

START-UP SPACE

UPDATE ON INVESTMENT
IN COMMERCIAL SPACE
VENTURES

2017

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Executive Summary

The *Start-Up Space* series examines space investment in the 21st century and analyzes investment trends, focusing on investors in new companies that have acquired private financing. Space is continuing to attract increased attention in Silicon Valley and in investment communities world-wide. Space ventures now appeal to investors because new, lower-cost systems are envisioned to follow the path terrestrial tech has profitably traveled: dropping system costs and massively increasing user bases for new products, especially new data products. Large valuations and exits are demonstrating the potential for high returns.

Start-Up Space reports on investment in **start-up space ventures**, defined as space companies that began as angel- and venture capital-backed start-ups. The report tracks seed, venture, and private equity investment in start-up space ventures as they grow and mature, over the period 2000 through 2016. The report includes debt financing for these companies where applicable to provide a complete picture of the capital available to them and also highlights start-up space venture merger and acquisition (M&A) activity.

Significant Investment in Start-up Space. Start-up space ventures have attracted over \$16.6 billion of investment, including \$5.1 billion in debt financing, since 2000. Over 140 angel- and venture-backed space companies have been founded and funded since 2000. Fifteen of these companies have been acquired, at a total value of \$3.2 billion. See Table E-1.

Investment Type	2000-2005 (millions)	2006-2011 (millions)	2012-2016 (millions)	Total 2000-2016 (millions)
Seed/Prize/Grant	\$640.2	\$295.6	\$799.0	\$1,734.7
Venture Capital	\$230.9	\$411.3	\$3,820.6	\$4,462.8
Private Equity	\$239.9	\$1,289.6	\$298.4	\$1,827.9
Acquisition	-	\$584.0	\$2,638.3	\$3,222.3
Public Offering	-	\$279.3	\$23.4	\$302.7
Total Investment	\$1,110.9	\$2,859.8	\$7,579.7	\$11,550.4
Debt Financing	-	\$4,695.9	\$373.7	\$5,069.5
Total with Debt	\$1,110.9	\$7,555.7	\$7,953.3	\$16,619.9

Table E-1. The magnitude of investments varies based on investment type and time period. Note that 2012-2016 interval is five years, while earlier intervals are six years each.

Growth in Recent Years. Start-up space investment activity has increased.

- Looking at investment only (excluding debt financing), two-thirds of investment in start-up space ventures since 2000 has been in the last five years.
- Venture capital in start-up space companies since 2000 totals \$4.5 billion, with 86 percent in the last five years.
- Three start-up space investments have exceeded one billion dollars: Jeff Bezos is estimated to have invested more than \$1 billion in Blue Origin since 2000, Google and Fidelity invested \$1 billion in SpaceX in 2015, and Softbank and other investors invested \$1.2 billion in OneWeb in 2016.

- In the early 2000s, an average of three funded space companies were started per year. In the last five years, the number of funded new companies has averaged nearly 17 per year.
- More than 80 percent of the value of acquisitions of start-up space ventures since 2000 has been transactions in the last five years. SES acquired O3b for \$730 million (2016). Apple acquired Mapsense for \$25 million (2015). Google acquired Terra Bella (formerly Skybox Imaging) for \$478 million (2014). Longford Energy acquired Urthecast for \$29 million (2013). In 2009, ViaSat acquired WildBlue for \$568 million. In addition, Uber acquired deCarta in 2015 and Spaceflight Industries acquired OpenWhere in 2016, for undisclosed amounts.

\$2.8 billion invested in start-up space companies in 2016.

Investment in 2016: More Funding, Fewer Deals. The year 2016 saw continued, strong investment in start-up space ventures. Including acquisitions and debt financing, 2016 exceeded a record-breaking 2015 by about 1 percent in total, making 2016 the highest investment year for start-up space. Average deal size increased by about 50 percent, while the number of deals, investors, and firms reporting new funding all decreased by about 30 percent.

- 114 investors put \$2.8 billion into 43 start-up space ventures across 49 deals.
- While total investment increased slightly, 2016 saw roughly 30 percent fewer investors and fewer deals compared to 2015. The number of deals dropped from 73 to 49, and the number of investors from 161 to 114.
- As a result, deal size overall was larger than in 2015. Average deal size increased from \$38 million to about \$57 million (across all investment types, including acquisitions and debt financing).

Investment Type	2015 (millions)	2016 (millions)	Change (millions)
Seed/Prize/Grant	\$264.5	\$416.0	+ \$151.5
Venture Capital	\$1,868.9	\$1,453.4	- \$415.5
Private Equity	\$175.0	\$0	- \$175.0
Acquisition	\$109.2	\$962.5	+ \$853.3
Public Offering	\$14.0	\$0	- \$14.0
Total Investment	\$2,431.6	\$2,831.9	+ \$400.3
Debt Financing	\$371.0	\$0.4	- \$370.6
Total with Debt	\$2,802.6	\$2,832.2	+ \$29.6

Table E-2. Total 2016 start-up space investment grew about 1 percent.

- The total number of start-up space companies reporting new funding also declined by about 30 percent. In 2015, 61 start-up space companies reported new funding; this number dropped to 43 in 2016.
- Three acquisitions in 2016 totaled \$963 million, including SES's \$730 million purchase of O3b Networks.

Executive Summary

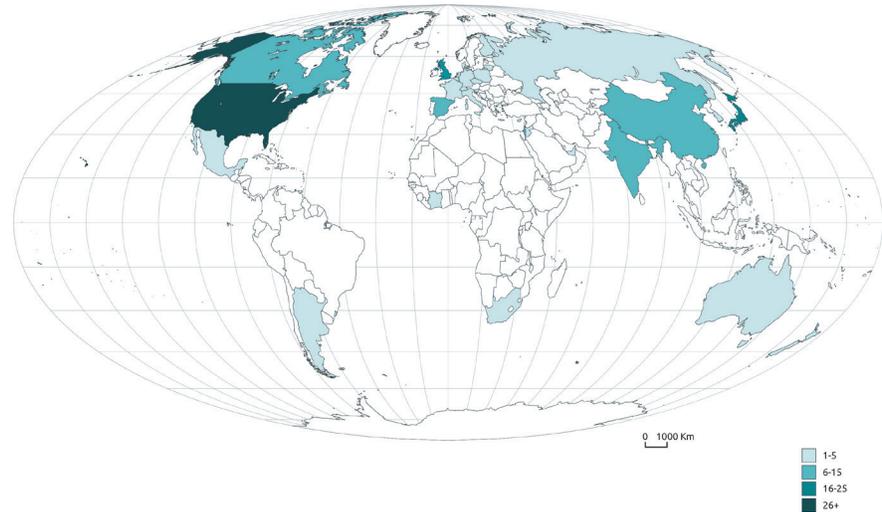


Figure E-1. Start-up space investors are based in 33 countries (most in U.S.)

Venture Capital Generally Strong, But Fewer Megadeals. Nearly \$1.5 billion in venture capital was invested in space deals in 2016. Over 60 venture capital firms invested in start-up space. In addition, 2016 saw a very large venture investment by an atypical venture investor. Softbank and other investors provided \$1.2 billion of funding to OneWeb. (Similarly, 2015 saw a large, atypical venture transaction with the Google/Fidelity investment of \$1 billion in SpaceX.) Venture capital declined 22 percent from 2015 (\$1.9 billion) to 2016. Excluding the Softbank investment and other very large deals of which there were three in 2015—the Google/Fidelity investment, OneWeb’s Series A (\$500 million), and Planet’s Series C (\$106 million)—a different story emerges. Looking only at more typical venture investments, venture capital was about the same from 2015 to 2016, around \$260 million. Across all U.S. venture capital investments (not only space), after a record-setting 2015, there was a slowdown in 2016, with investment reportedly dropping about 12 percent according to the National Venture Capital Association.

The number of start-up space venture deals in 2016 (18) declined by nearly half from 2015. The average investment was \$80.7 million, compared to \$60.3 million in 2015. Excluding the three large (\$100 million and above) venture investments in 2015, and the one large venture investment in 2016, the average venture deal size increased from 2015 to 2016 by 59 percent. (Excluding venture mega deals, the average venture deal size in 2015 was \$9.4 million.)

The number of venture capital firms investing in start-up space dropped by about 33 percent in 2016, from 89 to 62 firms. (The reported number of venture capital firms investing in 2015 has increased since our previous report, as more companies have announced transactions.)

Of the 62 venture capital firms that invested in start-up space companies in 2016, 19 had previously reported investment in start-up space companies; 43 had not, and appear to be new additions to the start-up space ecosystem.

Stable Flow of Larger Seed Deals. Seed investments in start-up space ventures got bigger in 2016. Average deal size grew 75 percent from 2015 to 2016, from \$9.1 million to \$16 million. Note that Jeff Bezos’s estimated investment in Blue Origin had a significant effect on this average. Excluding the Blue Origin investment, the average seed deal was \$0.5 million in 2015 and \$1.6 million in 2016. The number of seed deals declined slightly, with 29 deals in 2015 and 26 deals in 2016.

Space Unicorns. One start-up space company, SpaceX, has joined the elite group of “unicorns,” private companies with a valuation of \$1 billion or more. Three other start-up space companies may be on the path to unicorn valuations: Planet, Rocket Lab, and OneWeb.

Hundreds of Investors. This research has identified 439 investors in start-up space companies; all investors are not always disclosed, so the total number of investors is higher. Investors in space companies are primarily based in the United States, representing 63 percent of the total; California is home to nearly half of these investors. The non-U.S. investors are based in 32 countries.

See Figure E-1. Jeff Bezos, Richard Branson, and Elon Musk are well known “space billionaires”; of the 1,810 people on *Forbes’* 2016 World’s Billionaires List, 25 have an affiliation with a space enterprise. This represents about 1 percent of billionaires.

Leading VCs Investing in Space. More than 200 venture capital (VC) firms have invested in space companies. A handful of VCs have repeatedly invested in common with others: notably, Bessemer Venture Partners, Draper Fisher Jurvetson Venture Capital, First Round Capital, Founders Fund, Khosla Ventures, RRE Ventures, Promus Ventures, and New Enterprise Associates. At least two of these venture capital firms have invested in Accion Systems, Planet, Rocket Lab, Terra Bella, SpaceX, Spire, The Climate Corporation, Mapbox, and Swift Navigation. See Figure E-2.

Tracking Future Performance. After two years of record-setting investment in start-up space companies, many services and products that attracted \$4.2 billion of seed, venture capital, and private equity during this period are deploying or planning deployment in the near future. Investment in 2017 is likely to outpace 2016, both in terms of total magnitude and number of deals. The next few years have the potential to transform the start-up space ecosystem, and investors will be closely tracking the revenue dynamics and operational performance of maturing start-up space firms.

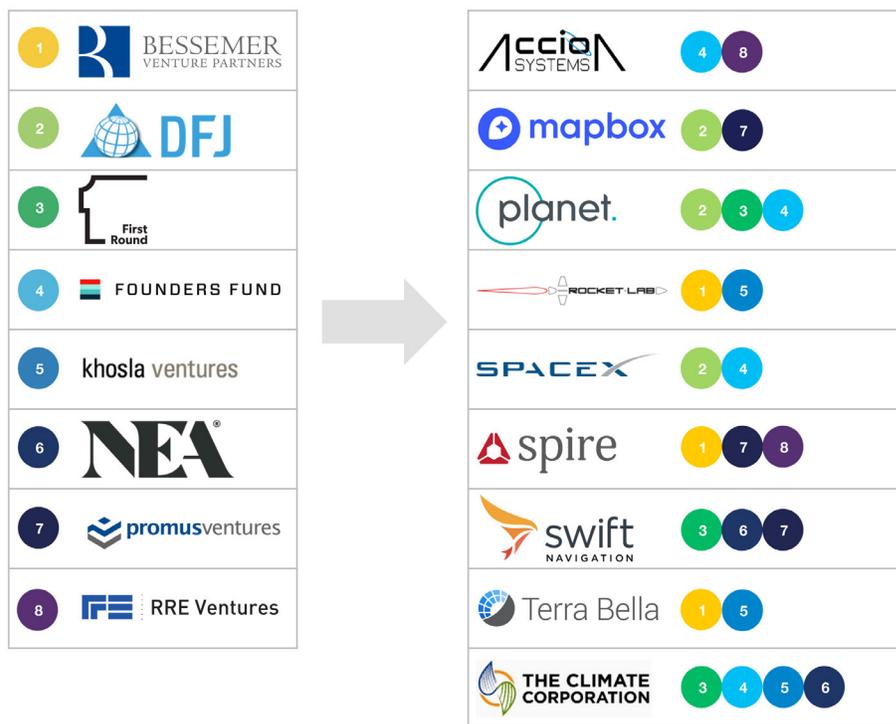


Figure E-2. Common investments among VCs.

Introduction

The *Start-Up Space* series characterizes investment in start-up space ventures and provides insight into investors.

Space is continuing to attract increased attention from Silicon Valley and from investment communities world-wide. Start-up space ventures have become attractive to investors because new, lower-cost systems are envisioned to follow the path terrestrial tech has profitably traveled: dropping system costs and massively increasing user bases for new products, especially new data products. Investors say that large valuations and exits are demonstrating the potential for high returns.

Start-up space ventures are defined here as space companies that began as angel- and venture capital-backed start-ups. (This terminology and definition are intended to generally differentiate start-up space ventures from aerospace and defense contractors and large, publicly-traded space enterprises.) *Start-Up Space* seeks to provide insight into the dynamics of this growing space industry segment and the investment driving it.

Purpose and Background

Bryce Space and Technology conducted the Start-Up Space study and produced this report, *Start-Up Space 2017*, the second report in this series. This project reflects Bryce's on-going commitment to aiding good decision-making in industry, government, and academia by providing the space community with rigorous analyses of industry dynamics.

Start-Up Space examines space investment in the 21st century and analyzes investment trends, focusing on investors in new companies that have attracted private financing. A key aspect of the current investment trend is that desirable capital that could be directed at any industry sector is flowing into space companies. This report seeks to inform investors, the aerospace industry, and the public about activity in this emerging space ecosystem, and to aid government and industry leaders in decision-making as new space firms and capabilities create new options and alternatives to consider.

Methodology

Our data set consists of publicly-reported investment transactions in start-up space ventures as they grow and mature, with details on investment level and investors where reported; additional companies for which little or no transaction data was reported, but which we have identified as start-up space ventures; and qualitative data about investment trends and investor motivations. Bryce conducts on-going interviews, surveys, and conversations throughout the global investment ecosystem, including key nodes such as Silicon Valley/San Francisco, Washington, D.C., Seattle, New York, Florida's Space Coast, Houston, London, Paris, Brussels, Luxembourg, Hong Kong, Singapore, and Sydney.

Definition of Start-Up Space Venture

What is a start-up space venture?

Our definition of a **space company** is a business entity that provides space products or services, specifically one that:

- Manufactures satellites, launch vehicles, or other space-based systems
- Manufactures satellite ground equipment
- Provides services that rely on these systems, such as satellite TV, radio, and broadband
- Provides analytic services based on data collected extensively from space-based systems, either alone or in combination with terrestrial systems

To define a **start-up venture**, we used a screening criterion that accepted those space firms that have received and reported seed funding or venture capital. We term these firms start-up space ventures throughout this report. (There is no one standard, widely accepted definition for what constitutes a start-up. Typically, different stages within start-ups are described. For example, one typology is: Seed stage is an idea that is not yet operational, early stage has begun operations but is not yet fully operational, growth stage has commercial revenues but needs outside capital to scale, and expansion stage is just prior to an initial public offering (IPO). These are examples; there is no universally agreed-to set of definitions. Venture capital firms may focus on a particular stage, such as building a portfolio of early stage companies, or one with a growth stage focus.)

Data Set

We include in our data set all firms that meet these criteria at any time during the period 2000–2016. Analysis of investment magnitude (i.e., value), investors, and transactions throughout this report is based on data available as of June 1, 2017.

Our data set includes all types of investment (seed, venture, private equity, acquisition, and public offering) in the firms that fall within the definition of start-up space ventures. A firm that receives venture funding and then receives a significant investment from a private equity group would be considered a start-up space venture by our definition, and the investments of both the venture firm and the private equity group would be included. On the other hand, a long-standing aerospace firm that recapitalizes and receives an investment from the same private equity group would not be considered a start-up and the private equity investment would not be included in this analysis. The focus of this analysis is new start-up space ventures and the capital they are attracting.

Note that the seed category includes funding from prizes (such as business plan competitions or XPRIZE), foundations, and crowdfunding campaigns, as well as angels and “space billionaire” super angels.

We also include debt financing for start-up space ventures to provide a complete picture of the capital available to the management team at these companies.

Sources of data on companies and investments include Bryce Space and Technology databases; company and investor press releases; annual reports, investor materials,

The Start-Up Space series characterizes investment in start-up space ventures and provides insight into investors.

Introduction

and SEC filings; financial newsletters and databases, such as Crunchbase, *PitchBook*, NewSpace Ventures, Owler, and CB Insights; news articles from major media outlets, such as *Wired*, Bloomberg, *Fortune*, *Forbes*; articles from investment publications, such as *PE Hub*, *VentureBeat*, and *TechCrunch*; trade press, such as *SpaceNews*, Milbank's *Space Business Review*, and business journals; and on-going engagement with industry subject matter experts. Where possible, we confirmed the details of each investment using multiple sources. We further validated our data with investment bankers, industry experts, management teams at space companies, and through targeted interviews.

The data set includes only publicly reported transactions; it does not include proprietary investment information. In some cases, transaction value, funding round, or investors are undisclosed. Depending on available information, these are either estimated or excluded.

The data set generally excludes government funding, except for certain grants. A few quasi-government corporations are included, where they participate in funding rounds with economic development objectives.

Overview of Start-Up Space Ventures

Over 140 new angel- and venture-backed space companies were started and funded in the period 2000 to 2016. In the early 2000s, an average of three such companies was started per year. In the last five years, the number of new angel- and venture-backed companies has averaged nearly 17 per year—and that average excludes new firms that have not yet secured investment. See Figure 1. There is generally a multi-year lag from a company’s founding to when it receives external investment. Therefore, recently founded companies have not had a chance to raise (and/or announce) external funding.

Number of Funded Start-Up Space Ventures by Year Founded*

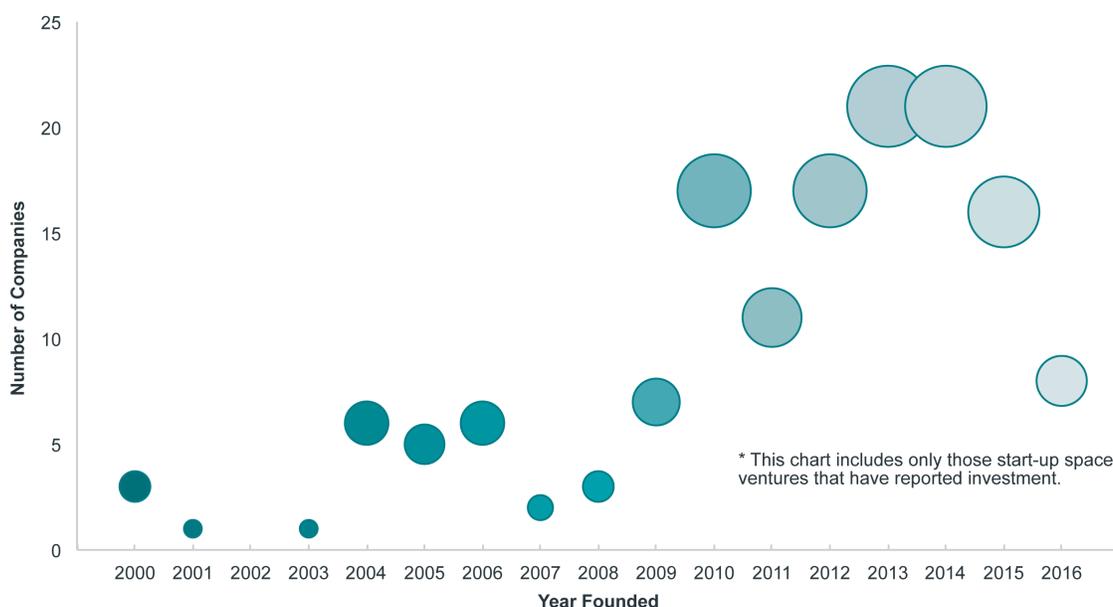


Figure 1. Over 140 angel- and venture-backed space companies have been founded and funded since 2000. Excludes companies that have not announced investment, including many founded in the last few years. In the 2016 *Start-Up Space* report, only 2 angel- or venture-backed start-up space companies were reported as having been founded in 2015. In the 2017 *Start-Up Space* report, the 2015 number increased to 16 companies. This suggests that the number of reported start-up space companies founded in 2016 may increase in the future.

Examples of recently founded start-up space ventures that have not announced investment are in the box below. Reasons for not announcing funding include actively pursuing funding or protecting a competitive advantage. Another group of companies has announced investment, but not who the investors are. These companies include AgileAero, AMR Propulsion Innovations, Makesat, TerraNIS, Ursa Space Systems, and Vanguard Advanced Systems.

Note that the total number of reported start-up ventures has increased compared to the *Start-Up Space 2016* report, reflecting new announcements by existing companies, new companies, and enhanced data sets.

Overview of Start-Up Space Ventures

Examples of recently founded start-ups that have not announced investment

4th Planet Logistics	Earth-i	Odyne Space	Spaceit
Agile Aero	EarthCube	Odysseus Space	SPiN
AMR Propulsion Innovations	EnduroSat	Open Cosmos	Stellar Space Industries
ATLAS	Energeo	Rokubun	Sunna-Wedra
B2Space	Global IP	Rose Galactic	Syntony
Bellatrix Aerospace	Halo Aerospace	Satelligence	Thermal Space
Blink Astro	HEAD Aerospace Netherlands	SatSearch	Tri-D Dynamics
Bluefield	Helios Wire	SatSure	Trident Space
bluShift Aerospace	Makesat	Space Exploration Network	VALT Enterprises
bSpace	Maritime Launch Services	Space Inventor	VanderSat
Celestia Satellite Test & Simulation	Nebula Sciences	Space Workbench	Vanguard Advanced Systems
Deep Space Ecology	Neumann Space	SpaceAnalyzer	Veoware
		SpaceFab.US	

Overview of Space Investors

This analysis considers six categories of investor to aid in understanding trends in investment and investor motivation.

Types of Investor

The investor typology used in this study consists of: angel investors, venture capital firms, private equity (PE) firms, banks (typically not strictly investors, but an important source of capital), corporations (as strategic partners and/or internal investors, or through corporate venture funds), and public markets. This typology conceptually groups some investor types that could be treated separately but share characteristics, such as sovereign wealth funds (included in private equity category) and hedge funds (included in the venture capital firm category). While investor categories continue to shift and evolve, the typology here provides a useful (and generally accepted) broad brushstroke description of groups of investors and their typical investment behaviors.

We describe each type of investor and typical (1) role as a funding source, including the stage of involvement, (2) preferred funding instrument (e.g., debt, equity, or hybrid debt/equity instruments) and (3) general objectives in investing. For illustrative purposes, examples of select space deals are also provided.

Angel Investors

Typically, angel investors are individuals or families (to include family offices) that have accumulated a high level of wealth and seek potentially high returns by investing in ventures during their early stages. Investment by angels into start-up space ventures is usually in the form of straight equity into the company. Investments often range from \$50,000 to more than \$1 million. There is a highly visible special category of angel investor in the space ecosystem, consisting of billionaires and other ultra high net worth individuals who have personally staked new space companies. The investment level by space billionaires far exceeds typical angel levels.

By getting in at the ground floor (i.e., when a company is usually at its nascent stage, just starting development of its product or service), an angel investor can realize an attractive potential return, as the early investment will secure a significant foothold in the company. Time horizons for angel investors are about 5 to 7 years, meaning they seek to realize their return (i.e., exit) about 5 to 7 years from the date of investment. Angels may expect an equity stake in the company as high as 30 to 40 percent in return for their investment; however, frequently, angel stakes are much lower, especially after subsequent, larger investors join the capital structure. Upon exit, angels may expect to receive at least 5 to 10 times their investment. Angel investors range from those who can comfortably make a \$50,000 investment to, as noted, particularly in commercial space ventures, super angel multi-billionaires who have already made their mark in technology-driven enterprises, such as Jeff Bezos of Blue Origin (Amazon), Elon Musk of SpaceX (PayPal), and Paul Allen of Stratolaunch (Microsoft).

Venture Capital Firms

Venture capital (VC) firms are groups of investors that invest in start-up, early stage, and growth companies with high growth potential, and accept a significant degree

Three start-up space investments over \$1B: Jeff Bezos in Blue Origin, Google and Fidelity in SpaceX, Softbank in OneWeb.

Overview of Space Investors

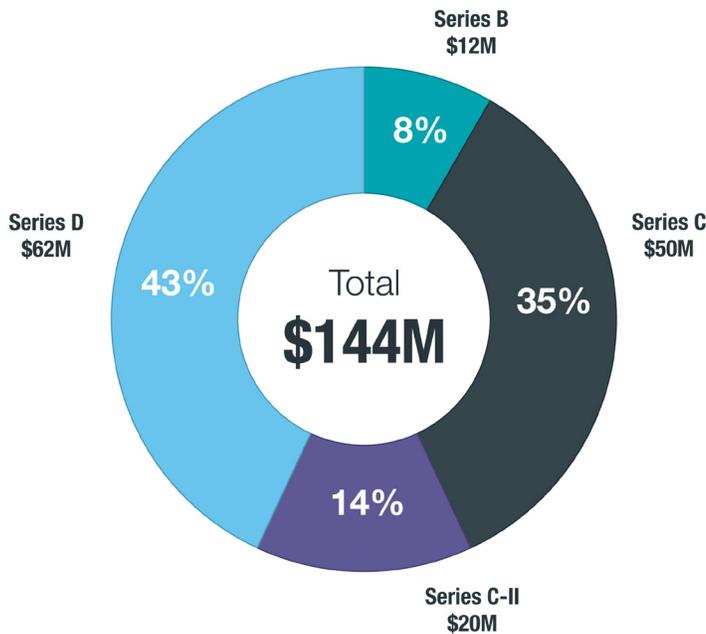


Figure 2. Venture capital investment in Kymeta.

of multiple VC firms may significantly increase these levels. Note that the distinct ‘series’ model for VC investments is evolving, with more continuous investment by an ongoing team of investors emerging as a trend.

An example of a space-based company receiving multi-stage VC investment is Kymeta, a company founded in 2011 with the goal of developing an omnidirectional, metamaterial-based satellite antenna. Its first reported round of VC funding was a \$12 million Series B tranche (by Lux Capital, Bill Gates, and Liberty Global) in 2012, followed by a \$50 million Series C funding (by Lux Capital, Bill Gates, Kresge Foundation, Osage University Partners, and Liberty Global) in 2013 and a \$20 million Series C-II round of venture capital from Lux Capital and Bill Gates in 2014. In 2016, Lux Capital, Bill Gates, Kresge Foundation, and Osage University Partners participated in a \$62 million Series D round of venture capital (for a total of \$144 million in VC funding). See Figure 2. Another example is Planet, which reported five investment rounds at increasing valuations. These rounds represent \$206 million of investment (including debt financing), involving 17 named investors and others. Many investors participated in multiple rounds.

Space-oriented VC funds are emerging from this class of investors. In 2016, Starburst Ventures, an extension of Starburst Accelerator, raised a \$200 million fund to invest in 35 start-up space ventures over the next three years. In a recent interview with *TechCrunch*, Starburst Accelerator CEO Francois Chopard describes the investment environment of the start-up space ecosystem: “Space technology is today where biotech

of risk. The trade of risk for potential high returns results in a high failure rate; a recent research study by a Harvard Business School faculty member finds that, “About three-quarters of venture-backed firms in the U.S. don’t return investors’ capital.”¹

VC funding has traditionally come in stages (or rounds), generally designated Series A, Series B, Series C, etc. The form of investment is equity; specifically, the instrument is usually preferred stock, which gives the VC firm an equity ownership stake in the company, but at a higher priority (or preference) than investors at common equity (e.g., founders, employees, and angels) and a lower priority than any holders of company debt. The preferred shares are usually convertible to common stock in the instance of a stock market launch or initial public offering (IPO; see “Public Markets”) or sale of the company, which are the typical instances of a VC’s exit. There is substantial variation in the size of rounds, but Series A investment rounds typically range from \$2 million to \$10 million; Series B, in the low tens of millions of dollars; and Series C, in the high tens of millions of dollars. Investment syndicates comprised

¹ Ghosh, Shikhar. “The Venture Capital Secret: 3 Out of 4 Start-Ups Fail.” *Harvard Business School*. President and Fellows of Harvard College, 19 Sept. 2012. Web. 1 Feb. 2015.

was about 15 years ago, in terms of potential for startups to flourish.”² Seraphim Capital also launched a space technology fund in 2016. The Seraphim Space Fund is a \$100 million space-focused fund raised by Airbus Defence and Space, Thales Alenia Space, Telespazio, Com Dev, and Avanti Communications (per Seraphim). Based in London and focused mostly on UK-based companies, the fund represents an interest in space investments (broadly defined, to extend to technologies developed for use in space and now being applied in other areas).

In 2015, Bessemer Venture Partners announced a \$1.6 billion fund, BVP IX, to invest in innovative companies, to include the space sector. Bessemer notes its investment in Terra Bella “was just the beginning.” Rocket Lab and Spire are also part of the Bessemer portfolio. Russia and China launched a \$200 million venture fund in 2015, with space technology as one focus area (reported by *Fortune*).³

**Space-oriented
VC funds are
emerging.**

Private Equity

Private equity firms or groups are formed by investors to directly invest in companies. They typically invest in established companies (not start-ups) at large transaction sizes, and often acquire an entire company or a group of related companies that can merge. Examples of investors represented include many types of institutional investors (e.g., large pension funds), as well as aggregated pools of high net worth individuals.

The larger investment firms, which typically have multi-billion dollar investment funds from which to draw, have shown some interest in space over the past 15 years. Firms such as Blackstone, Columbia Capital, Permira, Apax, and Carlyle Group have historically shown an appetite for investing in space firms, typically in the telecommunications industry or government contracting. Larger private equity firms are likely to invest between \$100 million to \$1 billion, usually in the form of equity. Sometimes, they invest in the form of later stage capital (i.e., later than angel and VC investors) or through outright purchase of targeted companies. This has been the case for several large commercial satellite operators.

Examples of private equity investment in space include Blackstone’s \$200 million investment in Sirius Satellite Radio and its nearly \$1 billion purchase of the commercial satellite capacity provider New Skies Satellite; Columbia Capital’s substantial investment in XM Satellite Radio and Ligado Networks (formerly LightSquared Company); and Apax, Permira, and Carlyle Group’s multi-hundred million dollar investments in the acquisitions of large satellite services companies, such as Intelsat, Inmarsat, and PanAmSat from 2003 to 2004. Permira bought Asia Broadcast Satellite for \$200 million in September 2010; however, there have been few space-related private equity deals since the financial downturn in 2007/2008. Investment of \$490 million in Virgin Galactic by Aabar Investments in 2009 and 2011 is one example. Being a suborbital space tourism and launch services provider start-up—Virgin Galactic was founded in 2004—sets it apart from earlier private equity deals in existing satellite communications companies.

² Kolodny, Lora. “Starburst Ventures Closes \$200 Million Debut Fund to Back Space Tech Startups.” *TechCrunch*. Oath Inc., 29 Nov. 2016. Web. 9 July 2017.

³ Vanian, Jonathan. “Russia, China Partner on \$200 Million Venture Fund, Tech Incubator.” *Fortune*. Time, Inc., 22 Apr. 2015. Web. 9 July 2017.

Overview of Space Investors

Corporations

Corporations have often provided the funding necessary to bring space-based programs to initial operating capability, as well as to sustain ongoing programs. Corporations invest internally, in R&D, in manufacturing, in operations and processes, and in many other areas to enhance capabilities to create or strengthen an existing expertise or advantage. (A special category of internal investment typical of space firms for whom the U.S. government is a major customer is “independent research and development (IR&D),” which is a type of government-sanctioned R&D expenditure that affects how the government pays a contractor firm for the work that it does.)

A corporation may also provide funding for a venture, usually in the form of straight equity or sometimes in the form of debt, with the option to convert the instrument into equity of the investee company. Some companies may also invest through a corporate venture fund, which acts as a company-owned VC equivalent.

Examples of a corporation serving as a strategic partner include: Liberty Global, a longtime cable operator, participating in private equity and venture capital deals from 2008 to 2013 in O3b, a satellite-based internet delivery constellation; and Kymeta, an omnidirectional satellite antenna developer. In 2009, SES, a commercial geosynchronous orbit (GEO) satellite fleet operator, invested \$75 million (a 30 percent stake, early in the investment cycle) in O3b. More recently, the industry has seen a number of different investors in space, with Google acquiring Terra Bella for \$478 million and major companies, such as Softbank, Virgin, Coca-Cola, Intelsat, Airbus, Qualcomm, and Hughes Network Systems, Totalplay, and Bharti Enterprises investing a total of \$1.7 billion in OneWeb. Google also invested \$900 million in SpaceX in February 2015 “to support continued innovation in areas of space transport, reusability and satellite manufacturing.” In addition, Tencent Holdings, an investment holding company based in China, has invested in Moon Express, Planetary Resources, Satellogic, and World View Enterprises.

Corporations also acquire firms. A record-setting example is the AT&T purchase of DirecTV in 2015 for \$48.5 billion, which set a new bar for acquisition of a space company. Note that DirecTV is not a start-up venture by our definition. This transaction is more typical of the merger and acquisition activity for established companies. Corporations have recently acquired firms that fit the model of start-up space ventures. For example, SES acquired O3b for \$730 million in 2016, Apple acquired Mapsense for \$25 million in 2015, Google acquired Terra Bella for \$478 million in 2014, and Monsanto acquired The Climate Corporation for \$930 million in 2013.

Banks

Banks have been heavily involved in providing funding for space-based programs of large, established firms, such as GEO satellite operators, during the past 17 years. The basic model is that equity investors provide a substantial “cushion” (e.g., 30 percent of the total capital expense or CapEx required for a certain program, such as deployment of a satellite or satellites). The remainder of CapEx (or other types of programmatic expenditure) is financed by debt, sometimes in the form of “convertible debt,” meaning that the initial instrument is in the form of debt. At certain trigger points, the debt can be converted, in whole or in part, into an equity stake in the financed company.

Commercial banks based in the U.S., such as Wachovia, Wells Fargo, and Citibank, and non-U.S.-based banks, such as Deutsche Bank, BNP Paribas, and ABN AMRO, in Europe, have provided debt financing at a magnitude of \$100 million to \$1 billion (sometimes exceeding \$1 billion) per funding event. Most of the companies financed are companies with large satellite CapEx requirements, such as Intelsat, SES, and Inmarsat, for which multiple GEO satellites are required: each costs \$250 million to \$300 million to build, launch, and insure. Other companies financed (e.g., Iridium and GlobalStar) have \$2 billion to \$3 billion CapEx requirements for low Earth orbit (LEO) satellite constellations.

In addition, government-backed banks (i.e., export credit agencies), such as U.S. Export-Import (Ex-Im) Bank and COFACE of France have provided debt funding (or guaranteed third-party debt funding) for several satellite systems. Ex-Im Bank has provided multi-hundred million-dollar debt financing at various points during the past four years to satellite operators, including ViaSat of the U.S., AsiaSat and Asia Broadcast Satellite in Asia, and Spacecom in Israel. COFACE has backed the debt obligations of several satellite constellations, including O3b, GlobalStar, and Iridium. Both Ex-Im Bank and COFACE have provided loans and debt guarantees to an Australian company, NewSat, for \$400 million. Moreover, Ex-Im Bank provided \$525 million in debt financing for ViaSat in November 2014. Proceeds were earmarked for the build and launch of the company's two Ka-Band (broadband) satellites.

Banks are less likely to have a major role in providing financing for start-up ventures.

Note that investment banks and investment bankers—often visible actors in complex investment transactions typically involving private equity, corporations, and/or public markets—act as brokers arranging and facilitating these transactions rather than lenders or investors. Investment banks play a variety of roles, including advising on capital raising approaches and more strategic transactions such as merger and acquisition (M&A), as well as underwriting a capital raising event (e.g., an IPO). Investment banks often focus on large transactions (typically in the multi-hundred million dollar to over \$1 billion range) and large space/satellite communications companies work with investment banks as financial advisors. These institutions will usually take the role of “lead managers” of a financing transaction, often with several fulfilling that position. (For example, J.P. Morgan, Lehman Brothers, and UBS acted as joint lead managers for a \$500 million capital raise in 2007 for fledgling mobile satellite services operator TerreStar (now owned by DISH Network)).

Public Markets

Toward the later stages of a space-based company's funding trajectory, there can be a public sale of the company's equity (common stock), or IPO. The IPO enables additional capital to be raised to supplement prior funding rounds and also provide previous investors an exit vehicle for their investments (i.e., sell their equity shares in the public market place). Many established space companies and government contractors have long since had their IPOs and continue to trade publicly. Examples include Boeing, Lockheed Martin, Orbital ATK, and Harris Corporation.

IPOs in the space industry have ranged from around \$100 million (e.g., GlobalStar and Orbcomm) to about \$800 million (e.g., Intelsat). Secondary offerings (post-IPO)

Overview of Space Investors

also serve to provide funds for capital expenditures and other corporate purposes (e.g., operations, working capital, and retirement of debt). DigitalGlobe raised \$279 million in 2009, and in 2014, Iridium raised \$170 million through public sales of \$50 million in common stock and \$120 million in convertible preferred stock. (Iridium is not a start-up space company, by our definition.) IPOs of space start-ups have been very limited, such as UrtheCast going public on the Toronto Stock Exchange through a reverse IPO in 2013. See Table 1.

Type of Investor	Characterization of Investor	Typical Space Investment	Investment Type	Examples of Transactions	Expected Returns/Exit Horizon
Angel Investors	High net worth individuals or families	\$50K – \$1M	Equity	York Space Systems with \$250K of angel investment from Dylan Taylor in 2015	5-10X investment/5-7 years
Venture Capital Firms	Groups of investors focusing on early stage, high growth ventures and accepting a significant degree of risk	\$2M – \$75M	Equity preferred stock in several tranches (e.g., Series A, B, C)	Kymeta with \$144M of venture capital from multiple (2012–present)	5X investment/5 years
Private Equity Firms	Large investment houses that have multi-billion dollar investment funds—focus on established companies	\$100M – \$1B	Equity	Virgin Galactic with \$490M of investment from Aabar Investments (2009 and 2011)	3-5X investment/3-5 years
Corporations	<p>Large companies providing strategic investments to support large CapEx space projects</p> <p>Internal R&D for special projects</p> <p>Independent R&D as government contractor</p> <p>Merger and acquisition</p> <p>Venture investing</p>	\$100M – \$1B	Equity and sometimes debt	O3b with \$75M of investment from SES in 2009	Significantly less returns than for PE firms/horizon is over a long term
Banks	Private and government-backed banks providing substantial debt financing layered over equity	\$100M – \$1B	Debt, sometimes convertible into equity	DigitalGlobe with \$600M of debt financing from J.P. Morgan and Morgan Stanley in 2011	Straightline interest rates (e.g., 5–10%)
Public Markets	Later stage funding vehicle for supplementary fundings	\$100M – \$1B	Equity	Iridium raising \$170M in an IPO	Serves as a vehicle to allow the earlier investors to exit

Table 1. Different types of investors pursue different types of investment objectives.

Space Investment by the Numbers

Two-thirds start-up space investment has been in the last five years.

Cumulative investment (including debt financing) in start-up space ventures since 2000 totals \$16.6 billion. This includes seed investment (and a small amount of grants and prizes), venture capital, private equity, acquisitions, public offerings, and debt financing. Looking at investment only (excluding debt financing), nearly two-thirds of investment in start-up space firms since 2000 has occurred in the last five years. Over \$4.1 billion (54 percent) of investment has been venture capital and private equity.

The mix of investment types (including debt financing) has evolved over the last 17 years. Seed funding is evident in most years; however, seed funding has typically been lower magnitude in terms of investment as compared to other investment types, with the notable exception of Jeff Bezos's super angel investment in Blue Origin. Debt financing is prominent in the middle years of this timeframe, whereas acquisitions and venture capital become more pronounced in recent years. Private equity is also most evident around the time when debt financing peaked. See Figure 3 for year-by-year investment. Figure 4 shows annual investment of private equity, venture capital, and seed/prize/grant investment. In addition, Table 4 shows investment by type in three periods, 2000-2005, 2006-2011, and 2012-2016. Table 5 shows annual averages for each period.

The year 2016 saw continued, strong investment in start-up space ventures. Including acquisitions and debt financing, 2016 exceeded a record-breaking 2015 by about 1 percent in total, making 2016 the highest investment year for start-up space. Average deal size increased by about 50 percent, while the number of deals, investors, and firms reporting new funding all decreased by about 30 percent.

This investment was from 114 investors in 43 companies across 49 deals.

While total investment increased slightly, 2016 saw roughly 30 percent fewer investors and fewer deals compared to 2015. The number of deals dropped from 73 to 49, and the number of investors from 161 to 114. Deal size on average was larger than

Magnitude of Investment, Including Debt, Acquisitions, and Offerings by Type (2000-2016)

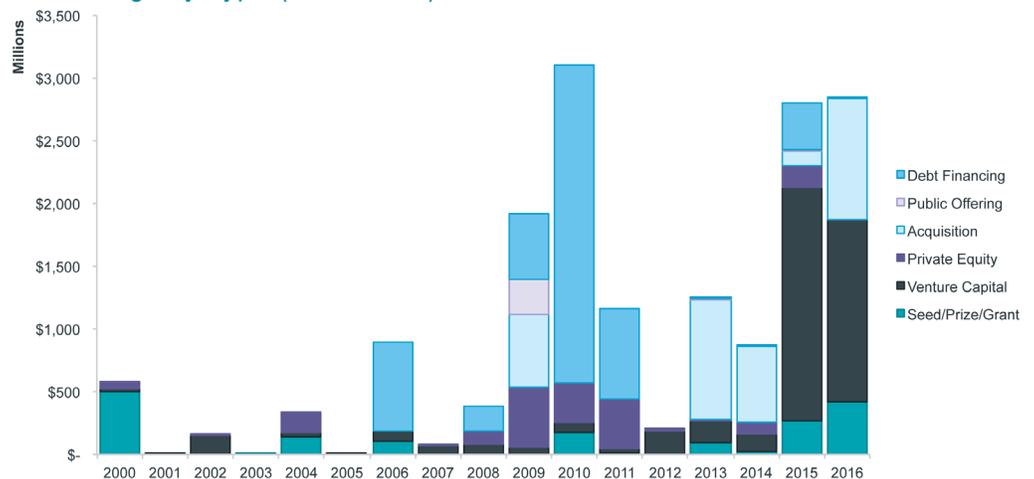


Figure 3. The mix of types of investment in space companies varies from 2000 to 2016.

Magnitude of Investment by Type (2000-2016)

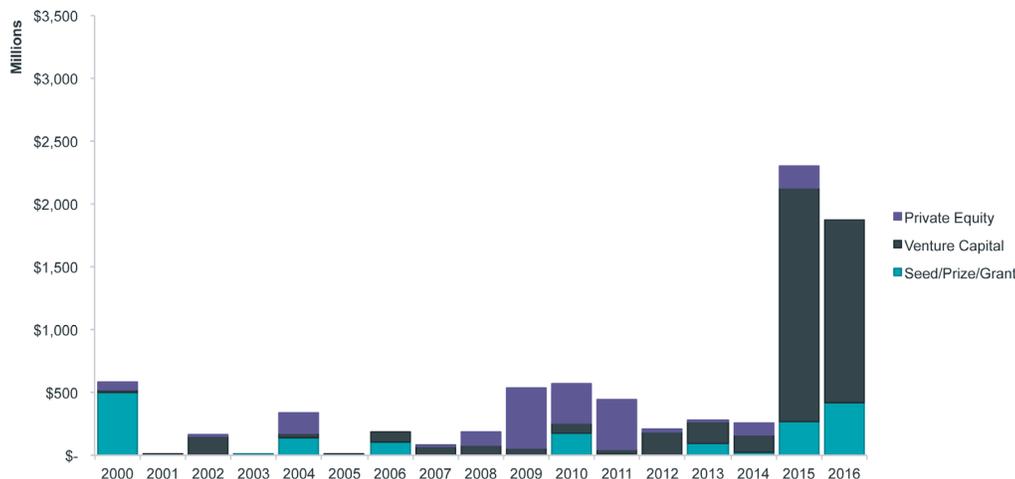


Figure 4. The mix of private equity, venture capital, and seed/prize/grant investment in space companies varies from 2000 to 2016.

in 2015. Average deal size increased from \$38 million to about \$57 million (across all investment types, including acquisitions and debt financing).

The total number of start-up space companies reporting new funding also declined by about 30 percent. In 2015, 61 start-up space companies reported new funding; this number dropped to 43 in 2016.

Investment Type	2015 (millions)	2016 (millions)	Change (millions)
Seed/Prize/Grant	\$264.5	\$416.0	+ \$151.5
Venture Capital	\$1,868.9	\$1,453.4	- \$415.5
Private Equity	\$175.0	\$0	- \$175.0
Acquisition	\$109.2	\$962.5	+ \$853.3
Public Offering	\$14.0	\$0	- \$14.0
Total Investment	\$2,431.6	\$2,831.9	+ \$400.3
Debt Financing	\$371.0	\$0.4	- \$370.6
Total with Debt	\$2,802.6	\$2,832.2	+ \$29.6

Table 2. Total 2016 start-up space investment grew about 1 percent.

Seed Funding

For the total period covered in this report, seed funding is \$1.7 billion. Note that the large seed funding amounts in 2000, 2015, and 2016 primarily represent an estimated \$1.1 billion commitment by Jeff Bezos to Blue Origin; \$500 million of this estimated funding is counted here in the year of the company’s founding. However, the timing

Space Investment by the Numbers

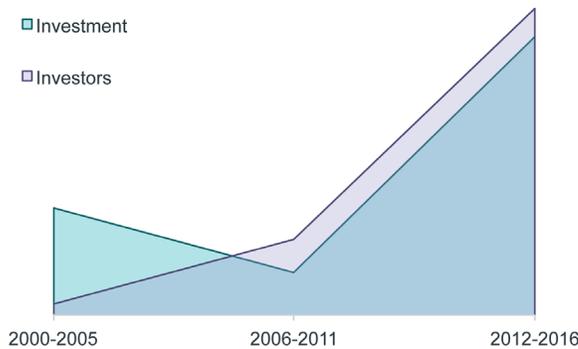


Figure 5. The magnitude of seed investment and number of seed investors are trending up. Note that this figure excludes super angel investments.

of the commitment is not public. It may be spread more evenly over the study period, and (based on company activity and employment) appears to have been spent at a higher rate in recent years. In early 2017, Blue Origin publicly commented on the New Glenn launch vehicle. In these public comments, Jeff Bezos said he would cash in \$1 billion per year of Amazon stock toward development of the new launch vehicle, which Blue forecasts will have a \$2.5 billion development cost. We have assumed that investment in Blue in 2016 was in the range of \$350 to \$400 million, reflecting development and operations costs associated with the New Glenn and New Shepard launch vehicles and other activities.

Overall, seed funding totals are dominated by a few super angel investments, including investment by Jeff Bezos in Blue Origin, Elon Musk's early

investment in SpaceX (\$100 million in 2006), Richard Branson's investment in Virgin Galactic (\$100 million since 2004), and Robert Bigelow's investment in Bigelow Aerospace (\$250 million largely invested around the period 2010 to 2013).

Excluding these super angel investments, seed funding decreased 61 percent from the 2000-2005 to 2006-2011 periods, and increased by 569 percent from the 2006-2011 to 2012-2016 periods. Despite the 61 percent decrease in investment magnitude from the 2000-2005 to 2006-2011 periods, there was a six-fold increase in the number of angels investing in start-up space ventures between those intervals. This upward trend continued from the 2006-2011 to 2012-2016 intervals—there was a three-fold increase in the number of angels investing in start-up space ventures between those periods. See Figure 5.

Excluding investment from super angels, total seed investment in 2015 was \$14 million. In 2016, total seed investment (excluding super angels) increased 183 percent to \$41 million. In addition, average investment per deal increased from \$0.5 million in 2015 to \$1.6 million in 2016. Note that the number of venture capital firms participating in seed rounds increased by 32 percent from 2015 to 2016, while the number of angel investors from 2015 to 2016 remained steady.

Including investment from super angels, seed investments in start-up space ventures grew from 2015 to 2016. Average deal size increased 75 percent from \$9.1 million to \$16 million. The number of seed deals declined slightly, with 29 deals in 2015 and 26 deals in 2016.

Venture Capital

Venture capital investment in start-up space ventures since 2000 totals \$4.5 billion, with 86 percent in the last five years.

Nearly \$1.5 billion in venture capital was invested in space deals in 2016. Over 60 venture capital firms invested in start-up space. In addition, 2016 saw a very large venture investment by an atypical venture investor. Softbank and other investors

provided \$1.2 billion of funding to OneWeb. (Similarly, 2015 saw a large, atypical venture transaction with the Google/Fidelity investment of \$1 billion in SpaceX.)

Venture capital declined 22 percent from 2015 (\$1.9 billion) to 2016. Excluding the Softbank investment and other very large deals of which there were three in 2015—the Google/Fidelity investment, OneWeb’s Series A (\$500 million), and Planet’s Series C (\$106 million)—a different story emerges. Looking only at more typical venture investments, venture capital was about the same from 2015 (\$263 million) to 2016 (\$253 million). Across all U.S. venture capital investments (not only space), after a record-setting 2015, there was a slowdown in 2016, with investment reportedly dropping about 12 percent.⁴

In 2016, venture investors invested in 18 start-up space firms. In addition to Softbank’s OneWeb investment, examples include Series A funding for Accion Systems, HawkEye 360, Planetary Resources, and SpaceBelt; Series B funding for Astroscale, Orbital Insight and Spaceflight Industries; and Series D funding for Kymeta. During the previous 16 years, venture investment totaled over \$3.0 billion in 56 firms. The largest venture rounds in that time period were in 2015: SpaceX’s \$1 billion Series E and OneWeb’s \$500 million Series A.

The number of start-up space venture deals in 2016 declined by nearly half from 2015. The average investment was \$80.7 million, compared to \$60.3 million in 2015. Excluding the three large (\$100 million and above) venture investments in 2015, and the one large venture investment in 2016, the average venture deal size increased from 2015 to 2016 by 59 percent. (Excluding venture mega deals, the average venture deal size in 2015 was \$9.4 million.)

The number of venture capital firms investing in start-up space dropped by about 33 percent in 2016, from 89 to 62 firms. (The reported number of venture capital firms investing in 2015 has increased since our previous report, as more companies have announced transactions.)

Of the 62 venture capital firms that invested in start-up space companies in 2016, 19 had previously reported investment in start-up space companies; 43 had not, and appear to be new additions to the start-up space ecosystem.

Note that the three largest venture investments in start-up space have been made by atypical venture investors, including Google/Fidelity (\$1 billion investment in SpaceX, 2015); several corporations, including Coca-Cola (\$500 million in OneWeb, 2015); and Softbank and others (\$1.2 billion in OneWeb, 2016). (A few sources have labeled the Softbank investment as private equity. Based on the nature and purpose of the investment, we have designated it as venture.)⁵

Venture capital in start-up space companies since 2000 totals \$4.5 billion, with 86 percent in the last five years.

4 Veghte, Ben, Stephanie Cook, and Abigail Havern. “After Peaking in 2015, Venture Investment Activity Normalizes in 2016, According to PitchBook-NVCA Venture Monitor.” *NVCA*. National Venture Capital Association, 11 Jan. 2017. Web. 09 July 2017.

5 In October 2016, Softbank announced the Softbank Vision Fund, and in May 2017, funding closed at \$93 billion. Some reports suggest the investment in OneWeb will be offered to the Vision Fund.

Space Investment by the Numbers

Private Equity

Private equity investment in space start-ups has totaled \$1.8 billion since 2000. Aabar Investments provided \$380 million to Virgin Galactic in 2009 and another \$110 million in 2011. O3b received investment of \$230 million in 2010 from investors including Google, North Bridge Venture Partners, Allen & Company, SES, Liberty Global, HSBC Holdings, Development Bank of Southern Africa, Sofina, and Satya Capital. In 2011, Ligado Networks raised \$265 million. There was no reported private equity in start-up space in 2016. By comparison, private equity in start-up space was \$175 million in 2015, including \$143 million in O3b and \$32 million in Reaction Engines.

Acquisition

Acquisitions total \$3.2 billion from 2000 to 2016, with 82 percent (\$2.6 billion) in the last five years. Over 140 angel- and venture-backed space companies have been founded since 2000; 15 of these companies have been acquired. The substantial values for acquisitions in 2013, 2014, and 2016 represent Monsanto's acquisition of the Climate Corporation for \$930 million, Google's acquisition of Terra Bella for \$478 million, and SES's acquisition of O3b for \$730 million, respectively. (Terra Bella was acquired by Planet in 2017, for an undisclosed amount.) The next largest acquisition was WildBlue by ViaSat for \$568 million in 2009.

Company	Seed Investment (millions)	Venture Capital (millions)	Private Equity (millions)	Debt Financing (millions)	Acquirer	Acquisition Value (millions)	Acquisition Year
WildBlue	-	\$206.0	-	\$550.0	ViaSat	\$568.0	2009
The Climate Corporation	\$4.3	\$104.6	-	-	Monsanto	\$930.0	2013
Terra Bella	-	\$91.0	-	-	Google	\$478.0	2014
deCarta	-	\$52.2	\$3.9	-	Uber	-	2015
Mapsense	\$2.5	-	-	-	Apple	\$25.0	2015

Table 3. Investors in several start-up space ventures have seen substantial returns through acquisition.

Table 3 shows five companies that started and exited during the study timeframe. Note that in the Terra Bella transaction, the acquisition value was approximately 5.3 times the reported previous investment. In the Climate Corporation example, it was 8.5 times. Other acquisitions during the study period include BlackBridge by Planet (undisclosed), Deimos by UrtheCast (\$84.2 million), Mapsense by Apple (\$25 million), and SkyWave by Orbcomm (\$130 million).

Public Offering

DigitalGlobe accounted for 92 percent of the \$302.7 million raised through public offerings from 2000 to 2016, followed by \$23.4 million (8 percent) for UrtheCast. The last major public offering for a space company was in 2013 when Intelsat raised \$349 million through an IPO. (Intelsat does not meet our criteria for a start-up space company.)

Debt Financing

Debt financing for start-up space ventures totals \$5.1 billion for 2000-2016, with 93 percent in the 2006-2011 period. The transactions were for Protostar (2006, 2008), WildBlue (2006), O3b (2009, 2010, 2011), Ligado Networks (2010), and DigitalGlobe (2011). In 2015, O3b, Planet, and UrtheCast obtained significant debt financing. In 2016, Kepler Communications and Space Tango also reported debt financing.

Investment Across All Types

The average start-up space investment per year is \$978 million, which is affected by a surge in debt financing in 2010. Looking at the other investment types, the average venture capital level is \$263 million per year, with an average of \$764 million in the

Investment Type	2000-2005 (millions)	2006-2011 (millions)	2012-2016 (millions)	Total 2000-2016 (millions)
Seed/Prize/Grant	\$640.2	\$295.6	\$799.0	\$1,734.7
Venture Capital	\$230.9	\$411.3	\$3,820.6	\$4,462.8
Private Equity	\$239.9	\$1,289.6	\$298.4	\$1,827.9
Acquisition	-	\$584.0	\$2,638.3	\$3,222.3
Public Offering	-	\$279.3	\$23.4	\$302.7
Total Investment	\$1,110.9	\$2,859.8	\$7,579.7	\$11,550.4
Debt Financing	-	\$4,695.9	\$373.7	\$5,069.5
Total with Debt	\$1,110.9	\$7,555.7	\$7,953.3	\$16,619.9

Table 4. The magnitude of investments varies based on investment type and time period. Note the 2012-2016 interval is five years, while earlier intervals are six years each.

Investment Type	Average 2000-2005 (millions)	Average 2006-2011 (millions)	Average 2012-2016 (millions)	Average 2000-2016 (millions)
Seed/Prize/Grant	\$106.7	\$49.3	\$159.9	\$102.1
Venture Capital	\$32.9	\$68.5	\$764.1	\$262.5
Private Equity	\$39.9	\$214.9	\$60.9	\$107.9
Acquisition	-	\$97.3	\$527.7	\$189.5
Public Offering	-	\$46.6	\$4.7	\$17.8
Average Investment	\$185.2	\$476.6	\$1,517.3	\$679.8
Debt Financing	-	\$782.6	\$74.7	\$298.2
Average with Debt	\$185.2	\$1,259.3	\$1,592.0	\$978.0

Table 5. The annual average of space investments varies based on investment type and time period. Note the 2012-2016 interval is five years, while earlier intervals are six years each.

Space Investment by the Numbers

Average Annual Investment by Type and Period

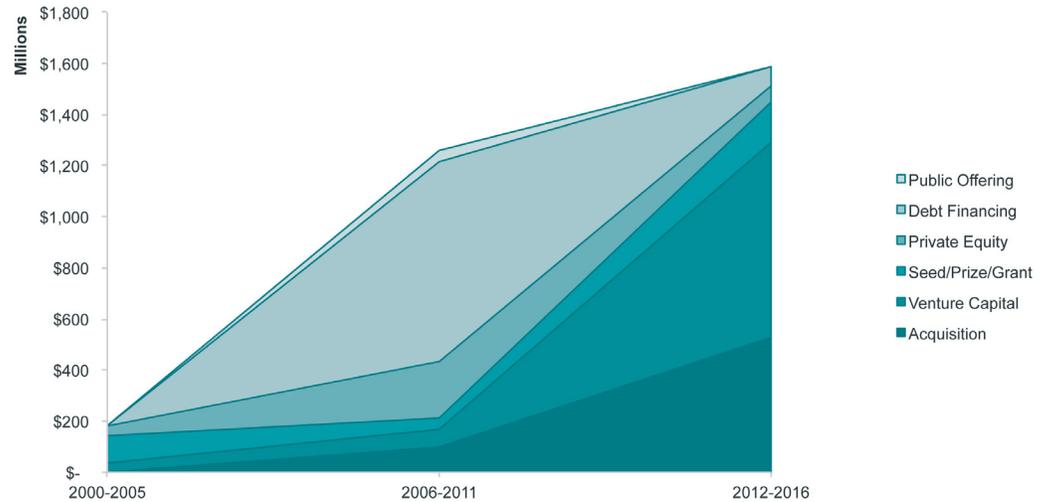


Figure 6. Considering multi-year periods, average annual start-up space seed funding, venture capital, and acquisitions have recently increased.

most recent five-year period. The average acquisition level is \$190 million per year, and is \$528 million per year in the most recent five-year period. The average seed funding level was \$160 million per year in the last five years, up from \$49 million per year in the prior five-year period. In addition, the average private equity funding level was \$60 million in the last five years, a decrease from the \$215 million per year in the 2006-2011 period. Looking at the data in these multi-year groupings, average annual values for seed, venture, and acquisition have increased, while those of private equity, public offering, and debt financing have decreased. See Figure 6.

Valuation

Substantial valuations can accompany substantial investment in start-up space ventures. While not all valuations for companies are publicly available, there are some notable valuations. One start-up space company, SpaceX, has joined the elite group of “unicorns,” private companies with a valuation of \$1 billion or more. SpaceX is reportedly valued at \$21 billion and holds the number 9 spot on *Fortune’s* Unicorn List, which numbers just over 170 companies as of June 2017. Three other start-up space companies may be on the path to unicorn valuations: Planet, Rocket Lab, and OneWeb. Investment publications and analytics firms have published valuations for each of these companies that exceed \$1 billion. After Planet closed a Series C round of venture capital, *PitchBook* valued the company at \$1.13 billion. *Forbes* published a valuation in excess of \$1 billion for Rocket Lab after the space start-up closed a Series D round of venture capital in March 2017, and *PitchBook* highlighted the company in its Unicorn List of 2017, publishing a \$1.1 billion valuation as of March 2017. OneWeb has reported over \$1.7 billion of investment since 2015; however, a valuation has not been reported.

Space Investors by the Numbers

Overall

This research has identified 439 investors that have provided funding to start-up space companies. All investors are not always disclosed, so the actual number of investors is higher.

Over the 17-year period, we looked at the distribution of investors across the five categories. Venture capital firms represent the largest number of investors in start-up space companies, followed by angel investors. These two investor groups comprise about 70 percent of the investors in start-up space ventures. Private equity firms, corporations, and banks (debt financing) make up the remaining 30 percent. There is small participation by a few altruists, who have provided grants or prizes, such as Thiel Foundation, Knight Foundation, XPRIZE Foundation, and Space Frontier Foundation, primarily through business plan or other competitions. See Figure 7.

The year 2016 saw roughly 30 percent fewer investors making investments, compared to 2015. The number of deals dropped from 73 to 49, and the number of investors in those deals dropped from 161 to 114. Nevertheless, new investors continue to enter the ecosystem, with more than 40 venture capital firms investing in start-up space for the first time in 2016.

The number of investors has grown over the last 17 years. From 2000 to 2005, the number of investors per year averaged 8, and from 2006 to 2011, the number averaged 23. From 2012 to 2016, the average is 93 investors. This is nearly a twelve-fold increase from the first period to the third. Figure 8 shows the unique investors in each year.

Number of Investors by Type from 2000 to 2016

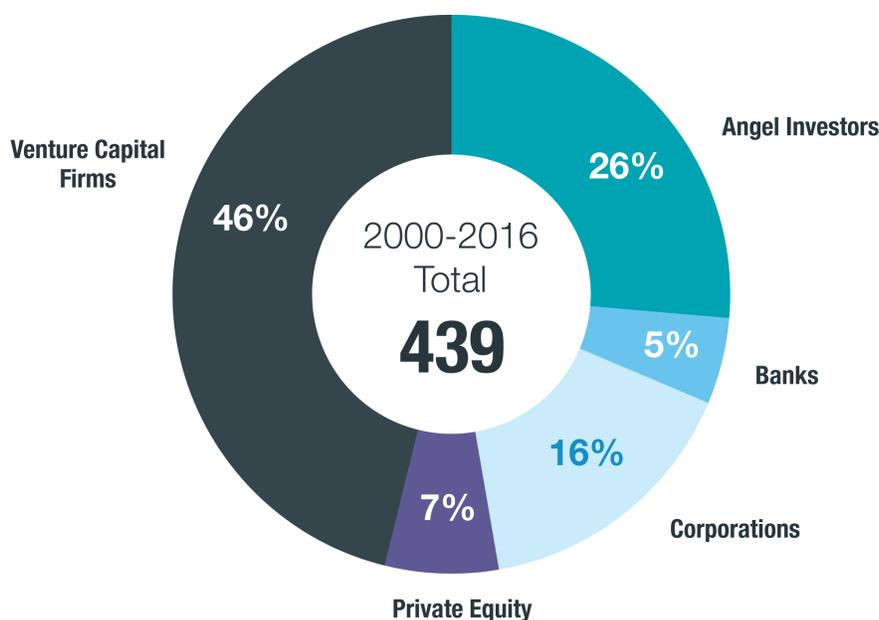


Figure 7. By number of investors, VCs are the largest investor group for space start-ups. Note that angel investors and altruists are combined into the angel investors category in this chart.

Space Investors by the Numbers



Figure 8. The average number of space investors per year has grown from 8 to 93, looking at multi-year periods.

The mix of investors changes from year to year, as shown in Figure 9. The trend for each investor group is discussed in the sections below. Venture capital firms are steady with a notable one-year increase during the first two-thirds of the study period and a considerable, sustained increase during the last one-third of the study period. Angels follow a similar pattern during the first two-thirds of the study period and show a marked increase during the last one-third of the study period. Activity by private equity firms and corporations is notable throughout.

The past two years show nearly a three-fold increase in the number of corporations investing in start-up space ventures, driven in part by a slew of international firms investing in OneWeb. There is very little activity in public markets from 2000 to 2016 as DigitalGlobe and UrtheCast are the only companies to go public (Urthecast through a reverse IPO). Banks (typically providing debt financing) appear prominently in 2010 and 2011. Deals for O3b and Ligado Networks brought many banks to the table in 2010, as did deals for O3b and DigitalGlobe in 2011.

Investors in space companies are primarily based in the United States. These 276 investors make up 63 percent of the global total (439). California is home to nearly half of U.S. investors (133), representing 30 percent of the global total. The other 143 investors are located elsewhere in the United States, with New York (47) as a notable example. See Figure 10.

The non-U.S. investors are based around the globe. These 163 investors are in 32 countries, represented in four regions: Americas, Africa/Asia/Oceania, Europe, and Middle East. The United Kingdom is home to 15 percent of non-U.S. investors (25), followed by and Japan (19), Israel (15), Canada (14), Spain (12), China (9), and India (10). Italy and Russia are home to five space investors. See Figure 11.

One third of investors in start-up space are from outside the U.S.

Number of Investors by Type (2000-2016)

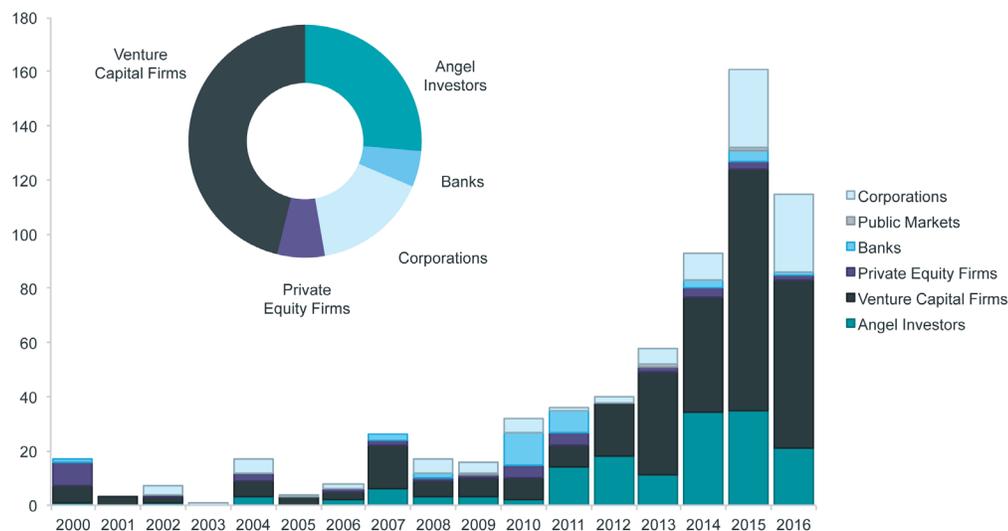


Figure 9. The mix of investors in space companies varies year to year.

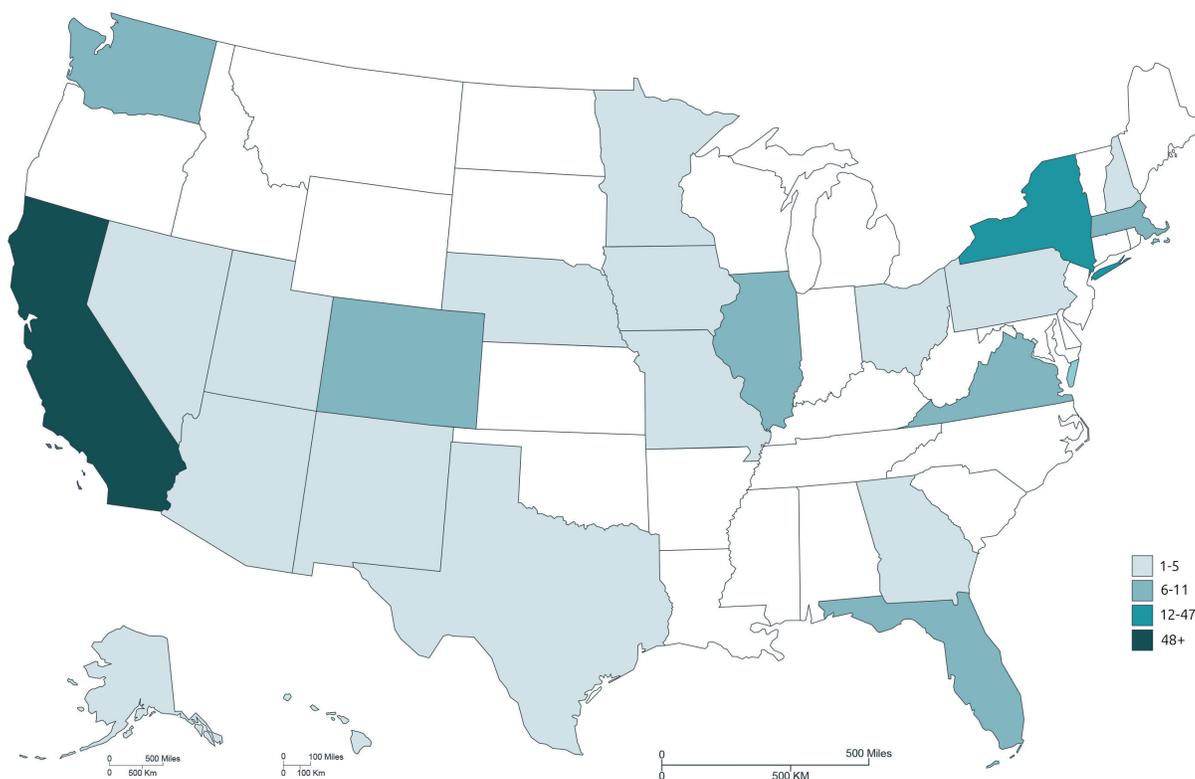


Figure 10. Investors in start-up space ventures headquartered in the U.S.

Space Investors by the Numbers

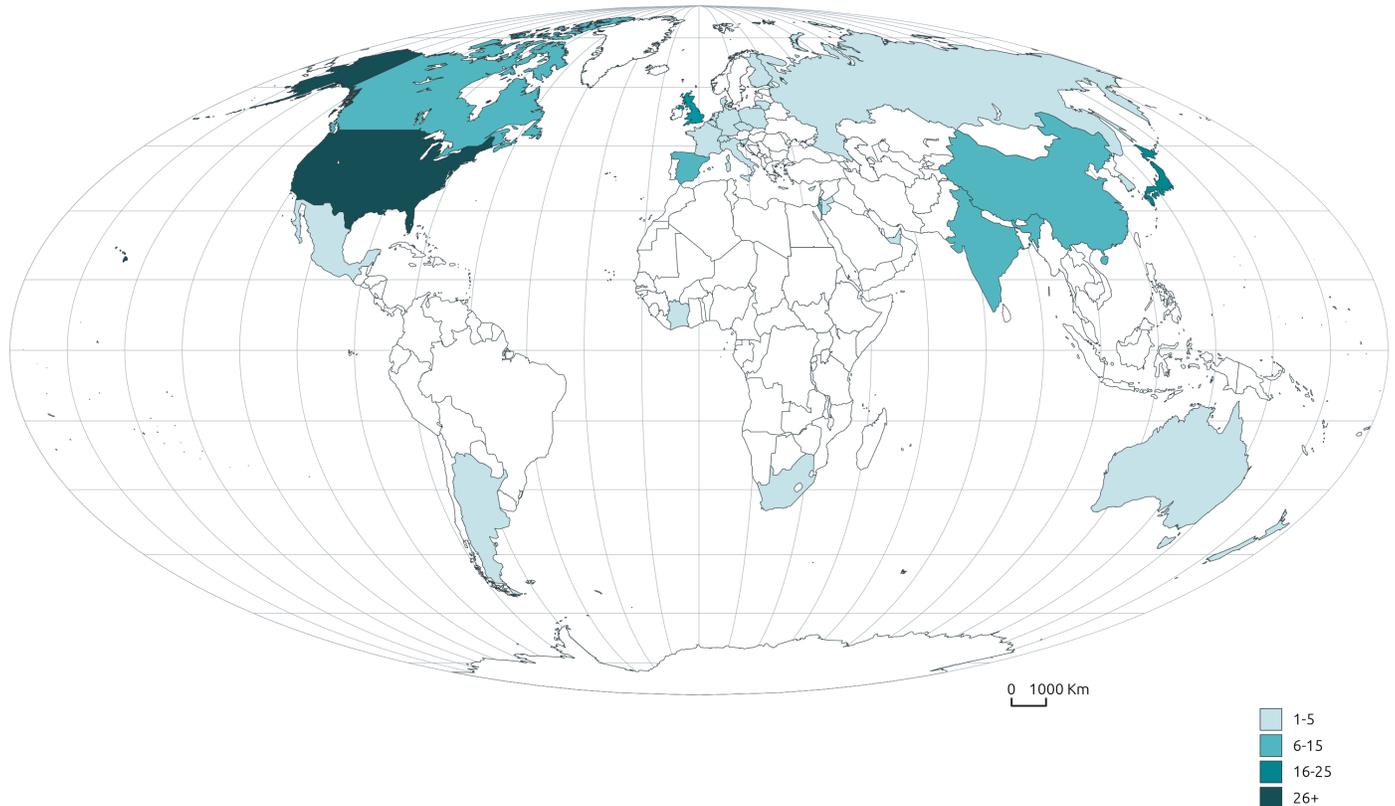


Figure 11. Investors in start-up space ventures are headquartered in the U.S. and 32 other countries.

Angels

Since 2000, over 115 angel investors have invested in start-up space companies. Angel investors include individual angels and groups of angels. Angels must be accredited investors, as defined by the Securities and Exchange Commission, with either earned income that exceeds \$200,000 (or \$300,000 if married) per year or net worth over \$1 million. For example, Space Angels has 250 accredited angels. To be included in the data set, at least one angel has to have announced an investment. Most angel investments are not made public, so the actual number of investors is higher.

The most prominent angel investors are “space billionaires.” These billionaires have accrued their wealth through other successful businesses or investments and have either founded a space company or invested their own money in a space company. Jeff Bezos, Richard Branson, and Elon Musk are usually the first billionaires mentioned, but they are not the only ones. Of the 1,810 people on *Forbes’* Billionaires List, 25 have an affiliation to a space enterprise. This represents about 1 percent of billionaires.^{6,7}

Other notable individual angel investors are Dylan Taylor and Esther Dyson. Taylor has invested in 10 different space start-ups, and Dyson has invested in XCOR Aerospace

6 “The World’s Billionaires.” *Forbes*. Forbes Magazine, 31 Dec. 2016. Web. 09 July 2017.

7 DeSantis, Nick. “Forbes Billionaires List Map: 2016 Billionaire Population by Country.” *Forbes*. Forbes Magazine, 07 Mar. 2016. Web. 09 July 2017.

and Space Adventures. Four companies that included many individual investors are Moon Express (14), Astroscale (8), Planetary Resources (8), and Dauria Aerospace (6).

Angel investors have found power in numbers and pool their resources. Angels come together and invest in groups, often called syndicates, such as Boston Harbor Angels, which invested in XCOR Aerospace, and Green Angel Syndicate, which invested in Global Surface Intelligence. Space Angels has been particularly active with nearly two dozen different transactions in the last 10 years.

Angels investing in space companies are primarily based in the United States (85). Angels based in the United States comprise 73 percent of the global total. California is home to the majority of angels in the United States, representing 45 percent of the U.S. total and 33 percent of the global total. The other 55 percent of angels investing in start-up space companies in the U.S. are located in New York, Washington, Colorado, Texas, and several other states.

The non-U.S. angel investors are based across the globe. Twelve countries are represented in four regions. Japan, India, Russia, Israel, the United Kingdom, and Canada are home to multiple angels investing in space companies, with Japan hosting 23 percent and India hosting 19 percent of non-U.S. angels.

Angels have been increasingly investing in space companies. From 2000 to 2005, the average number of angel investors per year was one. There was no angel activity publicly reported in 2001, 2003, and 2005. From 2006 to 2011, the average was five. Starting in 2012, the average number of angel investors per year jumped to 24—a five-fold increase over the 2006-2011 period. See Figure 12.

Twenty-five billionaires have a space connection.

Number of Angel Investors (2000-2016)

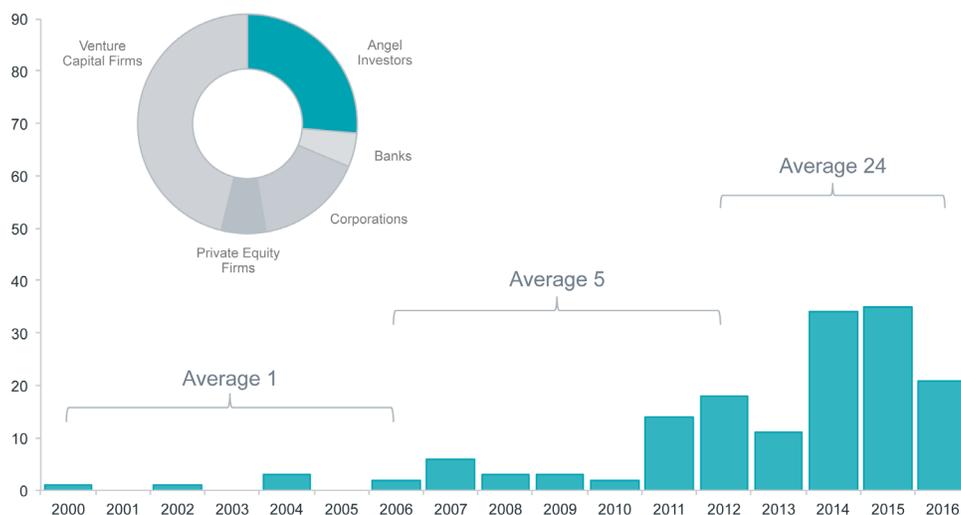


Figure 12. Considering multi-year periods, angel investor activity has increased.

Space Investors by the Numbers

Forty-three new venture capital firms invested in start-up space in 2016.

Venture Capital Firms

Since 2000, more than 200 VC firms have invested in start-up space companies. VCs generally focus on start-ups and early stage ventures. We include incubators and accelerators in this investor group because they provide funding as well as mentoring and networking. In 2016, 62 VCs invested in space companies. This is the second highest number over the study period, following a record-setting year for venture capital in 2015 when 89 VCs invested in start-up space companies. (The reported number of venture capital firms investing in 2015 has increased since our previous report, as more companies have publicly announced transactions.) Of the 62 VCs that invested in start-up space companies in 2016, 19 had previously reported investment in start-up space companies; 43 had not, and appear to be new additions to the start-up space ecosystem. See Figure 13. (We include Fidelity Investments in this investor group, because Fidelity provides venture capital to high-tech companies and, in particular, invested in SpaceX, though traditionally Fidelity runs mutual funds that focus on public company equity and debt.)

The number of VC firms investing in space companies has increased in recent years, with a peak in 2015. From 2000 to 2005, the average number of VCs per year is three. Over the next six years, the average is eight. From 2012 to 2016, the average is 50. This is nearly a six-fold increase from the 2006-2011 period. See Figure 13.

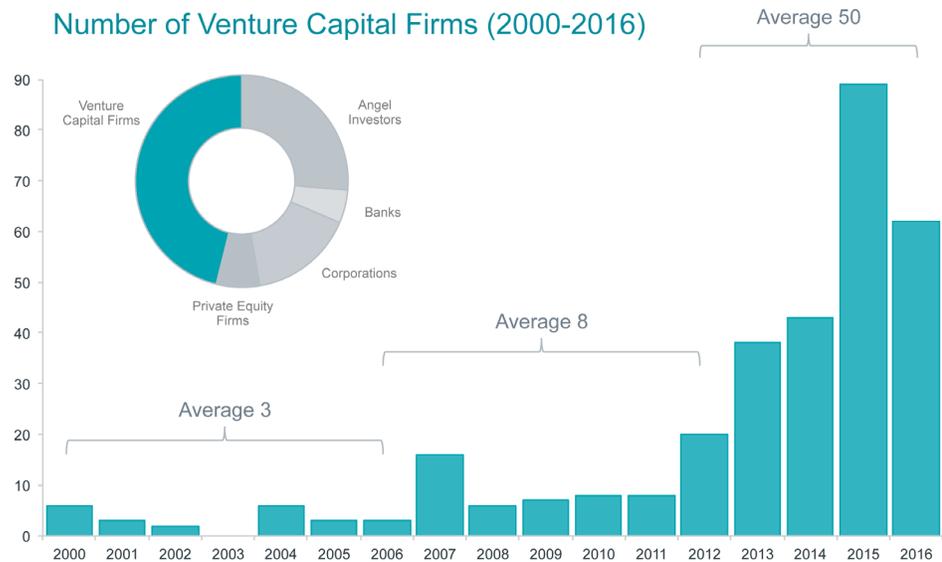


Figure 13. More VCs have invested in start-up space in recent years.

VCs investing in space companies are primarily based in the United States (136). VCs with headquarters in the United States make up 67 percent of the global total. Over half of U.S. VCs (57 percent) are based in California, representing 38 percent of the global total. The remaining 43 percent of U.S. VCs are located elsewhere in the United States, with New York, Maryland, Illinois, and Colorado as notable examples.

Non-U.S. VCs investing in start-up space ventures have headquarters across the globe. Twenty-four countries are represented in four regions. The United Kingdom, Israel,

China, Japan, Spain, Canada, India, Italy, Jordan, the Czech Republic, Denmark, and Switzerland are home to multiple VCs investing in space companies, with the UK hosting 18 percent of non-U.S. VC firms.

Most Active Space VCs

Thirteen venture capital firms have invested in three or more start-up space companies. Draper Fisher Jurvetson, In-Q-Tel, and Founders Fund have each invested in five and RRE Ventures has invested in four companies. Bessemer Venture Partners, Data Collective, Fresco Capital, First Round Capital, Khosla Ventures, Lux Capital, New Enterprise Associates, Norwest Venture Partners, and Promus Ventures have each invested in three companies. In addition, 20 venture capital firms have invested in two start-up space companies and 170 VCs have invested in one company. See Figure 14.



Figure 14. VCs investing in multiple space companies.

Nine start-up space companies have attracted investment from two or more of the most space-focused VCs (that is, the 13 VCs shown in Figure 14 that have invested in three or more start-up space companies). The nine companies are Accion Systems, Planet, Rocket Lab, Terra Bella, SpaceX, Spire, The Climate Corporation, Mapbox, and Swift Navigation. The relationships are diagrammed in Figure 15.

Space Investors by the Numbers

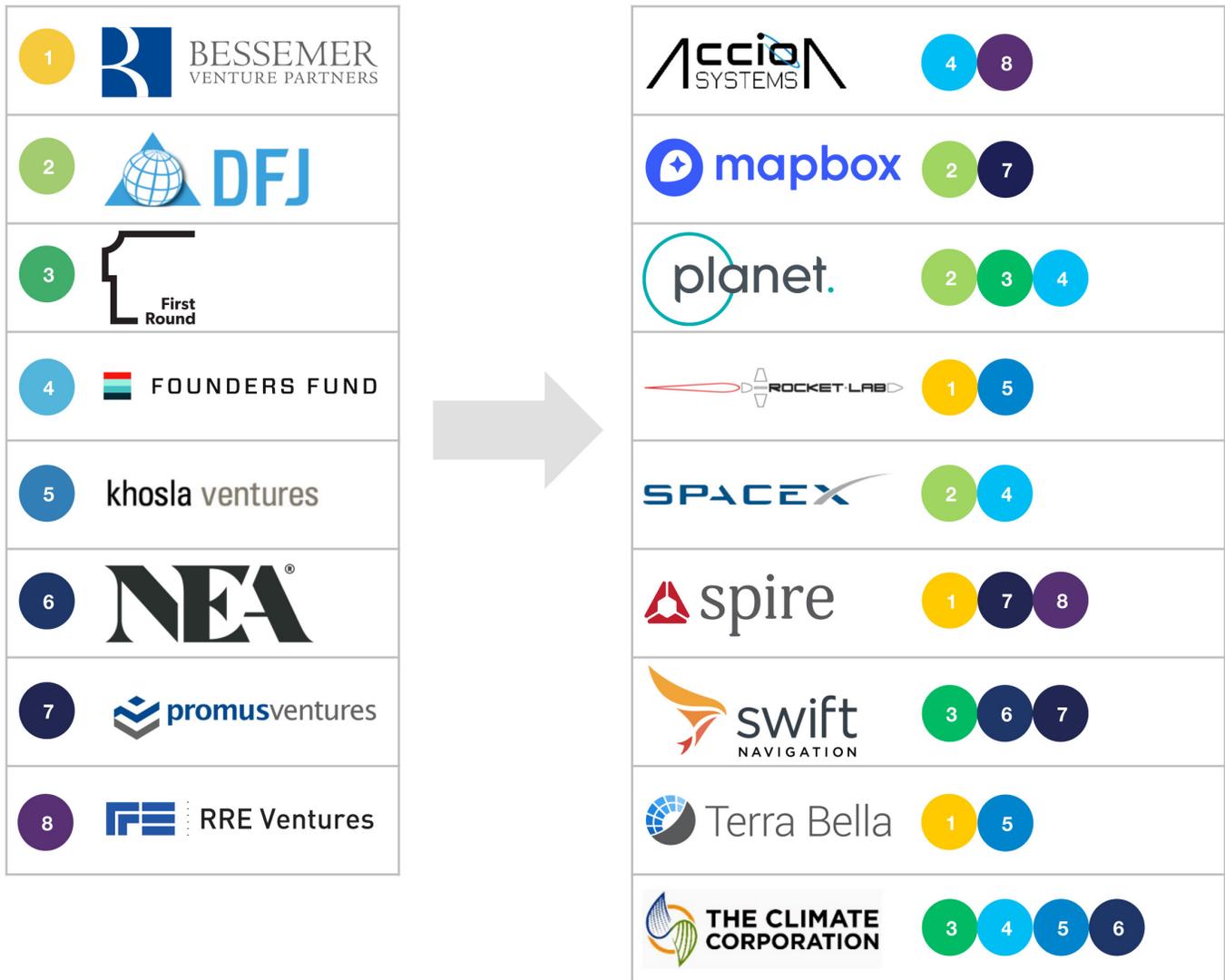


Figure 15. Common investments among VCs.

Eleven VCs have participated in five or more investment deals in start-up space companies since 2000. (That is, these VCs have participated in multiple rounds or other specific transactions, which may include more than one investment in a single company.) Draper Fisher Jurvetson leads this group, having participated in 12 start-up space deals during the study period, followed by Founders Fund (10), Lux Capital (9); Khosla Ventures, In-Q-Tel, and RRE Ventures (7); Data Collective, First Round Capital, and New Enterprise Associates (6); and Lemnos Labs and Norwest Venture Partners (5). See Figure 16.



Figure 16. VCs that have participated in multiple start-up space deals since 2000. Note: VC logo to left of Draper Fisher Jurvetson (DFJ) is Founders Fund.

Private Equity Groups

Since 2000, nearly 30 private equity firms have invested in start-up space companies. The number of PE firms investing in space companies has varied over the study period; the multi-year average is two to three per year. Transactions involving Ligado Networks, O3b, and Virgin Galactic are prominent in 2000, 2004, 2009, 2010, and 2011. See Figure 17.

Number of Private Equity Firms (2000-2016)

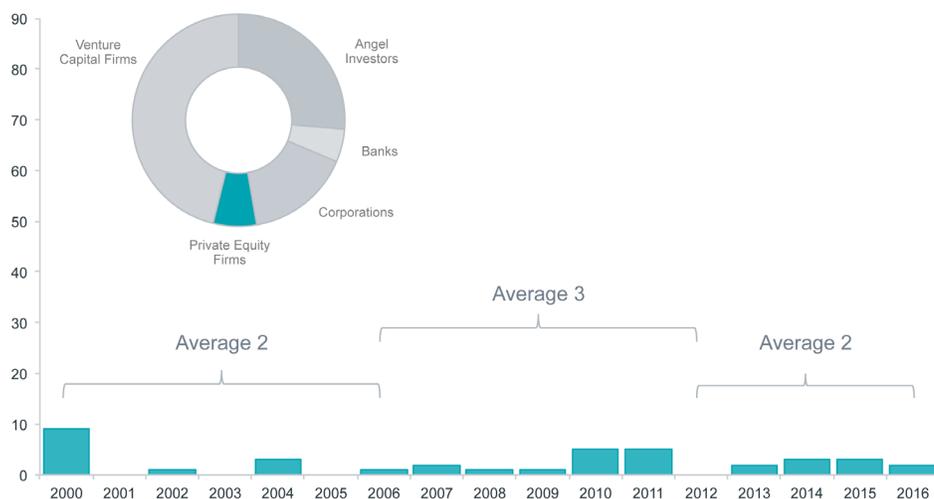


Figure 17. Private equity investor activity is variable over the study period, looking at multi-year periods.

Space Investors by the Numbers

PE firms investing in space companies are split between the United States and elsewhere across the world. Firms with headquarters in the United States make up 48 percent of the global total. The majority of U.S. firms are based in New York and California, representing 24 percent of the global total.

The international investors have headquarters across the globe. Nine countries are represented in four regions. The United Kingdom, Israel, and Canada are home to multiple private equity firms investing in space companies, with the U.K. hosting 27 percent of non-U.S. PE firms.

Corporations

Since 2000, 69 corporations have invested in start-up space ventures. The number of corporations investing in start-up space ventures has risen since 2012, and 2015 and 2016 have been peak years with 29 and 28 corporations investing in start-up space ventures in each year, respectively. (We include corporate venture funds in this investor group.) From 2000 to 2005, the average number of investors per year is two, and from 2006 to 2011, the average is three. From 2012 to 2016, the average is 15. This represents a five-fold increase in the number of corporations investing in start-up space ventures since the 2006-2011 period. See Figure 18.

Number of Corporations (2000-2016)

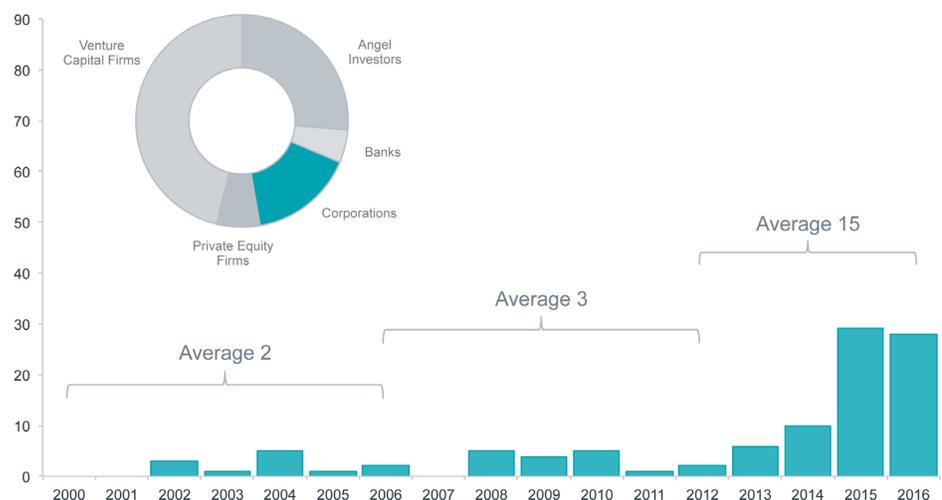


Figure 18. Corporations investing in start-up space ventures picked up starting in 2012, looking at multi-year periods.

Of the corporations investing in start-up space ventures, 49 percent are headquartered in the United States. A plurality of U.S. firms is based in California, representing 17 percent of the global total. The remaining U.S. portion of the global total is composed of firms located elsewhere in the United States, with New York as a notable example. Non-U.S. firms comprise 51 percent of the total.

Both space companies and non-space companies are investing in start-up space ventures. Existing space corporations represent 42 percent of this investor group,

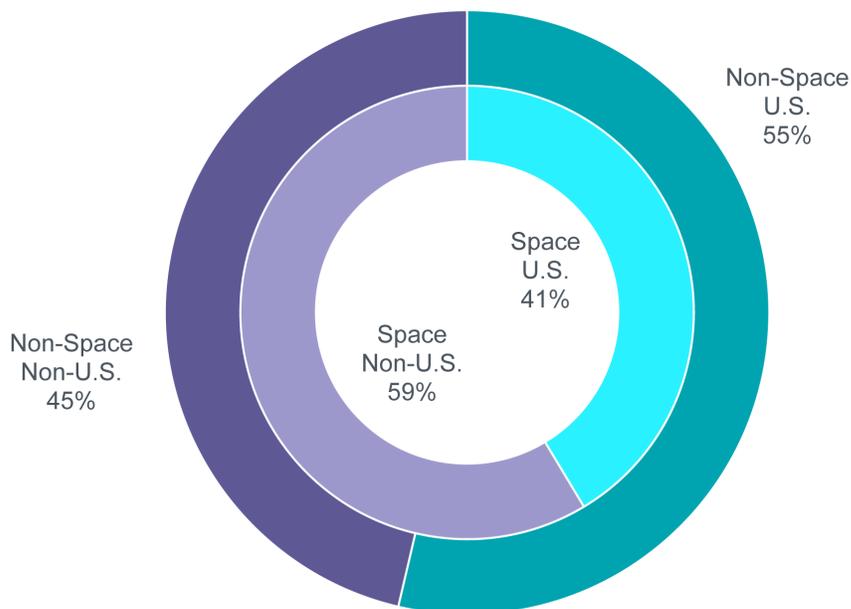


Figure 19. Space corporations investing in start-up space ventures are more likely to be headquartered outside of the United States. Non-space corporations investing in start-up space ventures are more likely to be headquartered inside the U.S.

while non-space corporations represent 58 percent. Of the space companies, 41 percent are headquartered in the U.S. Of the non-space corporations, 55 percent are headquartered in the U.S. See Figure 19.

The corporations outside the United States have headquarters across the globe. Sixteen countries are represented in four regions. Japan and Spain are each home to six corporations investing in start-up space ventures. The United Kingdom and Canada each have four companies that have reported investing in start-up space ventures.

Corporations have invested in nearly 50 start-up space ventures and participated in over 70 deals since 2000; about 21 percent of deals in which corporations have invested have been acquisitions. Acquisitions include BlackBridge by Planet, deCarta by Uber, Deimos by UrtheCast, Terra Bella by Google, SkyWave by Orbcomm, The Climate Corporation by Monsanto, WildBlue by ViaSat, O3b by SES, GATR Technologies by Cubic Corporation, and Mapsense by Apple. In addition, UrtheCast went public through a reverse IPO with an existing company, Longford Energy.

Space Investors by the Numbers

Banks and Other Financial Institutions

Relatively few—about 1 in 10—of the transactions covered in this analysis have reported debt financing as a significant component. The number of banks investing in start-up space ventures peaked in 2010 and 2011. See Figure 20.

Some examples of start-up space ventures receiving debt financing are:

- DigitalGlobe received \$600 million in debt financing in 2011.
- O3b received \$525 million in debt financing from COFACE, France’s export credit agency, and others.
- Planet received a debt facility of \$25 million from Western Technology Investment.
- Kepler Communications received a \$100,000 convertible note from Right Side Capital Management in 2016.

Number of Banks (2000-2016)

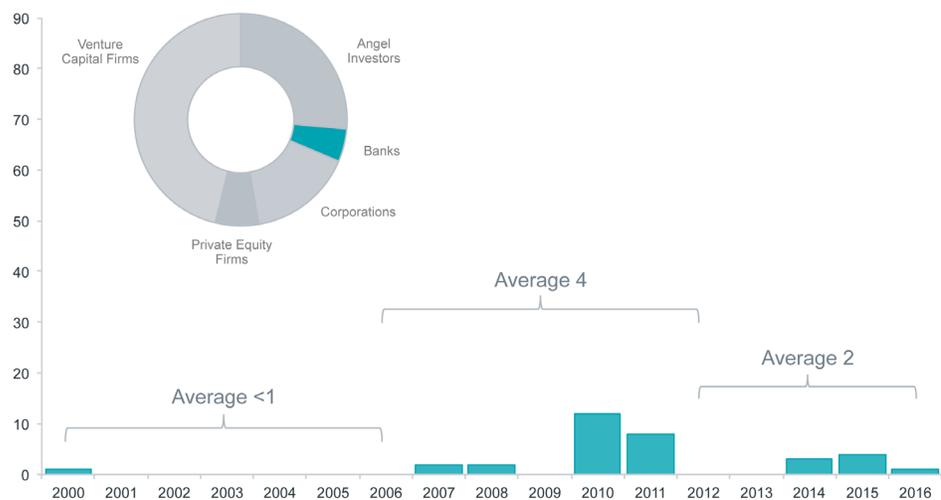


Figure 20. Banks financing start-up space ventures peaked in 2010 and 2011, coinciding with the peak in debt financing during the study period.

Start-Up Space: What's Next?

After two years of record-setting investment in start-up space companies, the services and products that attracted \$4.2 billion of seed, venture capital, and private equity during this period are deploying or are planned for deployment in the near future. Of course, some of these firms may not execute as planned. As of this writing, here are important planned next steps for start-up space firms.

In 2017, several space ventures are deploying products and services, including Kymeta, Planet, and Spire. In March 2017, Kymeta announced that it would begin a commercial trial of its mTenna™ omnidirectional, metamaterial-based satellite antenna during the second quarter of 2017. In July 2017, a Soyuz rocket launched 48 of Planet's Flock 2k remote sensing satellites on orbit, the 14th successful launch and deployment of Dove satellites. This followed a record deployment of 88 Dove satellites from an Indian Polar Satellite Launch Vehicle (PSLV) vehicle in February 2017. In the third quarter of 2017, Orbital ATK is expected to launch six 120-kilogram Planet satellites with 1-meter resolution, built by Space Systems Loral and designed by Terra Bella. (Planet completed its acquisition of Terra Bella in April 2017.)

Spire, a weather- and maritime-tracking space venture, announced in December 2016 that it would launch 25 satellites with Automatic Dependent Surveillance-Broadcast (ADB-S) aircraft-tracking payloads in 2017. The company plans to deploy another 50 satellites with ADB-S payloads in 2018. SpaceX, recipient of over \$1.2 billion of super angel (Elon Musk) and venture capital investment and several billion dollars in federal contracts, plans an inaugural launch in 2017 of the Falcon Heavy launch vehicle and an autonomous flight of the Crew Dragon spacecraft to the International Space Station (ISS) in early 2018. The company has announced that it plans to launch the first class of astronauts aboard Crew Dragon during the summer of 2018.

In late 2017, several start-up space ventures will compete for the Google Lunar XPRIZE (GLXP). The GLXP competition will award \$20 million to the first privately funded team that notifies XPRIZE about its launch and landing site; safely lands a craft with a GLXP-specified payload on the Moon; navigates its craft at least 500 meters (1,640 feet) above, on, or under the lunar surface; transmits two "Mooncasts"; and transmits and retransmits data provided by XPRIZE. The second team will receive a \$5 million award. If unclaimed, these awards expire on December 31, 2017. As of July 2017, five teams remain in the competition, including angel- and venture-backed space companies Team Indus and Moon Express.⁸

Team Indus has raised over \$35 million since 2014 and plans to launch its spacecraft to the Moon onboard a PSLV on December 28, 2017, with the goal of landing on the lunar surface in late January 2018.⁹ Moon Express has received over \$50 million of angel, venture, and private equity investment since 2011 and has selected Rocket Lab, another start-up space company, to launch its spacecraft onboard the Electron launch vehicle. Moon Express has also announced plans to launch several more missions to the lunar surface after the GLXP competition, including resource prospecting and sample return missions.

⁸ Arakali, Harichandan. "Team Indus: Aiming for the Moon." *Forbes India*. ForbesIndia, 7 June 2017. Web. 16 July 2017.

⁹ Wall, Mike. "Moon Express Reveals Bold New Plan to Explore Solar System." *NBCNews.com*. NBCUniversal News Group, 06 Mar. 2017. Web. 16 July 2017.

Start-Up Space: What's Next?

2017 will likely outpace 2016 in start-up space investment.

In May 2017, Rocket Lab conducted its first test flight of the Electron launch vehicle. The company plans to conduct two more test flights of Electron in 2017 and begin to launch customer payloads in 2018. Moon Express may be one of those customers.

A Chinese Long March 4B launch vehicle lifted one of Satellogic's high resolution, hyperspectral imaging satellites in June 2017, one of four secondary payloads launched with a government-owned x-ray telescope. This start-up venture has raised nearly \$50 million of angel and venture capital investment since 2010. Satellogic plans to launch two more satellites in August 2017 and 12-18 satellites in 2018 with the goal of a 300-satellite constellation by the early 2020s.

In early 2018, OneWeb plans to launch the first 10 satellites aboard a European Soyuz vehicle in a planned 900- to 2,620-satellite constellation to deliver global fiber-quality internet. Blue Origin and Virgin Galactic may also launch their first customers into suborbital space onboard the New Shepard and SpaceShipTwo vehicles, respectively.

During the period from 2000 to 2016, hundreds of angel investors, altruists, venture capital firms, private equity firms, corporations, banks, and public markets have provided over \$16.6 billion of funding to more than 140 start-up space companies. Investment in 2017 is likely to outpace 2016, both in terms of total magnitude and number of deals. The next few years have the potential to transform the start-up space ecosystem.

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Points of Contact

Carissa Christensen, CEO, Carissa.Christensen@brycetech.com

Raphael Perrino, Aerospace Analyst, Raphael.Perrino@brycetech.com
(2017 *Start-up Space* Lead)

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