



Space Exploration Industry

Exploring the final frontier

For the past 50 years, Space industry was mainly ran by the US government through NASA and other space programs. However, since the start of the 21st century, private companies such like SpaceX became the main driver behind the exploration. Since then, we have seen an increase in private companies and segments in this industry. We will first examine the development and trend in the market, such as reusable rockets and Wi-Fi satellites.

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History of Space Exploration: Business Spectacles



Over the past 50 years, space exploration has been largely publicly funded by governments through programs such as NASA. This has limited space exploration as government-run organizations such as NASA are financially constrained by government budgets to operate these programs. However, with the privatization of space, increased levels of private funding, and advances in space technology, this is slowly starting to change

2008 marked the first time a privately owned and operated company, SpaceX, sent vehicles and astronauts to space. SpaceX mainly generates revenue by charging government organizations such as NASA and commercial customers to send various goods to space. Goods such as International Space Station supplies, satellites, infrastructure, and people. The SpaceX Falcon 1 mission caused an unprecedented shift in the space industry, resulting in many billionaires, venture capitalists and private equity firms to start looking at the space industry as a viable investment option



The Space industry is expected to generate over 1 trillion dollars by the year 2040, up from \$350B USD currently. Furthermore, around 50% of the projected growth is driven from the satellite broadband industry. Morgan Stanley analyst Adam Jonas said, "The largest opportunity comes from providing internet access to underserved parts of the world and demand from autonomous cars, the internet of things, artificial intelligence, virtual reality, and video."

Recent Developments & Trends

Rocket Reusability

An Increase in the production and launch costs of Rockets have caused problems for private space organizations and government space agencies. Nearly five years ago it would cost government space agencies millions of dollars to build rockets just to use them once to send astronauts and satellites to space. However, with the reusable rockets by companies such as Blue Origin and SpaceX the cost of space such as the one used by the SpaceX Falcon 9 rocket costs less than half of the amount of building a new one.

WiFi Satellite

Close to 3 billion people worldwide don't have access to the internet currently. This is an untapped market and billionaires Elon Musk and Jeff Bezos are competing to send as many low-Earth orbit satellites into space. These satellites can be used to provide internet access to areas that are too remote for many of our ground based broadband lines. By the year 2040, Satellite broadband will represent up to 50% of the projected growth in the global space economy. The launch of satellites into Earth's atmosphere will significantly drive down the costs of Internet access all over the world. The cost to launch a satellite would cost on average \$200M USD but has since decreased to \$60M USD and with the increased development and emphasis on reusable rockets, this price can even further go down. Products such as Starlink are working towards providing low-cost internet to customers all over the world, with a goal of 42,000 satellites. The WIFI satellite industry is the largest industry in the space economy and is expected to grow even further.

Cost of Rocket Launch

The cost of launching a NASA rocket is roughly around \$400M USD per launch, whereas the launch of a SpaceX Falcon 9 rocket is roughly \$62M USD per launch, which is about a 75% saving percentage. The reduction in production costs of rockets have made investments in the field of space exploration worthwhile and an enticing one. With new companies starting to develop their own version of reusable rockets, interplanetary space exploration is becoming more and more of a possibility within the near future. One of the major drivers for a reduction in costs for rocket launches is the drive to make space life multi-planetary by putting millions of people in space. Given the significant decrease in costs for space flights and rocket launches over the past decade, it is expected that costs are going to decrease.

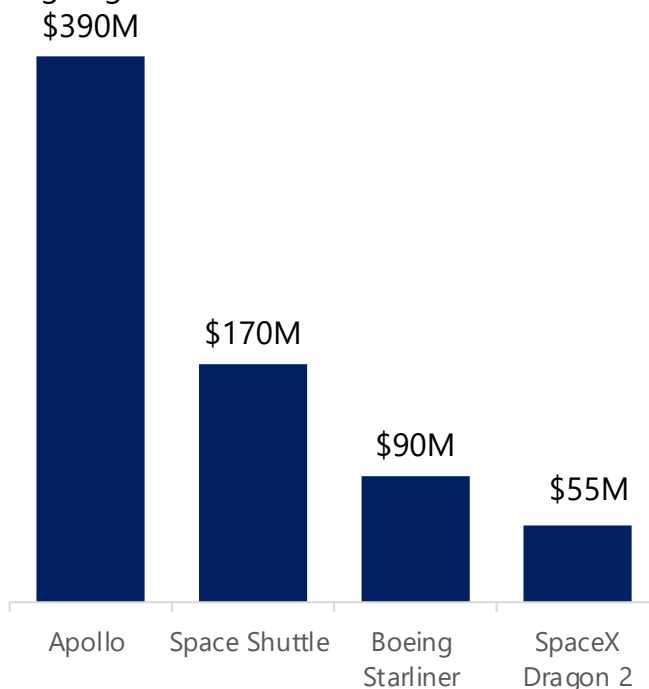


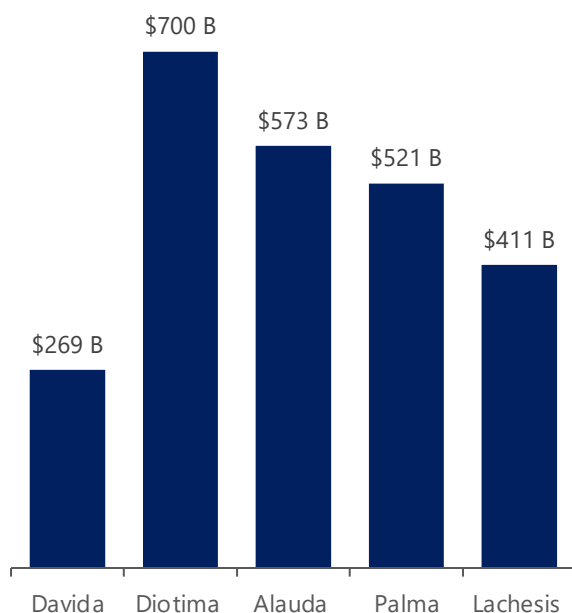
Figure 1: Cost of Rocket Launch

Development and trends

Risk of Crashing

Currently, there are over 2,000 active satellites orbiting Earth, and about 3,000 non active satellites that are littering near space, which have not broken up and are around 34,000 pieces of space junk orbiting space. There are over 27,000 pieces of space trash that are currently traveling near Earth's orbit. These pieces of Debris are large enough where they can significantly damage space vehicles such as the International Space Station and those inside. Although space trash is very small it poses a significant threat to spacecraft due to the extremely high velocity they travel at. The United Nations has asked all organizations such as NASA, SpaceX, etc to remove their satellites from orbit within the next 25 years as to reduce the risk of these satellites from burning up and crashing into other active objects.

Value of Asteroid (as of 2021 in USD Billions)



Space Mining

The space mining industry is expected to grow to \$3B USD by 2027 at a growth of 24%. With the decrease in costs of sending rockets to space, we are on the cusp of the beginning of commercial space mining. Currently, technology is not advanced enough to mine asteroids, however, the development of such technology might be worthwhile soon. Asteroids such as, Asteroid Ryugu have a total estimated value of \$83B USD if extracted and returned to Earth. The cost of future missions to return asteroids are estimated to be \$2.6B USD and ignoring the costs to develop infrastructure to extract and process the materials. Once the proper infrastructure is in place and investments from governments organizations, there is potential for significant profit, which could decrease the value of certain metals such as Iron.

Increased Reliance on Satellites

Satellites play a crucial role for many companies, people and even governments. The emergence of technologies such as 5G, blockchain, and cloud computing have increased the need for space based systems. The reliance on space-based systems such as satellites can cause a myriad of failures across systems. The potential for failures of satellites and disruptions can cause significant damage and problems for many people. In 1998, when one of America's communications satellites broke down, television and communications systems failed, credit card systems stopped processing payments, and automatic petrol pumps stopped working. Moving forward it is crucial for agencies to prioritize the development of various satellites that are less prone to failure and system errors.

Industry Drivers

Commercialization

Over the last 15 years, commercial activity in space has more than tripled, growing from \$110B in 2005 approximately \$357B in 2020 (~8% CAGR). Ambitions of commercializing space travel and being the first to market to reap the benefits are key industry drivers as billionaires, notably Elon Musk, Jeff Bezos, and Richard Branson pour vast amounts of their wealth into chasing and achieving their space travel goals, highlighting a key industry driver. Major industry players including SpaceX, Blue Origin, and Virgin Galactic are racing to achieve the first mover advantage in this relatively new industry, but they certainly are not the only ones competing with the growing number of space start-ups across the world focused on everything from satellite tech to orbiting hotels, highlighting the intensifying competitive environment as investors around the world pour capital into this industry, another industry driver.

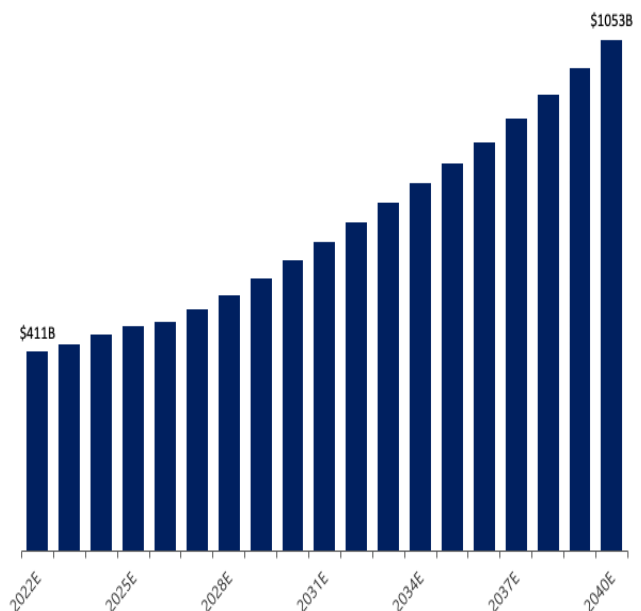
Research Initiatives

Space influences our lives more than we realize, thanks to space technology we can navigate with a GPS, stream television programs, and have accurate weather predictions, which all primarily driven by space research. As society continues to evolve and further rely on technology, space research initiatives are vital. Research budgets continue to increase with the Biden administration proposing ~\$26B for NASA's 2023 budgets, representing an 8% increase year-over-year. On the other hand, China is the second largest spender of government space programs, having spent ~10B in 2021 as it supports a robust program of civil activities, including a low-earth orbit space station and lunar exploration program. Geopolitical tensions, intensifying rivalry between leading space companies, and the value of space are industry drivers that highlight the increasing budgets for research initiatives.

Satellite Internet Market

The global satellite internet market size was valued at ~3B in 2020 and is expected to grow at a CAGR of ~20%, reaching ~19B by 2030. Satellite internet is much faster than traditional internet service and different than land-based internet services, which are prone to outages, as we have seen with Rogers Canada wide outage recently. Covid-19 significantly changed the future of work, with hybrid and remote models expected to stay. As a result of this societal shift, many citizens migrated out of large cities into more rural areas, where satellite internet is much more beneficial, thus creating a rise in demand for satellite internet. Governments are beginning to see this trend and are heavily investing in satellite broadband systems to provide services to rural populations. In addition, there are growing government initiatives to further develop and enhance satellite internet services to increase the safety and security of the public.

Global Space Economy



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Industry Trends

Growing Public Sector Interest

The investment implications for a more accessible, less expensive reach into outer space could be significant, with potential opportunities in fields such as satellite broadband, high-speed product delivery and perhaps even human space travel. While the most recent space exploration efforts have been driven by handful of private companies, the establishment of a sixth branch of the U.S. military in 2019—the “Space Force”—along with growing interest from Russia and China, means public-sector investment may also increase in the coming years. While private-equity projects have grabbed most of the headlines in recent years, public-sector interest has also grown. In December of 2019, the Trump Administration established a U.S. Space Command (including a Space Operations Force and a Space Development Agency) with the signing of the as part of the National Defense Authorization Act for 2020. This development will likely benefit the U.S. Defense Department—as well as the aerospace and defense industries—and help focus and accelerate investment in innovative technologies and capabilities. Then in May of 2020, NASA launched a manned flight to the International Space Station (ISS) on a commercially developed U.S. rocket. The launch represented the first time that the U.S. has flown a manned mission to the ISS since the shuttle program was retired in 2011. It also represents an important milestone for the relationship between private enterprise and the U.S. government in the space domain.

To Infinity and Beyond

Beyond the opportunities generated by satellite broadband Internet, the new frontiers in rocketry offer some tantalizing possibilities. Packages today delivered by airplane or truck could be delivered more quickly by rocket. Perhaps private space travel could become commercially available. Mining equipment could be sent to asteroids to extract minerals—all possible, theoretically, with the recent breakthroughs in rocketry. Jonas cautions that “history is littered with cautionary tales” of investing in satellite and other space-related companies, noting that stocks have been volatile and several such companies failed in the 1990s. Understandably, many investors would rather think about nearer-term themes that are actionable and can impact their portfolios in 2020. However, initiatives by large public and private firms suggest that space is an area where we will see significant development, potentially enhancing U.S. technological leadership and addressing opportunities and vulnerabilities in surveillance, mission deployment, cyber, and artificial intelligence.

Industry Outlook

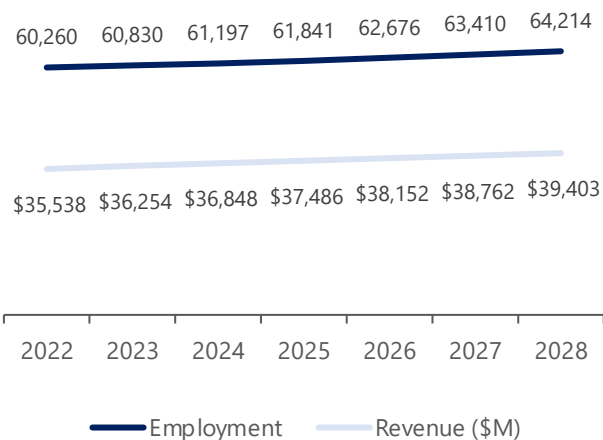
Commercial sector playing a bigger role

SpaceX will continue to resupply missions to international Space Station. A new supply contract will finally have Sierra Nevada Corp begin NASA missions. Moreover, it is expected that NASA will likely start allocating more money towards the Boeing Company and SpaceX's development of manned spacecraft flight to the International Space Station.

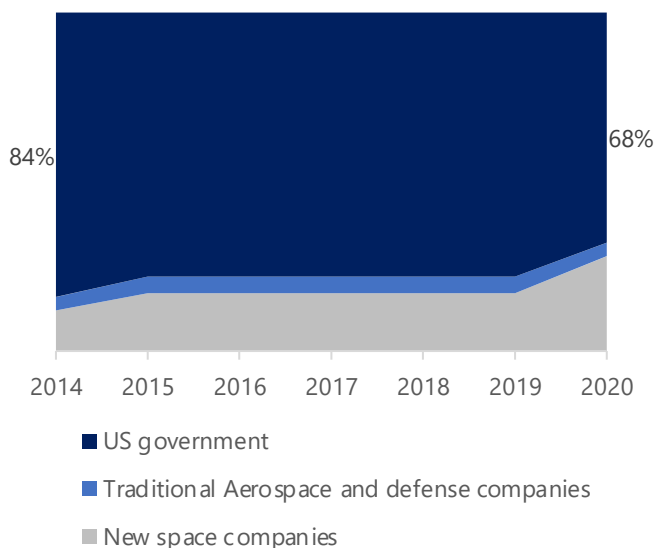
The Space-tourism sector is expected to expand and play a larger role in the next 5 years. Virgin Galactic and Blue Origin are expected to begin full operations. The growing popularity of low-Earth orbit Satellites will lead more companies to offer smaller launch vehicles.

The market overall is expected to grow. According to IBISworld, profit margins will increase 40 Basis Points until 2027. Moreover, employment number is expected to grow at 1% per year to 2017.

Industry Revenue and Employment Projection



Share of Space-Related R&D Expenditures



Fading reliance on government funding

NASA pivoted to more private enterprise contracts since 2006 after the space shuttle disaster. The space shuttle's costs were too bloated, carrying telescopes, people, and satellites. NASA is now focused on outsourcing specific contracts. For example, SpaceX has over 3.5B USD in government contracts and 500M USD in revenues from Starlink.

Given this relationship, NASA can dictate the types of missions that get funding such as going to the moon rather than mars. This forces billionaires such as Elon musk and Jeff Bezos to pay out of pocket to develop mars rockets.

This dynamic is changing, but slowly, as space tourism makes up 100M USD revenues for Blue Origin, tiny compared to government contracts. As Starlink, space tourism, and space junk removal continue to scale, private companies will transition to being more consumer and mission driven rather than government driven.

Comparable Companies



Founded in 2002, American rocket company produced Falcon, Dragon, Starlink, Starship and Star man rickets. All of which are drastically cheaper to build and operate than their government funded competitors. SpaceX also aims to build out its 2,000 satellite-strong Starlink internet constellation to provide global internet coverage.

Blue Origin was founded in 2000 by Jeff Bezos. Blue Origin's main goal is to make spaceflights accessible to private citizens. Blue Origin has developed a reusable rocket, "New Shepard", capable of carrying six passengers. Blue Origin offers an experience unlike any other, with traveler's submitting to an Apollo-like vertical takeoff in a trip expected to last roughly eleven minutes.



BLUE ORIGIN



Virgin Galactic is, a suborbital space tourism provider that transports its customers to suborbital space using rocket engines. However, they have recently announced delays till Q2 2023, due to upgrade. For Virgin Galactic's first spaceflight the first 1,000 reservations are already booked, with 800 more on the waitlist. A seat on VSS is priced at \$450,000.

Boeing, broke into the space industry upon its new agreement with NASA in 2014. This contract allows Boeing to sell seats to possible space tourists. Lockheed Martin and Boeing partnered create the United Launch Alliance, "ULA", in 2006.



Valuation Table

Comparable Company Analysis

(\$ in millions USD, except share price)

Name	Share Price	General			Stats			Trading Multiples	
		Market Cap	Value (TEV)	Revenue	EBITDA	EBIT	Net Income	TEV / Revenue	TEV / EBITDA
SpaceX (PRIVATE)		\$125,000	-	-	-	-	-	-	-
Boeing (NYSE: BA)	\$ 157.52	\$93,698	\$139,547	\$60,743	\$119	(\$1,922)	(\$5,278)	2.3x	279.7x
Virgin Galactic (NYSE: SPCE)	\$ 6.00	\$1,552	\$1,250	\$3	\$356	(\$366)	(\$333)	295.3x	3.5x
Blue Origin (PRIVATE)		-	-	-	-	-	-	-	-
Mean								148.8x	3.5x
Median								148.8x	3.5x
Minimum								2.3x	3.5x
25th Percentile								112.2x	3.5x
75th Percentile								185.4x	3.5x
Maximum								295.3x	3.5x