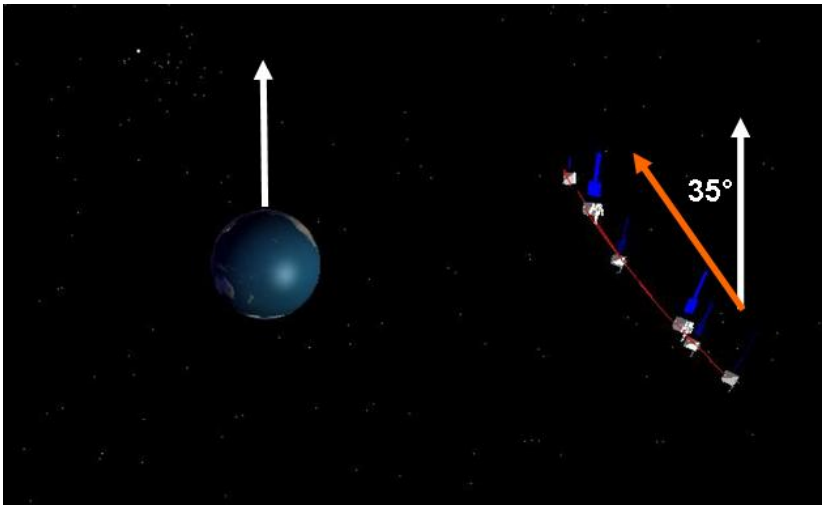


Space Segment

FormSat space segment is composed of reception and transmission bent-pipe satellites, AntSat, and processing satellite, HubSat, rotating in a 24 hours ellipse in geosynchronous orbit.

The dynamics and collision free characteristics of the formation are achieved by applying an inclination to the satellites' orbits, which causes an oscillation from northern to southern latitudes and an offset in eccentricity, which introduces an oscillation in longitude. The combination of both results in an ellipse, which enables an a priori collision free operation of the satellites. For achieving an equidistance spatial spacing, the true anomalies of all satellites are evenly distributed.

As represented in the figure below, the formation plane is tilted by ~35° to the Earth's rotation axis. The relative motion of the satellites may be described by a co-rotating co-ordinate system with the origin being the ideal geostationary position. The shortest distance between any two satellites is a design parameter, which has been optimized to 50km +/-2km.



The satellites are equipped with a GPS device for absolute navigation. For autonomous control, the absolute positions are distributed via inter-satellite links, allowing safe formation flight without need for ground control. In case of contingency, the system can also be operated via a conventional TT&C link.

FormSat integrated services and functionality is accomplished with a hub and spoke network topology between those AntSat providing primarily broadband services and HubSat. The inter-satellite link is established via analog optical inter-satellite links with bandwidth of up to 3 GHz. The link terminals include pointing and tracking capabilities and are based on existing terminal prototypes. The basic technologies have been validated in-flight on component or sub-system level in other missions, but a dedicated development and qualification effort is required to demonstrate that the power and reliability requirements can be met. The short link distances allow using highly de-rated laser power and ease pointing accuracy, which leads to significantly reduced complexity, compared with other optical space communication links.

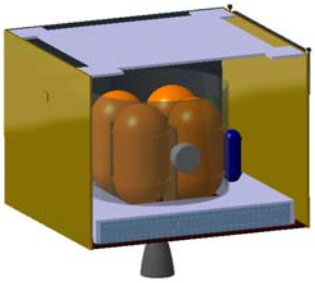
HubSat on-board processing functionality serves to the maximization of the in orbit resources in terms of capacity and performance. In particular, this is relevant for the provision of point-to-point or multipoint to multipoint services over multispot coverage areas. Capacity maximization is achieved by single hop routing and multispot connectivity, as well as access efficiency with low processing and connectivity granularity. This allows for performance maximization, low latency, and efficient resource usage to follow the traffic demand. Furthermore, the split functionality into a separated HubSat allows for graceful degradation of rapidly evolving technology.

In line with the on board processing technology evolution, HubSat processing capacity in excess of 30 Gbps is estimated for the initial development. The space segment will be gradually deployed to reach up to six satellites per formation which means one HubSat and five AntSats.

Platform

FormSat payload distribution optimizes services performances and scalability, while allowing for the standardization of medium platforms.

A new 7 kW product is established in "The Company" to embark the AntSat and HubSat payloads. The platform dimensions and payload hosting capabilities are shown in the following table.



Parameter	
Bus dimensions (HxWxL)	3,2 m x3,2 m x2,8 m
Payload mass capability	500 kg
Payload power	4.5 kW

The manufacturing of the platform is achieved by modifying an existing platform for specific implementations such as single rotating solar panel and tilted plane to accommodate the ISL terminal. The deployment strategy of FormSat allows reaching economies of scale due to the gradual deployment of further satellites associates to the same formation.

The power subsystem produces, stores, regulates and distributes electrical power to the spacecraft subsystems. Five solar panels of 7.5 m^2 each composed of solar arrays triple-junction Gallium Arsenide (GaAs) continuously provide 7000 W. Advanced lithium-ion batteries are used, coping with 7300 duty cycle and having a specific battery capacity of 130 Wh/kg. For the HubSat satellite, the lower payload power requirement allows for 4 instead of 5 solar panels of 7.5 m^2 providing 5500 W in total and considering sufficient margin for inter-satellite link terminals and potential for FormSat scalability.

Two different propulsion technologies are used for an 18-year lifetime: chemical propulsion and electrical propulsion. The chemical propulsion system is responsible for geostationary orbit circularization and East-West station keeping manoeuvres using an apogee engine and 4 AOCS thrusters. The propellant mass of 1175 kg consists of mono-methyl hydrazine (MMH) as fuel and a mixture of nitrogen oxides (MON) as oxidizer, applying a 1:1.65 mass ratio. The electrical xenon ion propulsion system, XIPS, is used with 8 thrusters for North-South station keeping, momentum dumping and disposal.

The zero momentum three-axis stabilized Attitude and Orbit Control System (AOCS) allows providing an overall pointing accuracy of 0.05 degrees, The Attitude and Orbit Control System is equipped with gyroscopes, Earth and Sun sensors as well as star trackers as attitude sensor elements and four 68Nms reaction wheels for momentum storage to compensate the offset of the center of mass and center of pressure.

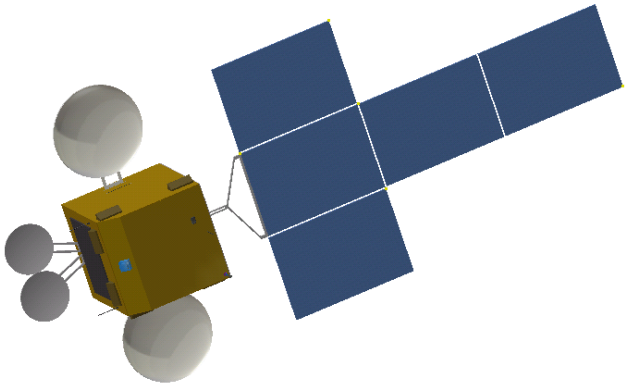
The Data Handling System (DHS) is mainly responsible for the handling of commands and telemetry data and the on board time management. This also includes interchange of the generated information between the sensing instruments to the respective actuator of the Attitude and Orbit Control Subsystem and the management of the heat dissipation for the thermal subsystem.

Communication Payloads

"Rivoluzione" communication payloads are targeted to respond to the evolving market demand. C/Ku-Band and Ka-Band payloads are hosted in different 7kW AntSat's.

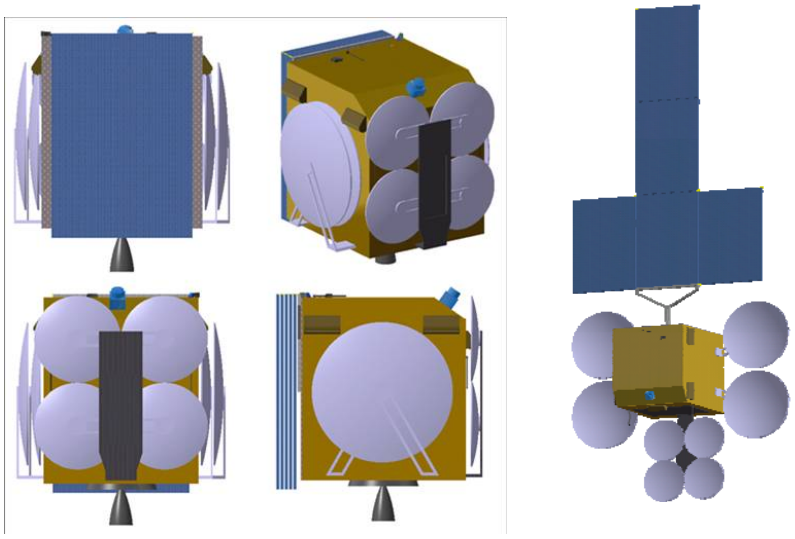
C/Ku-AntSat are suited to provide primarily broadcast services over wide coverage areas. The nominal operational mode for broadcasting services is transparent

mode of 18 transponders in Ku-band and 12 in C-band with 36 MHz each. The deployed configuration of the C/Ku-AntSat is shown.



The Ka-AntSat's are better suited for the provision of corporate network and consumer broadband services with multibeam coverage of 0.75 deg half-power bandwidth. On-board processing and therefore single hop end-to-end communication is provided by the HubSat in orbit. CONUS coverage is provided with 48 beams leading to a capacity of 4 Gbps. FormSat scalability allows reaching a maximum system capacity of 30 Gbps.

The stowed configuration of the Ka-AntSat and deployed configurations is depicted below:



Additional Hosted Payloads

Given the defined interfaces, other payloads can be hosted. This allows extension of the services provided from FormSat, e.g. from Satellite communications to Earth Observations or Navigations. The hosted payload would have a maximum consumption 4.5 kW and 500 kg weight.

Launchers

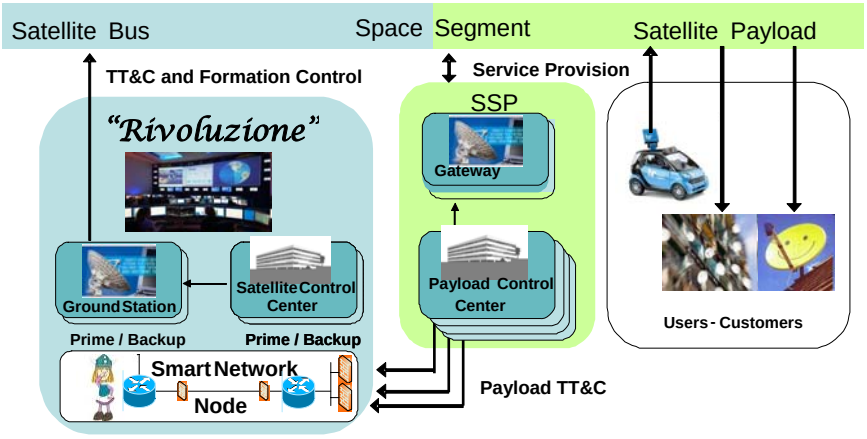
For added flexibility and cost effectiveness, a broad set of launch strategies covering single, dual and multiple launches is considered.
For a gradual deployment scenario of FormSat, the most cost-effective combination of launches is Land Launch or Soyuz / Fregat for a single transfer of an e.g. C/Ku-AntSat band satellite for provision of broadcast services, and Atlas V

for dual launch of HubSat and Ka-AntSat for broadband services.
A FormSat constellation having as a minimum one C/Ku-AntSat, one Ka-AntSat and one HubSat, requires delivering three satellites in one launch. Including propellant and adapters the entire constellation will have a mass of about 10 tons. This leads to an Ariane 5 or (in the future) to Falcon 9 Heavy.

Ground Segment

The ground segment architecture mirrors the prime idea of separated ownership of the payload hosting model by splitting operational responsibilities between "Rivoluzione" and the customer: "Rivoluzione" is in charge of operating the system and the platforms while the customer is in charge of delivering the service and operating the payload.

The "Rivoluzione" ground control segment deals with all issues that are needed to control the entire space segment. It is composed of a Satellite control centre (SCC) which monitors and controls the satellites via tracking, telemetry & command. This is performed using a single ground station, and back-up ground station service in case of emergency, interfacing the entire FormSat via any satellite.



The satellite service provider ground segment deals with all issues that are related to the provision of the service. The payload control center (PCC) is in charge of the planning of the payload operations (payload configuration, processing capacity, ISL bandwidth), which is provided to the SCC as the central entity that coordinates the sharing of on-board resources. The satellite service provider uploads the service content to the satellites via the Gateway Earth Station (GES).

The user ground segment is based on end user off-the-shelf terminals for transmission and/or reception depending of the type of service.

System Development Lifecycle

FormSat system development and deployment follow a phased approach:

Phase 0, 2009-2013: Planning and Development of the specifications of the whole system. Development of components and technologies required for the System.

Phase 1, 2012-2013: Integration, test and verification of first "Rivoluzione" products.

Phase 2, 2014: Initial setup phase constitutes the initial build up of the formation. The first deployment foreseen is C/Ku-AntSat suited for provision of broadcasting services in transparent mode. This allows "Rivoluzione" to start up the business with the first satellite in space.

Phase 3, 2015-2017: During this phase one HubSat and a second AntSat will be launched. Technology evaluation of the formation integrated functionality, covering formation flying dynamics and autonomy as well as cooperation via inter-satellite links will be performed during the initial three months; afterwards provision of broadband services will be established.

Phase 4: This phase constitutes the final population of the formation up to its maximum capacity or customer needs.

Business

Strategic Business Model

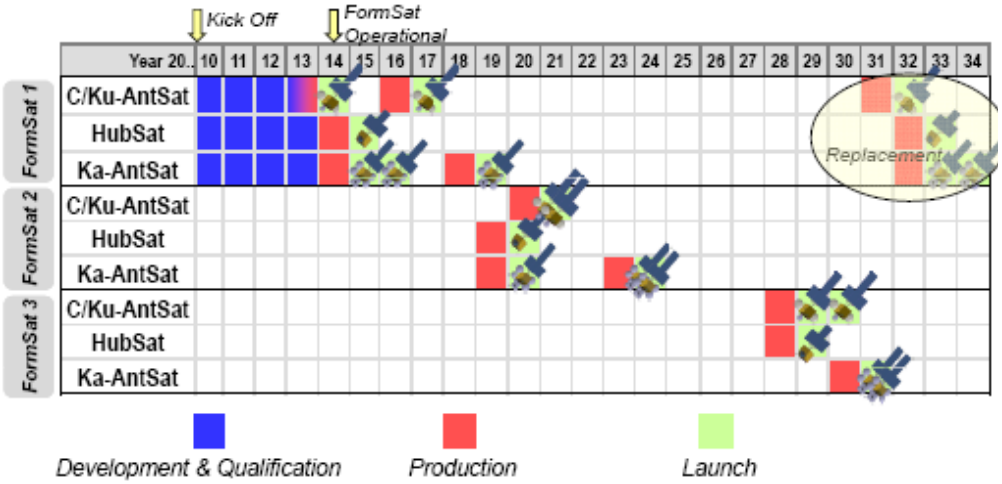
"Rivoluzione" is proposing a new version of the traditional payload hosting model in which "Rivoluzione", as a wholly owned subsidiary of "The Company", sells hosted payloads to customers at a fraction of what it would cost them to enter the market with the competition. "Rivoluzione" provides all infrastructure of the space segment including the satellite platform and in-orbit operations, and shares the cost of insurance and launch with the SSP. SSPs also benefit by being able to establish or expand their coverage sooner at a fraction of the traditional cost which enables them to follow marker trends more efficiently. "Rivoluzione" is able to provide this discounted service, infrastructure and reduced risk in exchange for a portion of the SSP revenue.

The financial figures shown in the Business Case clarify the opportunity for a satellite service provider in sharing revenues and sharing their overall business risks with "Rivoluzione". Through this strategic partnership, "Rivoluzione" allows new emerging SSPs to enter the market operational in Year 0 at a cost of roughly 60 million Euros less than our competition, and have a cumulative cost in Year 5 that is 50M Euros lower than the investment would be with alternative contractors.

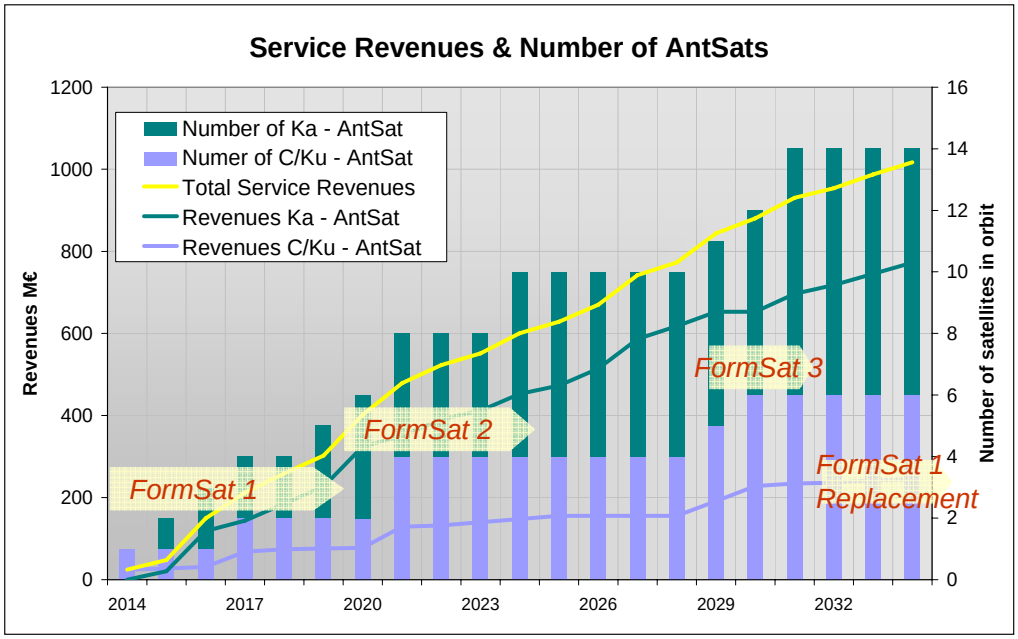
This strategic business model aims to sell to the customer only the item that they desire – the ability to provide service - without the cost and burden of owning and managing the additional space infrastructure needed to operate the business.

Market Share and Revenues

FormSat is a unique solution that allows for the capture of multiple satellite service markets in one system. Deployment of FormSat over the strategic geographical regions allows market capture sufficient to justify investment.



The figures below show the market potential for FormSat deployment over North America, which is selected as an attractive market because by 2016 it will have 20-30% of the world's market for Broadcasting, Broadband, and Corporate Networks.

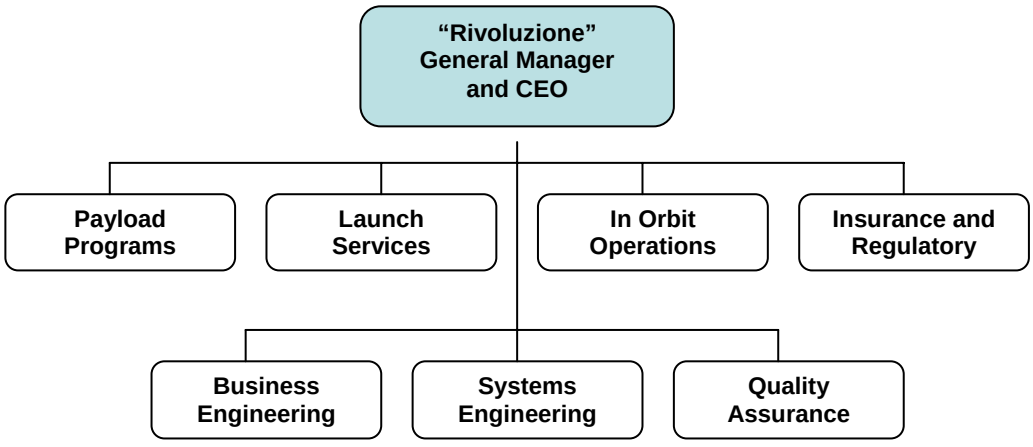


Considering a conservative market penetration ramping from 1% in year one to 10% in year 20, "Rivoluzione" will launch its first C/Ku-AntSat in 2014. Gradual deployment of additional satellites in the FormSat system over time will allow service providers to follow the growing market demand with incremental investments.

FormSat system scalability allows for market risk mitigation through scalability and incremental coverage providing satellite service providers with additional flexibility to follow the market.

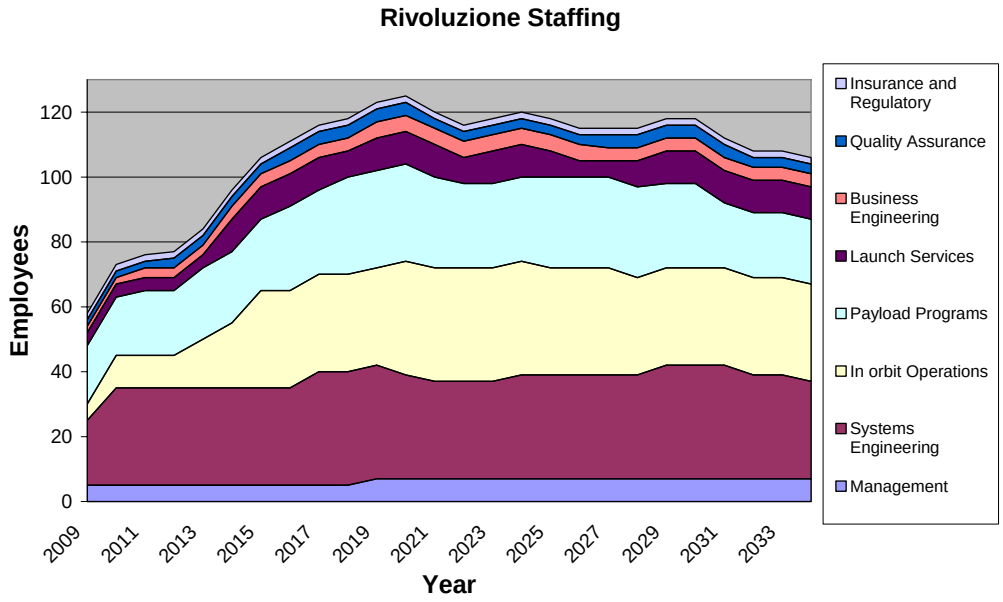
Management and Organization

"Rivoluzione" is formed as a subsidiary of "The Company", with the Board of Directors driving its strategic development. The organizational structural of "Rivoluzione" mirrors the products and services "The Company" provides.



"Rivoluzione" is a matrix organization that supports the Payload Programs Department, which is responsible for the management of each SSP customer's payload(s). The System Engineering Department provides the primary staffing for Payload Programs and is also responsible for the space based HubSat

infrastructure in FormSat that "Rivoluzione" owns. In-Orbit Operations is responsible for all FormSat operations for HubSats and AntSats including formation keeping and data processing. Launch Service and Insurance and Regulatory Services are responsible for the brokerage of Launch and Insurance Services which are both shared cost and risk with the SSP customer. Business Engineering includes Marketing, Sales (including after-sales activities, customer relationship, etc.) and Finance support of "Rivoluzione". Quality Assurance is intentionally a stand-alone "watch-dog" organization responsible for mission assurance of all of "Rivoluzione's" products and services.
A time-phased growth of personnel is required to support the operational requirements of FormSat gradual deployment.



Financial

Highlights

"Rivoluzione" not only provides an unprecedented profit on the sale of satellites to "The Company", but is also a profitable business in and of itself, with substantial value.

Over a period of 25 years, the "Rivoluzione" business creates the following values for "The Company":

- Continuous sales of satellite products for "The Company" at a profit margin of 15%
- 6.3% annual return from the Rivoluzione venture
- Ownership of a subsidiary with 725 M€ in assets and 45M€ cash in bank
- Ownership of a subsidiary with an EBIDTA-margin above 150M
- Ownership of a subsidiary returning substantial dividends to "The Company" from year 12
- An overall return on investment of 8.5 %

The creation of "Rivoluzione" also enables "The Company", as a satellite manufacturer, to launch a sustainable and profitable stream of its core business and the ability to move up the commercial satellite services value chain.

Cost and Pricing Strategy

Costs of products and services are based on industry research and interviews with key stakeholders, as well as analysis of the cost of the system bill of materials and estimated labour.

Satellite products, including HubSats and AntSats will be procured from "The Company" including a 15% profit (for "The Company"). Satellite payloads are then sold to the SSP at a price of 37M€ for C/Ku-band and 44M€ for Ka-band payloads with a built-in profit for "Rivoluzione".

Launch and insurance for the entire system are brokered by "Rivoluzione". The satellite service provider splits the price of launch and insurance of their AntSat with "Rivoluzione". "Rivoluzione" will offer these services to the SSP at market costs with an additional fee for this brokerage of the service to determine the price. This arrangement is on a case-by-case basis and will be included in the overall contract.

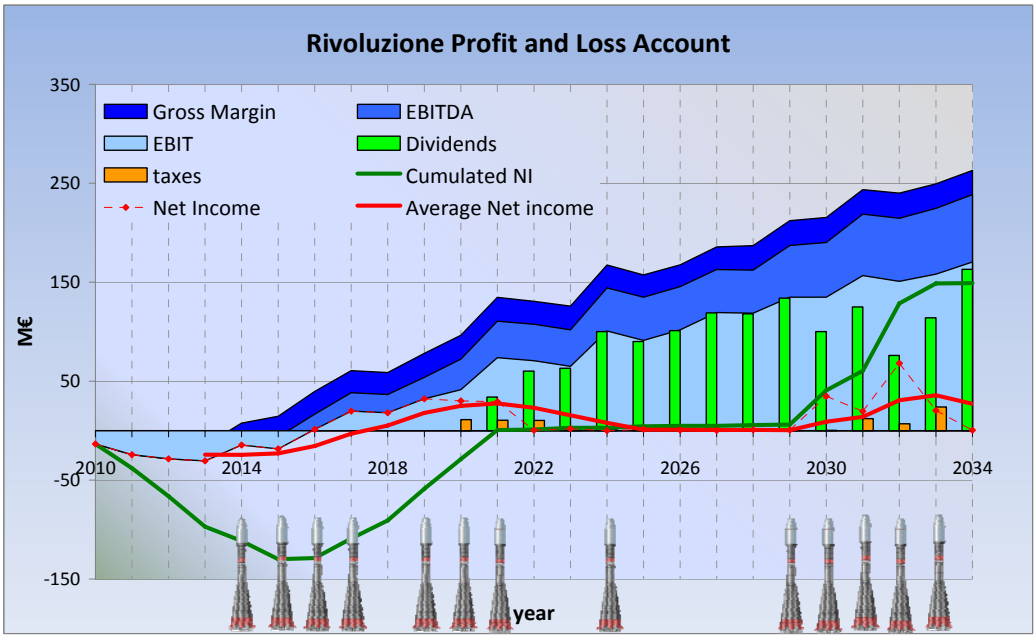
"Rivoluzione" provides in-obit operations at an internal initial financial loss, but recoups this investment through a contractual agreement to receive 25% of the satellite service providers' future revenues. This arrangement will be included in the overall contract at the time of purchase of the AntSat.

Profit and Loss Account

The following assumption have been taken for the pro-forma financials:

- **Planning Period:** 25 years (from 2010)
- **Structure:**
  - Separate Legal Entity (LLC)
  - 100% owned by "The Company"
- **Market:**
  - North America
  - Penetration:
    - Broadcasting 1-25%
    - Broadband & Corporate Network 1-15%
- **Service Revenue:**
  - C/Ku-AntSat: 37 M€ p.a.
  - Ka-AntSat: 98 M€ p.a.
- **Investments (CAPEX):**
  - Space Segment:
    - 7 C/Ku-AntSat = 214 M€
    - 13 Ka-AntSat = 345 M€
    - 4 HubSat = 390 M€
  - Ground Segment: 4.4 M€
  - Lifetime: 18 years
- **Expenses (OPEX):**
  - Personnel: 60-120 staff
  - Other corporate
  - In-Orbit-Insurance
- **Costs of Goods Sold (COGS):**
  - Ka-AntSat Payload
  - C/Ku-AntSat Payload
- **Financing:**
  - 100% Equity: 618 M€
  - (The Company: 317M€ Cash + 301M€ Loan, 5% p.a. Interest Rate)
  - Dividends: 100% to "The Company"
- **Taxes:**
  - 35% Corporate Tax

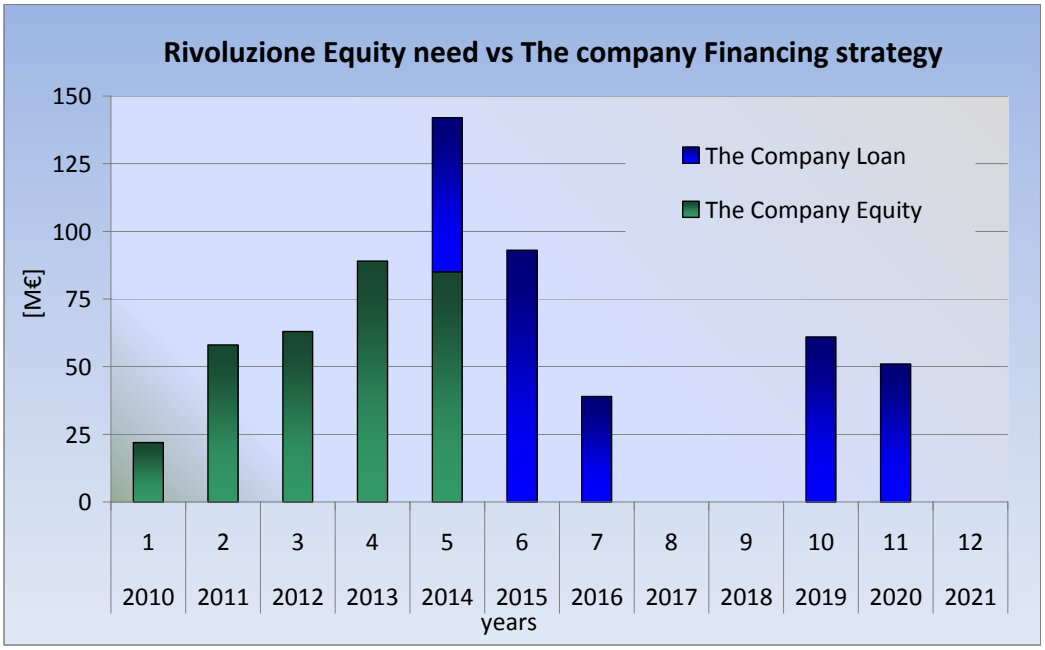
"Rivoluzione" financial results show it starts being profitable in years 2016, which makes a time to profit of 7 years. The payback period is 11 years. The performance of the business improves steadily enabling substantial dividend payments.



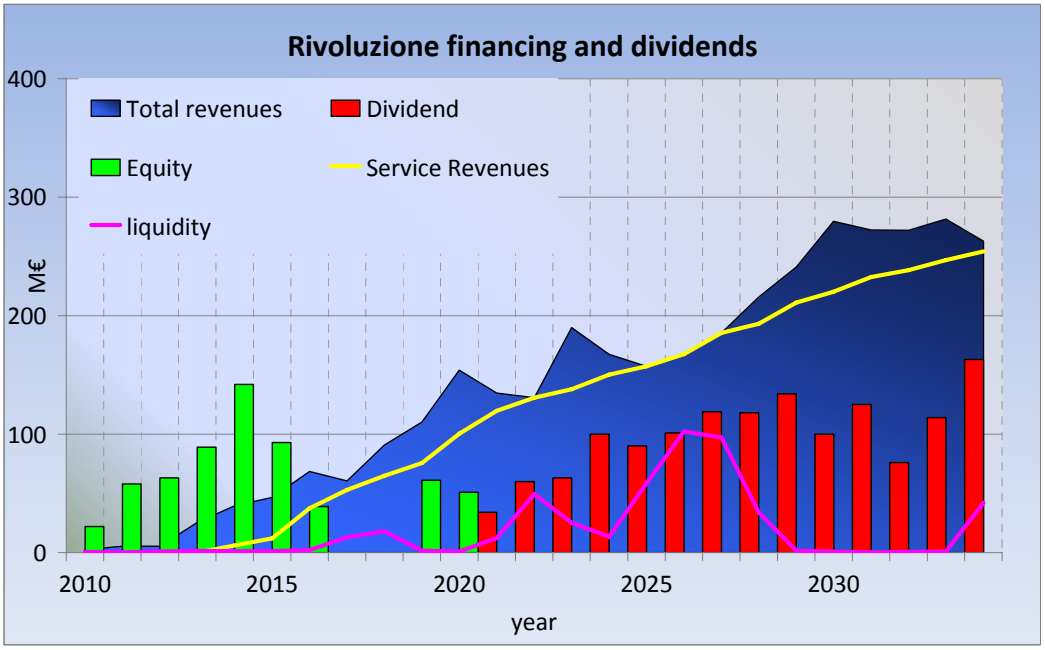
Financing Plan

"The Company" will provide the necessary funds to establish "Rivoluzione". Options include using own cash, involving partners (equity investors), a combination of straight

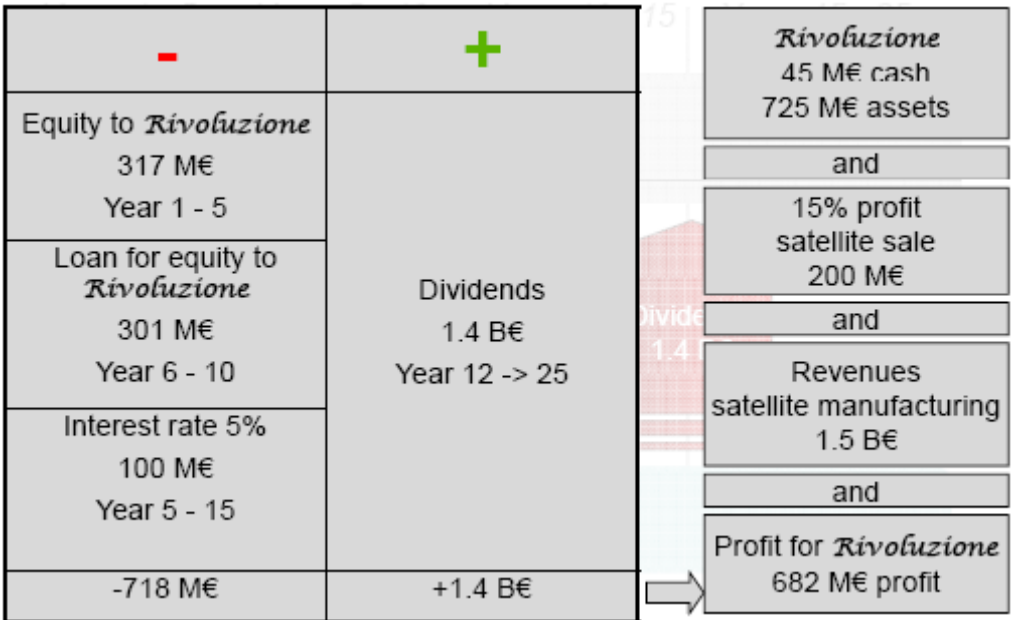
equity and bank financing (debt) as well as partial flotation at the stock market (IPO). A suggested financing strategy is presented in the figure below and presented in the following sections.



The following chart shows financing and dividend return from "Rivoluzione" starting in 2021.



The cash-on-cash balance for "The Company" resulting from Rivoluzione for the 25-year planning period case is presented in the next table.



The following table summarizes the performance for "The Company" for the 25 years business case for the new manufacturing product line introduced and for the financing of "Rivoluzione".

The Company IRR	
Satellite sales	15%
Return from "Rivoluzione" venture	6.3%
Compound IRR	8.5%

In summary, the creation of "Rivoluzione" not only enables "The Company", as a satellite manufacturer, to maintain a sustainable and profitable business, but it also provides additional value resulting in an overall return on investment of 8.5 %.

Risk Management

Overview

Identification and assessment of business, technical, legal and regulatory risks allows implementation of risk management to minimize, monitor, and control the probability and/or impact of issues.
"Rivoluzione" risk management process evaluated alternatives required for risk mitigation. A risk register is established to support the process.

Business Risks

The following table presents the highest severity risks and associated mitigation technique.

Risk	Impact	Probability	Severity	Risk mitigation
Downturn in the market	Lower profit	low	high	Conservative market penetration analysis
Schedule slip	Cost and revenues impact and customer dissatisfaction	medium	high	- Rigid project management - Low Non Recurring Engineering
Underestimated non recurring costs	Lower profit	medium	high	Assessment via sensitivity analysis
Organizational interfaces and responsibility overlap	Inefficiency and cost impact	low	high	Clear organisation according to work breakdown structure and work package description

"Rivoluzione" has performed a sensitity analysis of its business, which showed robustness against several negative scenarios, such as cost increase and schedule delay. The analysis also showed sensitivity to revenues sharing assumption.

FormSat Technical Risks

The innovative FormSat solution requires systematic assessment of design risk related to the system's technical complexity, performance, schedule and cost. Identification of critical risks well upfront in the system design phase is fundamental and allows for the definition of architectural guidelines: scalability, service availability, operational complexity, system development timeline. These provided guidance and priorities for trade-offs during the architectural definition of the FormSat system.

Risk	Impact	Probability	Severity	Risk mitigation
Integration of the complete satellite functionality via inter-satellite link	Service disruption	Medium	High	- Full ground qualification plan for ISL ground - ISL terminal with 2-to-1 internal redundancy - Additional ISL terminal with link handovers for HubSat

Solar panel line of sight interference with ISL	Limits number of satellites in formation	Low	High	Platform design adapted to ensure free optical link field of view with single solar panel and tilted plane
HubSat failure	Service unavailability	Low	High	Redundancy in HubSat system AntSat autonomy in bypass mode
Collision of satellites	Loss of service	Low	High	Autonomous navigation for formation flying and relative position keeping

Legal and Regulatory Risks

All legal and regulatory aspects of the "Rivoluzione" business, including products and services, have been analysed by consulting with industry insurance representative and have been determined to present no unique issues. A flying formation system occupying one geostationary orbital slot is subject to the same restrictions as any one spacecraft or system occupying the orbital slot, including frequency allocation and interference requirements.

Orbital slots will continue to be obtained by the Satellite Service Provider. A contractual arrangement will be made with the first use customer for "Rivoluzione" to make use of the orbital slot rights for the additional expansion of the FormSat system.

Conclusions

The market is primed for the FormSat solution which has the capability to provide Broadband and Broadcast services in the same system, allowing penetration of the fastest growing satellite service markets.

The innovative FormSat system provides a solution to the scarcity of prime geostationary orbit slots and provides satellite service providers with a flexible and scalable space system solution fulfilling their need to follow market evolution.

The new payload hosting business model based on a split ownership, risk, and revenue sharing enables satellite service providers to overcome the high barrier to entering the market and expanding their services. This attractive model invites emerging small satellite service providers to break into the industry, as well as medium and large service providers to expand their businesses.

"Rivoluzione" will provide a profitable and sustainable business for "The Company" with an acceptable upfront investment and additional new value for Satellite Service Providers. The "Rivoluzione" business case shows stable and promising financial performance, and the return of 8.5% profit to "The Company" plus the company "Rivoluzione" (a next generation player in the satellite industry), which is unparalleled in the manufacturing industry today.

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