Micro-launchers: what is the market?

Quick and flexible delivery of small payloads

Micro-launchers: an alternative option for small-satellite delivery

Traditionally, small satellites (below 500kg) are delivered as piggyback payloads on rockets commissioned for larger spacecraft. In this situation the primary payload takes priority, and extra payloads have to be adapted to the launch schedule and orbit. Other small-satellite delivery systems exist, such as the CubeSat deployers that are used on board the International Space Station (ISS). In addition to conventional rockets, some companies are currently developing micro-launchers for small-satellite deliveries, and suborbital applications, such as microgravity experiments, which at the moment are generally performed using sounding rockets.

In 2015, the small-satellite delivery market was estimated to be worth between €180 million and €410 million[1] (for satellites below 500kg and a variable price per kilo depending on the launch systems and options).

Types of micro-launchers

There are two main types of micro-launchers currently developed by the launcher community. The first are airborne launch systems using a launcher released in high altitude from specifically designed or converted aerial platforms. The second are land-launch systems operated from mobile or static launch platforms.

A need for quick and flexible space delivery of small payloads

The rapid increase in forecasted small satellites to be orbited and the need for placement flexibility and launch responsiveness to maintain such constellations can create a launch offer crunch, stimulating the need for innovative launch services that are convenient, cost-effective and flexible. In addition, a number of small satellites for governmental customers are currently launched using converted Intercontinental Ballistic Missiles (ICBM). The progressive depletion of decommissioned ICBMs stock and the still valid restriction on their commercial use[2] adds to the need for alternative dedicated launch systems.

Several advances were made in the past, but so far attempts to create reliable and affordable micro-launchers have failed, mainly due to high launch prices or immature technology. The limited availability of appropriate launch systems can be expected to curb the deployment pace of small satellites. In the latest SpaceWorks forecast[3], the projections of nano/microsatellites launches in the coming years have been scaled down by about 30%, due, among others, to a restrained access to launchers.

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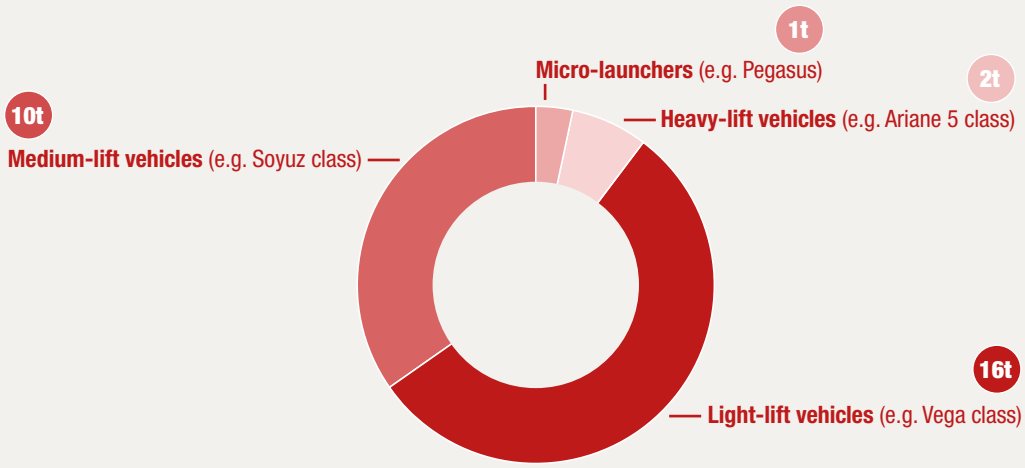
A changing regulatory framework

Typically, the low Earth orbit (LEO) for small satellites is an altitude of under 800km. With mitigation guidelines from the Inter-Agency Space Debris Coordination Committee (IADC) potentially becoming mandatory for small satellites without deorbiting systems, the authorized orbits for such payloads would be under 500km, reducing the number of piggyback missions that launchers not specifically tailored to small-satellite delivery can perform.

Figure 1 - **Mass of small satellites (below 500kg) launched from 2011 to 2015, by launch vehicle type**



State of the micro-launcher market

A major opportunity pursued by micro-launcher companies is to develop differentiating factors from the other solutions described above to win significant market share in the delivery of small satellites.

The demand for micro-launcher compatible payload delivery is here

Between 2011 and 2015, demand for institutional and educational payloads was relatively stable and represented around 60% of small-satellite launches. However, it should be noted that most of the launches were free.

Interestingly, over the same period small-satellite (below 500kg) commercial space deliveries grew significantly between 2012 and 2014, especially due to the number of satellites weighing less than 10kg each delivered for Planet (formerly Planet Labs).

Market demand for small-satellite delivery is expected to grow

Currently, small satellites are typically used for Earth observation missions, technological trials, and telecommunication and educational purposes. More and more SMEs specialized in small satellites are emerging, and other major small satellite constellation projects are in development.

These projects are expected to be deployed in the coming years, involving a delivery phase for the related space infrastructure. At the time of writing, OneWeb, for example, has announced a programme involving around 900 satellites weighing 150kg each, and SpaceX has a project involving around 4,000 satellites weighing 390kg.[4] Their goal is to provide worldwide connectivity, offering satellite-based internet to end users. For the initial satellite deployment phase of its constellation project, OneWeb signed a contract with the proven medium-lift launcher Soyuz for 21 launches to deliver more than 700 of the 900 satellites in the constellation.

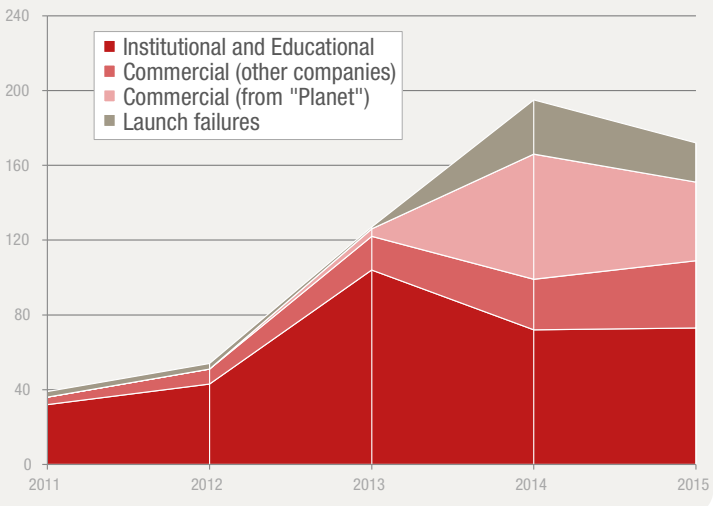
New companies and historical launcher integrators could develop the offering

Between 2011 and 2015, micro-launcher systems were mainly used for performing experiments (e.g. the Pegasus XL launch vehicle) or by emerging spacefaring nations with the objective of developing heavier lift vehicles (e.g. Iran with the Safir and Simorgh launch vehicles).

With lower entry barriers than for heavier lift vehicles, micro-launchers represent an opportunity to be seized for countries eager to develop a national space industry. In addition, new entrants backed by private investors and institutional funding, and driven particularly by the potential offered by LEO small-satellite delivery, are currently developing launch solutions to capture a share of this promising market. For example, in 2015, Rocket Lab, based in the United States and New Zealand, was awarded a launch services contract by NASA[5] and in November 2016, the Spanish startup PLD Space announced that it had been granted financial support from the European Space Agency (ESA) as part of its Future Launchers Preparatory Programme[6].

Depending on how demand evolves, historical space companies may also continue to invest in existing solutions (e.g. Orbital ATK's Pegasus XL) or shift their investment strategy to the development of new vehicles, using the experience gained from developing technology demonstrators and from partnerships with space agencies.

Figure 2 - **Number of payloads delivered below 500 kg (2011 - 2015)**



The view of the space community

New entrants in the satellite business want quick access to space

New entrants in the space community such as the "NewSpace" satellite operators are concerned about the current capacity for quick and cost-effective deployment of their space infrastructures. They are often discouraged by the prices and availability of existing launch services which are not tailored to their needs.

Microsatellite operators have welcomed the appearance of micro-launcher providers offering competitive prices compared to piggyback options, as well as flexibility and availability for regular launches.

An alternative approach for incumbents in the launch market

Historical players in the launch vehicle industry have adopted a cautious position regarding the potential emergence of a micro-launcher market. Most of them are focusing on their core business based on geostationary transfer orbit (GTO) capable launch vehicles, and related challenges such as modularity, reusability and cost-reduction. However, those established players do not exclude the possibility of expanding their range of micro-launcher services if and when the expected demand is confirmed.

Expanding their service offering would allow those historical players to penetrate a promising potential market, but this could also lead to drawbacks.
The main reason for choosing a launch service provider in the GTO-class market is the reliability of the launch vehicles. However, for the in-orbit delivery of payloads using micro-launchers, the main criteria are availability and launch frequency.
To reconcile the different approaches needed for the two launcher markets, historical players in the launch industry will have to challenge the conventional "cutting-edge" industrial processes which would not fit the "good-enough" culture of the micro-launcher market.

Institutions are backing the development of micro-launchers

Institutional bodies worldwide are supporting and encouraging initiatives to develop micro-launcher-based solutions. In Europe, the Space Strategy published in October 2016 by the European Commission announced that it will support "*research and innovation efforts, in particular to ensure Europe's ability to react to and anticipate disruptive changes (re-usability, small launchers)*".

In the US, NASA's Launch Services Program awarded three Venture Class Launch Services (VCLS) contracts to provide small satellites access to LEO using specifically designed launch vehicles. The companies selected include Rocket Lab, Firefly Space Systems and Virgin Galactic, which received financial support from the agency to develop their launch vehicles.

KEY HIGHLIGHTS

- Micro-launchers are an alternative method to launch small satellites into low Earth orbit.
- Most of the small satellites are currently launched as piggyback payloads on conventional launchers. Market changes are encouraging launch companies to develop vehicles specifically tailored for small satellites.
- Regulatory frameworks related to space debris mitigation and sub-orbital flight will have a significant impact on the operations of micro-launchers.
- Financial support from the public and private sector is crucial for the development of a micro-launcher market.

Financial challenges

The development of a micro-launcher system requires considerable funding and sizeable technological assets, and several projects have already been cancelled due to a lack of financial resources. In Europe, existing institutional and private bodies could be the agents of change for the segment. For example, the European Commission's H2020 programme is already supporting micro-launcher initiatives through the ALTAIR project.

Thanks to the financial support provided by NASA as part of the VCLS contracts, Rocket Lab and Virgin Galactic are close to performing their first launches, whereas at the time of writing, Firefly Space Systems is looking for additional funding. Undeniably, micro-launcher programmes represent a high level of risk, but they could also prove to be an extremely promising alternative and a valuable solution to a booming need. ■

Scenarios for the next five years

Considering the current demand and the technological progress being made on launch vehicles, three possible scenarios can be considered for the development of the micro-launcher market over the next five years.

Demonstration of a sustainable business model	Even though several programmes are currently ongoing and have received both public and private funding, the lack of a sustainable business model for the micro-launcher market could prevent its development. Potential barriers to the success of a launch market for micro-launchers include technological challenges, overly optimistic demand forecasts and the emergence of alternative solutions, such as the delivery of multiple small satellites on heavier launch vehicles using tailored satellite dispensers.
Status quo	Micro-launchers could continue operating in a market limited to institutional and educational applications (e.g. suborbital missions and technology demonstrators) and relatively small commercial satellite programmes. For small satellite operators, finding available, affordable launch solutions would still represent a challenge. Furthermore, any absence of institutional support for a favourable regulatory framework could prevent the growth of the micro-launcher market.
Boom	With technological challenges overcome, a favourable environment (e.g. support from institutional entities, private investment and positive regulatory frameworks), and sustained demand due to a global need to deliver and replace small satellites, the market for micro launchers could win a significant share of the global launch services market. If so, it could stimulate the interest of new entrants (including non-space companies) and also encourage emerging space nations to develop their own micro-launcher systems.

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Our vision

The success of the business model of micro-launcher service providers depends on the success of the small-satellites market (which has not yet been confirmed), mainly for the delivery and replacement of satellites as part of mega-constellation programmes.

The main challenges facing micro-launcher companies internally are related to the technology used, financial investment and the business models that have to be chosen. Micro-launcher companies will have to consider digitalisation, standardisation or automation of the manufacturing processes to reduce the price per kilogram and the cost of future launch options (e.g. piggybacking or dispensers on conventional launch vehicles).

In addition, the main advantages that micro-launcher companies are claiming to offer to their customers compared to conventional solutions are the greater availability of launch slots, higher launch frequencies and a flexible payload delivery. New ways to sell launch services will have to be considered by companies willing to enter this promising potential market which could mean more risk sharing with the customers.

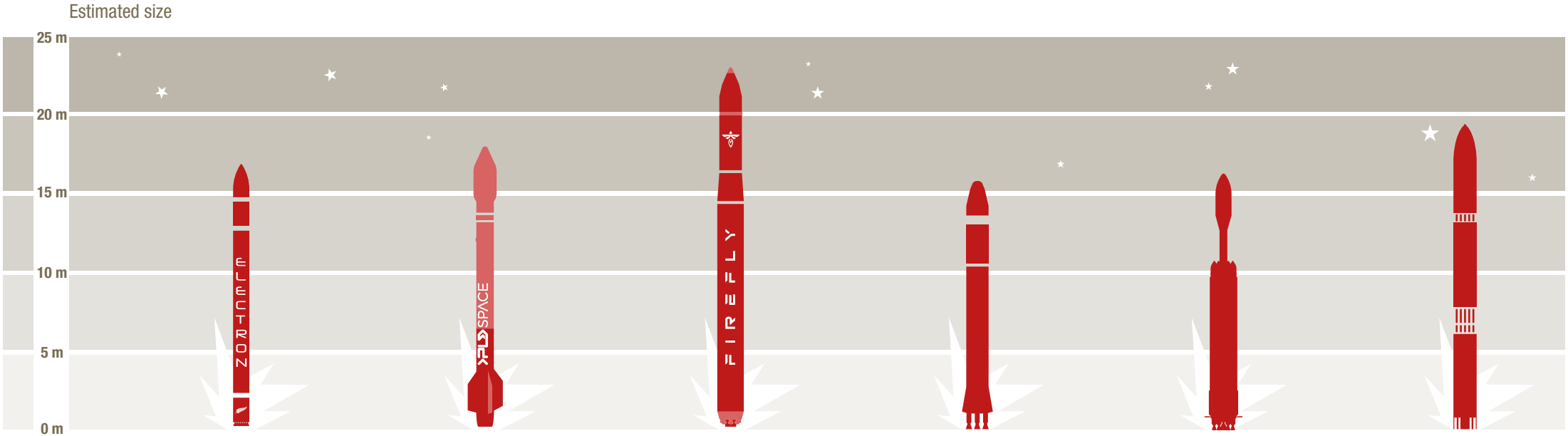
Finally, the creation of a favourable environment is a necessity for the development of the market.
Current and future micro-launcher programmes could benefit from the support of institutional entities through innovative procurement approaches, financial support and a tailored, flexible and coordinated regulatory framework that could allow launch companies to operate micro-launchers in orbital and also sub-orbital flights. ■

Sources

Stakeholder consultations
(1) PwC analysis based on internal space launch database (PwC)
(2) FAA Advisory Committee report, Spring Meeting, April 2016 (FAA)
(3) SpaceWorks, Nano/microsatellite Market Forecast 2016 and 2017
(4) OneWeb Press Release, 19 April 2016
Business Insider France, 17 November 2016
(5) Rocket Lab, 31 October 2016 (Rocket Lab)
(6) PLD Space, 7 November 2016 (PLD Space)

Examples of land launched systems being developed*

(*) Not exhaustive list



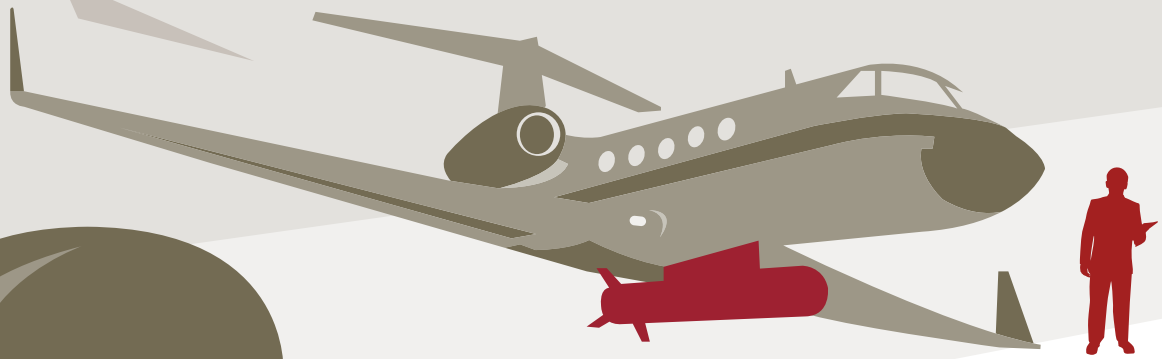
System	Electron	Arion 2	Alpha	Vector H	Taymyr 7	VLM 1
Manufacturer	Rocket Lab	PLD Space	Firefly Space Systems	Vector Space Systems	Lin Industrial	CTA
Country of Origin	USA / New Zealand	Spain	USA	USA	Russia	Brazil
Max payload	225 kg LEO	150 kg LEO	200 kg LEO	120 kg LEO	180 kg LEO	200 kg LEO
First launch	2017 (expected)	2021 (expected)	Unknown	Unknown	Unknown	2018
Status	In development	In development	Most likely cancelled	In development	In development	In development

Examples of air launched systems being developed*

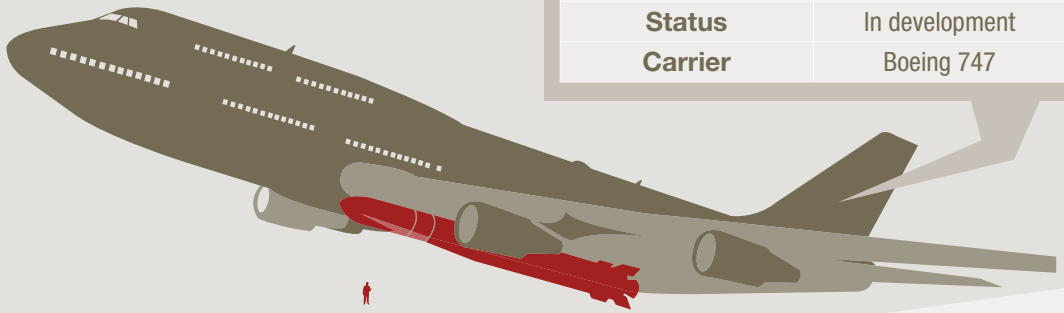
(*) Not exhaustive list

Manufacturer	Generation Orbit
Country of Origin	USA
Max payload	90 kg LEO
First launch	2017 (expected)
Status	In development
Carrier	Learjet 35/45

Go Launcher



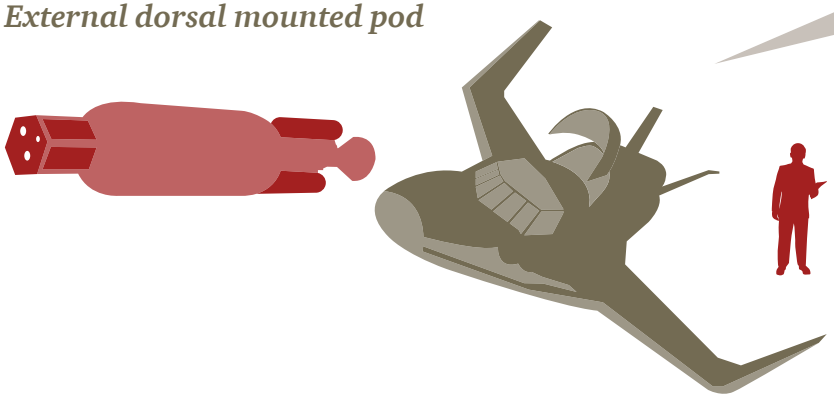
Launcher One



Manufacturer	Virgin Galactic
Country of Origin	USA
Max payload	Unknown
First launch	Unknown
Status	In development
Carrier	Boeing 747

Manufacturer	XCOR Aerospace
Country of Origin	US
Max payload	15 kg LEO
First launch	Unknown
Status	Most likely cancelled
Carrier	Lynx Mark III

External dorsal mounted pod



Manufacturer	Zero 2 infinity
Country of Origin	Spain
Max payload	75 kg LEO
First launch	Unknown
Status	In development
Carrier	Stratospheric baloon

Bloostar

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About PwC and the space sector

Data
The information presented in this document provides an analysis of the micro-launcher sector. The figures are based on available data as of December 2016, and are subject to change over time.

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