[Template:Use American English](/wiki/Template:Use_American_English" \o "Template:Use American English) [Template:Use mdy dates](/wiki/Template:Use_mdy_dates) [Template:Infobox company](/wiki/Template:Infobox_company)

**Space Exploration Technologies Corporation**, better known as **SpaceX**, is an American [aerospace manufacturer](/wiki/Aerospace_manufacturer) and [space transport](/wiki/Space_transport) services company headquartered in [Hawthorne, California](/wiki/Hawthorne,_California), [USA](/wiki/USA). It was founded in 2002 by former [PayPal](/wiki/PayPal) entrepreneur and [Tesla Motors](/wiki/Tesla_Motors) CEO [Elon Musk](/wiki/Elon_Musk) with the goal of creating the technologies to reduce space transportation costs and enable the [colonization of Mars](/wiki/Colonization_of_Mars). It has developed the [Falcon 1](/wiki/Falcon_1) and [Falcon 9](/wiki/Falcon_9) launch vehicles, both designed to be [reusable](/wiki/Reusable_launch_system), and the [Dragon spacecraft](/wiki/Dragon_(spacecraft)) which is flown into orbit by the Falcon 9 launch vehicle to supply the [International Space Station](/wiki/International_Space_Station) (ISS) with cargo. A [manned version of Dragon](/wiki/Dragon_V2) is in development.

SpaceX's achievements include the first privately funded, [liquid-propellant rocket](/wiki/Liquid-propellant_rocket) (Falcon 1) to reach orbit, in 2008;<ref name=sfn20080928> [Template:Cite web](/wiki/Template:Cite_web)</ref> the first privately funded company to successfully launch, orbit and recover a spacecraft (Dragon), in 2010; and the first private company to send a spacecraft (Dragon) to the ISS, in 2012.[[1]](#cite_note-1) The launch of [SES-8](/wiki/SES-8), in 2013, was the first SpaceX delivery into [geosynchronous orbit](/wiki/Geosynchronous_orbit), while the launch of the [Deep Space Climate Observatory](/wiki/Deep_Space_Climate_Observatory) (DSCOVR), in 2015, was the company's first delivery beyond Earth orbit.

SpaceX began a privately-funded [reusable launch system technology development program](/wiki/SpaceX_reusable_launch_system_development_program) in 2011 and, in December 2015, successfully returned a first stage back to a landing pad near the launch site and accomplished a propulsive [vertical landing](/wiki/VTVL). The was the first such accomplishment by a rocket on an [orbital](/wiki/Orbital_spaceflight) [trajectory](/wiki/Trajectory).<ref name=guardian20151222>[Template:Cite news](/wiki/Template:Cite_news)</ref> On April 8, 2016, with the launch of [CRS-8](/wiki/CRS-8), SpaceX successfully vertically landed a first stage on an ocean [drone-ship](/wiki/Autonomous_spaceport_drone_ship) landing platform on a mission that also delivered a Dragon space capsule to Low Earth Orbit.<ref name=guardian20160408>[Template:Cite news](/wiki/Template:Cite_news)</ref> On May 6, 2016, SpaceX again landed a first stage, but on a [geostationary transfer orbit](/wiki/Geostationary_transfer_orbit) mission, another first.<ref name=verge>[Template:Cite news](/wiki/Template:Cite_news)</ref>

[NASA](/wiki/NASA) awarded the company a [Commercial Orbital Transportation Services](/wiki/Commercial_Orbital_Transportation_Services) (COTS) contract in 2006, to design and demonstrate a launch system to resupply cargo to the [International Space Station](/wiki/International_Space_Station) (ISS). SpaceX, [Template:As of](/wiki/Template:As_of) has flown eight missions to the ISS under a [cargo resupply](/wiki/Commercial_Resupply_Services) contract.<ref name=nsf20150515>[Template:Cite web](/wiki/Template:Cite_web)</ref> NASA also awarded SpaceX a contract in 2011 to develop and demonstrate a [human-rated](/wiki/Human-rating_certification) Dragon as part of its [Commercial Crew Development](/wiki/Commercial_Crew_Development) (CCDev) program to transport crew to the ISS.[[2]](#cite_note-2)

## Contents

* 1 History[[edit](/index.php?title=(none)&action=edit&section=1)]
  + 1.1 History[[edit](/index.php?title=(none)&action=edit&section=2)]
  + 1.2 Funding[[edit](/index.php?title=(none)&action=edit&section=3)]
  + 1.3 Goals[[edit](/index.php?title=(none)&action=edit&section=4)]
    - 1.3.1 Mars[[edit](/index.php?title=(none)&action=edit&section=5)]
    - 1.3.2 Reusable rockets[[edit](/index.php?title=(none)&action=edit&section=6)]
  + 1.4 Setbacks[[edit](/index.php?title=(none)&action=edit&section=7)]
    - 1.4.1 Failed launch[[edit](/index.php?title=(none)&action=edit&section=8)]
    - 1.4.2 Issues in flight[[edit](/index.php?title=(none)&action=edit&section=9)]
* 2 Facilities[[edit](/index.php?title=(none)&action=edit&section=10)]
  + 2.1 Headquarters and rocket manufacturing plant[[edit](/index.php?title=(none)&action=edit&section=11)]
  + 2.2 Satellite development facility[[edit](/index.php?title=(none)&action=edit&section=12)]
  + 2.3 Regional offices[[edit](/index.php?title=(none)&action=edit&section=13)]
  + 2.4 Test and post-flight disassembly facilities[[edit](/index.php?title=(none)&action=edit&section=14)]
  + 2.5 Flight operations[[edit](/index.php?title=(none)&action=edit&section=15)]
    - 2.5.1 New commercial-only launch site[[edit](/index.php?title=(none)&action=edit&section=16)]
    - 2.5.2 Crewed-mission leased launch site[[edit](/index.php?title=(none)&action=edit&section=17)]
* 3 NASA collaborations[[edit](/index.php?title=(none)&action=edit&section=18)]
  + 3.1 Commercial cargo contracts[[edit](/index.php?title=(none)&action=edit&section=19)]
  + 3.2 Commercial crew contracts[[edit](/index.php?title=(none)&action=edit&section=20)]
  + 3.3 "Red Dragon" Mars mission concept[[edit](/index.php?title=(none)&action=edit&section=21)]
* 4 Other contracts[[edit](/index.php?title=(none)&action=edit&section=22)]
  + 4.1 Launch market competition and pricing pressure[[edit](/index.php?title=(none)&action=edit&section=23)]
* 5 Commercial and government launch contracts summary[[edit](/index.php?title=(none)&action=edit&section=24)]
* 6 Space vehicles[[edit](/index.php?title=(none)&action=edit&section=25)]
  + 6.1 Falcon launch vehicles[[edit](/index.php?title=(none)&action=edit&section=26)]
  + 6.2 Dragon[[edit](/index.php?title=(none)&action=edit&section=27)]
  + 6.3 Other concepts under development[[edit](/index.php?title=(none)&action=edit&section=28)]
* 7 Rocket engines[[edit](/index.php?title=(none)&action=edit&section=29)]
* 8 See also[[edit](/index.php?title=(none)&action=edit&section=30)]
* 9 References[[edit](/index.php?title=(none)&action=edit&section=31)]
* 10 Further reading[[edit](/index.php?title=(none)&action=edit&section=32)]
* 11 External links[[edit](/index.php?title=(none)&action=edit&section=33)]

## History[[edit](/index.php?title=(none)&action=edit&section=1)]

[thumb|Launch of Falcon 9 carrying ORBCOMM OG2-M1](/wiki/File:Launch_of_Falcon_9_carrying_ORBCOMM_OG2-M1_(16601442698).jpg) [thumb|Falcon 9 carrying CRS-7 Dragon on SLC-40 pad](/wiki/File:Falcon_9_carrying_CRS-7_Dragon_on_SLC-40_pad_(19045370790).jpg) [thumb|SpaceX employees with the Dragon capsule at SpaceX HQ in Hawthorne, California, February 2015](/wiki/File:Dragon_capsule_and_SpaceX_employees_(16491695667).jpg)

### History[[edit](/index.php?title=(none)&action=edit&section=2)]

In 2001, Musk conceptualized "Mars Oasis"; a project to land a miniature experimental greenhouse on Mars, containing seeds with dehydrated gel, hydrating the gel and having plants grow on [Martian soil](/wiki/Martian_soil), "so this would be the furthest that life’s ever traveled"[[3]](#cite_note-3) in an attempt to regain public interest in space exploration and increase the [Budget of NASA](/wiki/Budget_of_NASA).[[4]](#cite_note-4)<ref name=spectrum>[Template:Cite news](/wiki/Template:Cite_news)</ref>[[5]](#cite_note-5) But Musk realized that even with a much larger space budget, travel to Mars would be prohibitively expensive and that a fundamental breakthrough in rocket technology was needed.[[5]](#cite_note-5) In October 2001, Musk travelled to Moscow with Jim Cantrell (an aerospace supplies fixer), and [Adeo Ressi](/wiki/Adeo_Ressi) (his best friend from college), to buy refurbished ICBMs ([Dnepr](/wiki/Dnepr_(rocket))) that could send the envisioned payloads into space.<ref name=A&Ssmithsonian201201> [Template:Cite news](/wiki/Template:Cite_news)</ref> The group met with companies such as [Lavochkin](/wiki/Lavochkin) and [ISC Kosmotras](/wiki/ISC_Kosmotras). However, according to Cantrell, Musk was seen as a novice and was consequently spat on by one of the Russian chief designers, and the group returned to the US empty-handed.[[6]](#cite_note-6) In February 2002, the group returned to Russia to look for three ICBMs, bringing along Mike Griffin, who had worked for the CIA’s venture capital arm, [In-Q-Tel](/wiki/In-Q-Tel); NASA's [Jet Propulsion Laboratory](/wiki/Jet_Propulsion_Laboratory); and was just leaving [Orbital Sciences Corporation](/wiki/Orbital_Sciences_Corporation), a maker of satellites and spacecraft. The group met again with [Kosmotras](/wiki/Kosmotras), and were offered one rocket for US$8 million. However, this was seen by Musk as too expensive; Musk consequently stormed out of the meeting. On the flight back from [Moscow](/wiki/Moscow), Musk realized that he could start a company that could build the affordable rockets he needed.[[6]](#cite_note-6) According to early Tesla and SpaceX investor [Steve Jurvetson](/wiki/Steve_Jurvetson),[[7]](#cite_note-7) Musk calculated that the raw materials for building a rocket actually were only 3 percent of the sales price of a rocket at the time. By applying [vertical integration](/wiki/Vertical_integration)—principally for cost reasons;<ref name=A&Ssmithsonian201201/> around 85% of the entire Falcon/Dragon vehicle is produced in-house[[8]](#cite_note-8)[[9]](#cite_note-9)— and the modular approach from software engineering ([Falcon 9](/wiki/Falcon_9) uses 9 of the Merlin engines, which were tested on the single engine [Falcon 1](/wiki/Falcon_1), [Falcon Heavy](/wiki/Falcon_Heavy) uses three Falcon 9 booster stages), SpaceX could cut launch price by a factor of ten and still enjoy a 70 percent [gross margin](/wiki/Gross_margin).[[10]](#cite_note-10) Another reason for vertical integration is that Musk thinks reusable rockets cannot be built with components from existing suppliers, that all the other aerospace companies are buying from as well. For example, SpaceX had to design a machine that could [friction stir](/wiki/Friction_stir) weld [aluminium-lithium alloy](/wiki/Aluminium-lithium_alloy) for the [airframe](/wiki/Airframe) of the [Falcon 9](/wiki/Falcon_9), because such a machine did not exist anywhere in the world.[[11]](#cite_note-11) According to Musk, SpaceX started with the [smallest useful orbital rocket](/wiki/Minimum_viable_product) (Falcon 1 with about half a ton to orbit), instead of building a more complex and riskier launch vehicle, which could have failed and bankrupted the company.[[12]](#cite_note-12) In early 2002, Musk was seeking staff for his new space company, soon to be named SpaceX. Musk approached renowned rocket engineer [Tom Mueller](/wiki/Tom_Mueller) (now SpaceX's VP of Propulsion), Mueller agreed to work for Musk and SpaceX was born.[[13]](#cite_note-13) SpaceX was first headquartered in a 75,000 square feet warehouse in [El Segundo, California](/wiki/El_Segundo,_California). Musk decided SpaceX's first rocket would be named [Falcon 1](/wiki/Falcon_1), a nod to Star Wars' [Millennium Falcon](/wiki/Millennium_Falcon). Musk planned for Falcon 1's first launch to occur in November 2003, 15 months after the company started.[[6]](#cite_note-6) In January 2005, SpaceX bought a 10% stake in [Surrey Satellite Technology](/wiki/Surrey_Satellite_Technology).[[14]](#cite_note-14) By March 2006, Musk had invested [Template:USD](/wiki/Template:USD) of his own money into the company.[[15]](#cite_note-15) On August 4, 2008, SpaceX accepted a further $20 million investment from [Founders Fund](/wiki/Founders_Fund).[[16]](#cite_note-16)In early 2012, approximately two-thirds of the company was owned by its founder[[17]](#cite_note-17) and his 70 million shares were then estimated to be worth $875 million on [private markets](/wiki/Private_equity),[[18]](#cite_note-18) which roughly valued SpaceX at $1.3 billion as of February 2012.[[19]](#cite_note-19) After the [COTS 2+](/wiki/Dragon_C2+) flight in May 2012, the company private equity valuation nearly doubled to $2.4 billion.[[20]](#cite_note-20)[[21]](#cite_note-21) On 16 June 2009, SpaceX announced the opening of its Astronaut Safety and Mission Assurance Department. It hired former [NASA](/wiki/NASA) astronaut [Ken Bowersox](/wiki/Ken_Bowersox) to oversee the department as a vice president of the company.[[22]](#cite_note-22) However, it has since been reported that the former astronaut subsequently left SpaceX in late 2011. No reason was given and no replacement in that position has been announced.<ref name=Bowersox>[Template:Cite news](/wiki/Template:Cite_news)</ref>

In 2010, Musk's calculations convinced him that the colonization of Mars was possible.[[23]](#cite_note-23) In 2012, an [initial public offering](/wiki/Initial_public_offering) (IPO) was perceived as possible by the end of 2013,[[24]](#cite_note-24)but then Musk stated in June 2013 that he planned to hold off any potential IPO until after the "[Mars Colonial Transporter](/wiki/Mars_Colonial_Transporter) is flying regularly,"[[25]](#cite_note-25)and this was reiterated in 2015 indicating that it would be many years before SpaceX would become a publicly traded company,[[26]](#cite_note-26)[[27]](#cite_note-27) where Musk stated that "I just don’t want [SpaceX] to be controlled by some [private equity firm](/wiki/Private_equity_firm) that would milk it for near-term revenue"[[28]](#cite_note-28)[thumb|Falcon 9 rocket's first stage on the landing pad after the first successful vertical landing of an orbital rocket stage.](/wiki/File:Falcon_9_Flight_20_OG2_first_stage_post-landing_(23273082823)_cropped.jpg) [thumb|Falcon 9 first stage on an ASDS barge after the first successful landing at sea.](/wiki/File:CRS-8_(26239020092).jpg)

The company has grown rapidly since it was founded in 2002, growing from 160 employees in November 2005 to more than 500 by July 2008, to over 1,100 in 2010,[[29]](#cite_note-29)[[30]](#cite_note-30)1,800 in early 2012,[[31]](#cite_note-31)and 3,000 by early 2013.[[32]](#cite_note-32) The company had grown to 3,800 employees and contractors by October 2013,[[33]](#cite_note-33) and had "nearly 5,000" in late 2015<ref name=st20151107/> and February 2016.<ref name=shotwell20160203> [Template:Cite AV media](/wiki/Template:Cite_AV_media)</ref>

Achievements of SpaceX include:[[34]](#cite_note-34)

* The first privately funded, liquid-fueled rocket (Falcon 1) to reach orbit (28 September 2008)
* The first privately funded company to successfully launch (by Falcon 9) orbit and recover a spacecraft (Dragon) (9 December 2010)
* The first private company to send a spacecraft (Dragon) to the International Space Station (25 May 2012)
* The first private company to send a satellite into geosynchronous orbit ([SES-8](/wiki/SES-8), 3 December 2013)
* The first landing of a first stage orbital capable rocket (Falcon 9) (22 December 2015 1:39 UTC)
* The first water landing of a first stage orbital capable rocket (Falcon 9) (8 April 2016 20:53 UTC)

On 22 December 2015 at around 1:29 UTC SpaceX launched an upgraded Falcon 9 rocket from [Cape Canaveral Air Force Station](/wiki/Cape_Canaveral_Air_Force_Station) into [low Earth orbit](/wiki/Low_Earth_orbit). After completing its primary burn, the first stage of the [multistage rocket](/wiki/Multistage_rocket) detached from the second stage as usual. The first stage then fired some of its engines to send it back to Cape Canaveral, where it achieved the world's first successful landing of a rocket that was used for an orbital launch. The landing happened at around 1:39 UTC on December 22. Stage two successfully deployed eleven communication satellites for [Orbcomm](/wiki/Orbcomm).[[35]](#cite_note-35)

### Funding[[edit](/index.php?title=(none)&action=edit&section=3)]

[thumb|Number of SpaceX launches per year](/wiki/File:SpaceX_launches.png) SpaceX is privately funded.<ref name=st20130301/> It developed its first launch vehicle—[Falcon 1](/wiki/Falcon_1)—and three [rocket engines](/wiki/Rocket_engine)—[Merlin](/wiki/Merlin_(rocket_engine)), [Kestrel](/wiki/Kestrel_(rocket_engine)), and [Draco](/wiki/Draco_(rocket_engine))—completely with [private capital](/wiki/Private_capital). SpaceX contracted with the [US government](/wiki/Federal_government_of_the_United_States) for a portion of the development funding for the [Falcon 9](/wiki/Falcon_9) launch vehicle, which uses a modified version of the [Merlin rocket engine](/wiki/Merlin_1C).<ref name=st20130301> [Template:Cite news](/wiki/Template:Cite_news)</ref> SpaceX is developing the [Falcon Heavy](/wiki/Falcon_Heavy) launch vehicle,<ref name=tsr20140310> [Template:Cite journal](/wiki/Template:Cite_journal)</ref> the [Raptor methane-fueled rocket engine](/wiki/Raptor_(rocket_engine)),[[36]](#cite_note-36) and a set of [reusable launch vehicle technologies](/wiki/SpaceX_reusable_launch_system_development_program) with private capital.<ref name=AtlanticCouncil20140604> [Template:Cite AV media](/wiki/Template:Cite_AV_media)</ref>

[Template:Asof](/wiki/Template:Asof), SpaceX had operated on total funding of approximately $1 billion in its first ten years of operation. Of this, private equity provided about $200M, with Musk investing approximately $100M and other investors having put in about $100M ([Founders Fund](/wiki/Founders_Fund), [Draper Fisher Jurvetson](/wiki/Draper_Fisher_Jurvetson), ...).[[37]](#cite_note-37) The remainder has come from progress payments on long-term launch contracts and development contracts. [Template:Asof](/wiki/Template:Asof), NASA had put in about $400–500M of this amount, with most of that as progress payments on launch contracts.<ref name=cnbc20120427/> By May 2012, SpaceX had contracts for 40 launch missions, and each of those contracts provide down payments at contract signing, plus many are paying progress payments as launch vehicle components are built in advance of mission launch, driven in part by US accounting rules for [recognizing long-term revenue](/wiki/Revenue_recognition#Long-term_contracts).<ref name=cnbc20120427> [Template:Cite news](/wiki/Template:Cite_news)</ref>

In August 2012, SpaceX signed a large development contract with NASA to design and develop a crew-carrying [space capsule](/wiki/Space_capsule) for the "[next generation of U.S. human spaceflight capabilities](/wiki/CCiCap)", in order to re-enable the launch of astronauts from U.S. soil by 2017. Two other companies, Boeing and [Sierra Nevada Corporation](/wiki/Sierra_Nevada_Corporation), received similar development contracts. Advances made by all three companies under Space Act Agreements through NASA's Commercial Crew Integrated Capability ([CCiCap](/wiki/CCiCap)) initiative are intended to ultimately lead to the availability of commercial human spaceflight services for both government and commercial customers. As part of this agreement, SpaceX was awarded a contract worth up to $440 million for contract deliverables between 2012 and May 2014.[[38]](#cite_note-38)<ref name=nasa20120803>[Template:Cite web](/wiki/Template:Cite_web)</ref>

At year-end 2012, SpaceX had over 40 launches on its manifest representing about $4 billion in contract revenue—with many of those contracts already making progress payments to SpaceX—with both commercial and [government](/wiki/Federal_government_of_the_United_States) (NASA/DOD) customers.<ref name=sx20121231> [Template:Cite web](/wiki/Template:Cite_web)</ref> [Template:Asof](/wiki/Template:Asof), SpaceX has a total of 50 future launches under contract, two-thirds of them are for commercial customers.<ref name=usat20131204> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=sfn-20131203/> In late 2013, space industry media began to comment on the phenomenon that SpaceX [prices are undercutting](/wiki/Competition_(economics)) the major competitors in the commercial [commsat](/wiki/Commsat) launch market—the [Ariane 5](/wiki/Ariane_5) and [Proton-M](/wiki/Proton-M)<ref name=sfn-20131124>[Template:Cite news](/wiki/Template:Cite_news)</ref>—at which time SpaceX had at least 10 further geostationary orbit flights on its books.<ref name=sfn-20131203/>

In January 2015, SpaceX raised $1 billion in funding from [Google](/wiki/Google) and [Fidelity](/wiki/Fidelity_Ventures), in exchange for 8.333% of the company, establishing the company valuation at approximately $12 billion. Google and Fidelity joined the then current investorship group of Draper Fisher Jurvetson, Founders Fund, Valor Equity Partners and Capricorn.[[39]](#cite_note-39)[[40]](#cite_note-40)Although the investment was thought to be related to SpaceX's launch of a [satellite construction business and global satellite internet service](/wiki/SpaceX_satellite_constellation) effort,[[41]](#cite_note-41)[Gwynne Shotwell](/wiki/Gwynne_Shotwell) said in March 2015 that the investment was not specifically for the global internet project.<ref name=mb20170317> [Template:Cite news](/wiki/Template:Cite_news)</ref> Google had been searching for a satellite internet partner since the split with [O3b Networks](/wiki/O3b_Networks) and [OneWeb](/wiki/OneWeb).[[42]](#cite_note-42)

### Goals[[edit](/index.php?title=(none)&action=edit&section=4)]

[thumb|Conceptual render of Falcon Heavy at Pad 39A, Cape Canaveral](/wiki/File:Falcon_Heavy_Pad_39A_(21048044876).jpg) Musk has stated that one of his goals is to improve the cost and reliability of access to [space](/wiki/Outer_space), ultimately by a factor of ten.[[43]](#cite_note-43) The company plans in 2004 called for "development of a heavy lift product and even a super-heavy, if there is customer demand" with each size increase resulting in a significant decrease in cost per pound to orbit. CEO Elon Musk said: "I believe $500 per pound ($1,100/kg) or less is very achievable."[[44]](#cite_note-44) SpaceX has on occasion developed new engineering development technologies to enable it to pursue its various goals. In 2015, public sources revealed that SpaceX is developing their own [computational fluid dynamics](/wiki/Computational_fluid_dynamics) (CFD) software to improve the [simulation](/wiki/Computer_simulation) capability of evaluating rocket engine combustion design.<ref name=tpdn20150327> [Template:Cite news](/wiki/Template:Cite_news)</ref>

In June 2015 the company asked the federal government for permission to begin testing for a project that aims to build a constellation of 4000 satellites capable of beaming the Internet to the entire globe, including remote regions which currently do not have internet access.[[45]](#cite_note-45)[[46]](#cite_note-46)

#### Mars[[edit](/index.php?title=(none)&action=edit&section=5)]

He stated in a 2011 interview that he hopes to send humans to Mars' surface within 10–20 years.[[47]](#cite_note-47) In June 2013, Musk used the descriptor [Mars Colonial Transporter](/wiki/Mars_Colonial_Transporter) to refer to the [privately funded](/wiki/Private_capital) [development project](/wiki/New_product_development) to design and build a spaceflight system of [rocket engines](/wiki/Rocket_engine), [launch vehicles](/wiki/Launch_vehicle) and [space capsules](/wiki/Space_capsule) to [transport](/wiki/Space_transport) [humans](/wiki/Human_spaceflight) to Mars and return to [Earth](/wiki/Earth).<ref name=forbes20130606/> In March 2014, COO Gwynne Shotwell said that once the Falcon Heavy and Dragon v2 crew version are flying, the focus for the company engineering team will be on developing the technology to support the transport infrastructure necessary for Mars missions.<ref name=tss20140321> [Template:Cite AV media](/wiki/Template:Cite_AV_media)</ref>

Musk's long term vision for the company is the development of technology and resources suitable for human colonization on Mars. He has expressed his interest in someday traveling to the planet, stating "I'd like to die on Mars, just not on impact."[[48]](#cite_note-48) To achieve it, Musk plans to establish cargo flights to Mars, getting the first delivery there by 2018. A rocket every two years or so after that could provide a base for the people arriving in 2025 after a launch in 2024.[[49]](#cite_note-49) According to Steve Jurvetson, Musk believes that by 2035 at the latest, there will be thousands of rockets flying a million people to Mars, in order to enable a self-sustaining human colony.[[50]](#cite_note-50)

#### Reusable rockets[[edit](/index.php?title=(none)&action=edit&section=6)]

[Template:Main](/wiki/Template:Main) [thumb|](/wiki/File:SpaceX_ASDS_in_position_prior_to_Falcon_9_Flight_17_carrying_CRS-6_(17127808431).jpg)[*Just Read the Instructions*](/wiki/Just_Read_the_Instructions) in position prior to Falcon 9 Flight 17 carrying CRS-6 SpaceX has been improving the autonomous landing and recovery of the first stage of the Falcon 9 launch vehicle, with increasing success. As a result of Elon Musk's goal of crafting more cost-effective launch vehicles, SpaceX conceived a method to reuse the first stage of their primary rocket, the [Falcon 9](/wiki/Falcon_9),[[51]](#cite_note-51) by attempting propulsive vertical landings on solid surfaces. Once the company determined that soft landings were feasible by touching down over the Atlantic and Pacific ocean, they began landing attempts on a solid platform. SpaceX leased and modified several barges to sit out at sea as a target for the returning first stage, converting them to [autonomous spaceport drone ships](/wiki/Autonomous_spaceport_drone_ship) (ASDS).

On January 10, 2015 [CRS-5](/wiki/SpaceX_CRS-5), or Commercial Resupply Service 5, launched with the rocket stage set to be the first to land on a solid surface and be recovered intact.[[51]](#cite_note-51) The craft made it to the ASDS, though it came in too fast and at an angle, exploding on the surface of the ship and scattering debris on its surface and in the ocean. The drone ship experienced some structural damages, but nothing irreparable. The cause of the failed landing was determined a failure of the [grid fins](/wiki/Grid_fin) used on the craft during the descent to stabilize it, which ran out of [hydraulic fluid](/wiki/Hydraulic_fluid) and ceased to function properly.[[52]](#cite_note-52) On their next attempt, during the [CRS-6](/wiki/SpaceX_CRS-6) mission, SpaceX was once again able to hit their target, however two issues occurred during the landing. The first was that the craft came in with a higher than expected lateral velocity, though the craft still made contact with the ASDS. Since the spacecraft was drifting sideways, the [bipropellant](/wiki/Liquid-propellant_rocket) for the rocket’s attitude control should have kept it from tipping, however a valve became stuck and kept the craft from reacting to the issue quickly. The rocket once again tipped over and was mostly destroyed. In both cases, debris was recovered and examined by SpaceX. Though both landings of the rocket stages resulted in failures, the primary mission was successful- the [Dragon](/wiki/Dragon_(spacecraft)) capsules for each mission made it to the [International Space Station](/wiki/International_Space_Station) safely and later splashed down in the Pacific ocean.[[53]](#cite_note-53) On the next attempt, December 21, 2015, SpaceX successfully landed the first stage for the first time for an orbital launch, landing the first stage booster from their second mission for [Orbcomm](/wiki/Orbcomm) at [Landing Zone 1](/wiki/Landing_Zone_1) at [Kennedy Space Center](/wiki/Kennedy_Space_Center) (a [Return To Launch Site](/wiki/Return_To_Launch_Site) landing).[[54]](#cite_note-54)

In January 2016 another ASDS landing attempt was made during the launch of the Jason-3 satellite from Vandenberg Air Force Base, California. The stage successfully touched down on the drone ship, landing 1.3 meters from the center of the painted target[[55]](#cite_note-55) at a suitable speed. However, a landing leg collet failed to lock, and the stage again tipped over and was destroyed. The leg collet failure was attributed to frozen condensation from fog at Vandenberg prior to launch.[[56]](#cite_note-56) On April 8, 2016, the first stage booster successfully landed on the ASDS [*Of Course I Still Love You*](/wiki/Of_Course_I_Still_Love_You),<ref name=crs84klanding>[Template:Cite video](/wiki/Template:Cite_video)</ref><ref name=crs8hostedlanding>[Template:Cite video](/wiki/Template:Cite_video)</ref> marking the first time SpaceX successfully landed and recovered an orbitally launched rocket at sea.[[57]](#cite_note-57) On May 6, 2016, SpaceX landed the first stage of the Falcon 9 on *Of Course I Still Love You* during the [JCSat-14](/wiki/JCSAT-14) mission, its second time successfully landing on a drone ship at sea.[[58]](#cite_note-58) This was the first time a booster on a geostationary transfer mission landed successfully. This feat was repeated on May 27 during the Thaicom-8 mission.[[59]](#cite_note-59)

### Setbacks[[edit](/index.php?title=(none)&action=edit&section=7)]

#### Failed launch[[edit](/index.php?title=(none)&action=edit&section=8)]

On June 28, 2015, [CRS-7](/wiki/SpaceX_CRS-7) launched a [Falcon 9](/wiki/Falcon_9) topped with an unmanned [Dragon](/wiki/Dragon_(spacecraft)) capsule destined to bring supplies to the [International Space Station](/wiki/International_Space_Station). All statistics were nominal until 2 minutes and 19 seconds into the flight when a cloud of vapor formed outside the craft, seen by the tracking camera. A few seconds after this cloud formed, there was a loss of [helium](/wiki/Helium) tank pressure, after which the tanks exploded and caused a complete failure of the mission.[[60]](#cite_note-60) The [software](/wiki/Software) was not programmed to deploy the parachute for the [Dragon](/wiki/Dragon_(spacecraft)) capsule after a launch mishap, therefore the Dragon broke up on impact.[[61]](#cite_note-61) The problem was discovered to be a failed strut on the [helium](/wiki/Helium) [pressure vessels](/wiki/Pressure_vessel) that broke due to the force of [acceleration](/wiki/Acceleration). This caused a breach and allowed [helium](/wiki/Helium) to escape causing the demise of the spacecraft.

SpaceX plans to move past the issue while also learning from it by inspecting each of the struts, like that which failed, to ensure they have been manufactured correctly and will function properly. The software issue was also fixed in addition to an analysis of the entire program in order to ensure proper abort mechanisms are in place for future rockets and their payload.[[62]](#cite_note-62) SpaceX President [Gwynne Shotwell](/wiki/Gwynne_Shotwell) stated that in terms of the differences between the six previous successful [Falcon 9](/wiki/Falcon_9) [Commercial Resupply](/wiki/Commercial_Resupply_Services) Launches, “there’s nothing that stands out as being different for any particular flight.” Though the craft was set to bring a resupply of food and water to the [ISS](/wiki/International_Space_Station), the crew members had enough supplies to last another 4 months before another resupply, which would end up being the Russian Progress 60P vehicle.[[63]](#cite_note-63) Student science experiments as well as a docking adapter and other miscellaneous cargo was lost due to [CRS-7](/wiki/SpaceX_CRS-7) failure as well.[[64]](#cite_note-64)

#### Issues in flight[[edit](/index.php?title=(none)&action=edit&section=9)]

On March 1, 2013, a [Dragon spacecraft](/wiki/Dragon_(spacecraft)) in [orbit](/wiki/Orbit) developed issues with its thrusters. Due to blocked fuel valves, the craft was unable to properly control itself. SpaceX engineers were able to remotely clear the blockages. Because of this issue, the craft arrived at and docked with the [International Space Station](/wiki/International_Space_Station) one day later than expected. Since spacecraft like the Dragon are classified as [munitions](/wiki/Munitions) and considered weapons under [arms regulations](/wiki/International_Traffic_in_Arms_Regulations), SpaceX Mission controllers were unable to release more information to the public.[[65]](#cite_note-65)

## Facilities[[edit](/index.php?title=(none)&action=edit&section=10)]

### Headquarters and rocket manufacturing plant[[edit](/index.php?title=(none)&action=edit&section=11)]

[thumb|The company's headquarters, located in](/wiki/File:Entrance_to_SpaceX_headquarters.jpg) [Hawthorne, California](/wiki/Hawthorne,_California) [thumb|](/wiki/File:Falcon_9_rocket_cores_under_construction_at_SpaceX_Hawthorne_facility_(16846994851).jpg)[Falcon 9 v1.1](/wiki/Falcon_9_v1.1) rocket cores under construction at the SpaceX Hawthorne facility, November 2014. SpaceX Headquarters is located in the Los Angeles suburb of Hawthorne at 1 Rocket Road, [Hawthorne, California](/wiki/Hawthorne,_California). The large three-story facility, originally built by [Northrop Corporation](/wiki/Northrop_Corporation) to build [Boeing 747](/wiki/Boeing_747) fuselages,[[66]](#cite_note-66) houses SpaceX's office space, mission control, and vehicle factory. The area has one of the largest concentrations of aerospace headquarters, facilities, and/or subsidiaries in the U.S., including [Boeing](/wiki/Boeing)/McDonnell Douglas main satellite building campuses, [Raytheon](/wiki/Raytheon), NASA's [Jet Propulsion Laboratory](/wiki/Jet_Propulsion_Laboratory), [Lockheed Martin](/wiki/Lockheed_Martin), [BAE Systems](/wiki/BAE_Systems), [Northrop Grumman](/wiki/Northrop_Grumman), and [AECOM](/wiki/AECOM), etc., with a large pool of aerospace engineers and recent college engineering graduates.<ref name=pm>[Template:Cite web](/wiki/Template:Cite_web)</ref>

SpaceX utilizes a high degree of [vertical integration](/wiki/Vertical_integration) in the production of its rockets and rocket engines.<ref name=A&Ssmithsonian201201/> Unusually for the aerospace industry, SpaceX builds its [rocket engines](/wiki/Rocket_engine), [rocket stages](/wiki/Launch_vehicle), [spacecraft](/wiki/Spacecraft), principal [avionics](/wiki/Avionics) and all [software](/wiki/Embedded_software) in-house in their Hawthorne facility. Nevertheless, SpaceX still has over 3000 suppliers with some 1100 of those delivering to SpaceX nearly weekly.<ref name=AtlanticCouncil20140604q2> [Template:Cite AV media](/wiki/Template:Cite_AV_media)</ref>

### Satellite development facility[[edit](/index.php?title=(none)&action=edit&section=12)]

[Template:Main](/wiki/Template:Main) In January 2015, SpaceX announced it would be entering the satellite production business and global satellite internet business. The satellite factory would be located in Seattle, Washington. The office will initially have approximately 60 engineers, with the potential to grow to 1,000 over several years. The internet service would use a [satellite constellation](/wiki/Satellite_constellation) of 4,000 [communications satellites](/wiki/Communications_satellite) in 1100 km orbits, and start operations in 2020. The goal of the business is to increase profitability and cashflow, to allow SpaceX to build its Mars colony.<ref name=sn20150119>[Template:Cite news](/wiki/Template:Cite_news)</ref>

### Regional offices[[edit](/index.php?title=(none)&action=edit&section=13)]

SpaceX has regional offices in Houston, Texas; Chantilly, Virginia; and Washington, D.C.[[67]](#cite_note-67) and opened an office in the [Seattle](/wiki/Seattle) region in 2014 from which it is heavily recruiting engineers and software developers.<ref name=gw20141006> [Template:Cite news](/wiki/Template:Cite_news)</ref>

### Test and post-flight disassembly facilities[[edit](/index.php?title=(none)&action=edit&section=14)]

[Template:Details](/wiki/Template:Details) SpaceX has two rocket test facilities: the [SpaceX Rocket Development and Test Facility](/wiki/SpaceX_Rocket_Development_and_Test_Facility) in [McGregor, Texas](/wiki/McGregor,_Texas) and a leased [VTVL](/wiki/VTVL) (vertical takeoff, vertical landing) test facility at [Spaceport America](/wiki/Spaceport_America) in southern [New Mexico](/wiki/New_Mexico). All SpaceX rocket engines are tested on [rocket test stands](/wiki/Rocket_engine_test_facility), and low-altitude VTVL flight testing of the Falcon 9 [Grasshopper](/wiki/Grasshopper_(rocket)) v1.0 and [F9R Dev1](/wiki/F9R_Dev1) test vehicles were done at McGregor. [High-altitude](/wiki/Suborbital), [high-velocity](/wiki/Supersonic) flight testing of the followon [F9R Dev2](/wiki/F9R_Dev2) test vehicle are planned to begin at Spaceport America in 2015. In addition, the McGregor facility is used for post-flight disassembly and defueling of the Dragon spacecraft.

The company purchased the McGregor, Texas, testing facilities of defunct [Beal Aerospace](/wiki/Beal_Aerospace), where it refitted the largest test stand at the facilities for [Falcon 9](/wiki/Falcon 9) engine testing. SpaceX has made a number of improvements to the facility since purchase, and has also extended the size of the facility by purchasing several pieces of adjacent farmland. In 2011, the company announced plans to upgrade the facility for launch testing a VTVL rocket,<ref name=satspot20110926/> and then constructed a half-acre concrete launch facility in 2012 to support the Grasshopper test flight program.<ref name=sfn20120709/>

[SpaceX McGregor engine test bunker, September 2012|right|thumb](/wiki/File:SpaceX_Engine_Test_Bunker.jpg) SpaceX builds all of its rocket engines and thrusters at its main facility in [Hawthorne, California](/wiki/Hawthorne,_California) where the largest SpaceX campus is located, and where most of the high-technology components are engineered. A test facility in McGregor, Texas is one of the secondary locations where the company tests each new engine off of the assembly line, as well as those being developed for future missions to orbit and beyond"<ref name=wired20121010> [Template:Cite news](/wiki/Template:Cite_news)</ref> before each one can be used on a flight mission. [Template:Asof](/wiki/Template:Asof), the McGregor facility has seven test stands that are operated "18 hours a day, six days a week"<ref name=wired20121010/> and is building more test stands because production is ramping up and the company has a large [manifest](/wiki/List_of_Falcon_9_launches#Launch_Manifest) in the next several years.

The Dragon spacecraft, following use on a space mission, [splashdown](/wiki/Splashdown_(spacecraft_landing)) and recovery, are shipped to McGregor for de-fueling, cleanup, and refurbishment for potential reuse in future flight missions.

In May 2013, SpaceX announced that the high-altitude, high-velocity [flight test](/wiki/Flight_test) program of the F9R Development vehicles—the second generation of the SpaceX experimental VTVL [suborbital](/wiki/Suborbital) technology-demonstrator—would be conducted at Spaceport America near [Las Cruces, New Mexico](/wiki/Las_Cruces,_New_Mexico). SpaceX signed a three-year lease with the [spaceport](/wiki/Spaceport)<ref name=nsw20130507> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=stt20130508> [Template:Cite news](/wiki/Template:Cite_news)</ref> and has constructed a [Template:Convert](/wiki/Template:Convert) pad at Spaceport America, [Template:Convert](/wiki/Template:Convert) southwest of the spaceport's main campus. It will lease the pad for [Template:USD](/wiki/Template:USD) per month plus [Template:USD](/wiki/Template:USD) per Grasshopper flight. The spaceport administrator expects SpaceX to be operational at the Spaceport sometime between October 2013 and February 2014, and that is the time that the lease payments will begin.<ref name=stt20130508/><ref name=sn20130513> [Template:Cite news](/wiki/Template:Cite_news)</ref>

### Flight operations[[edit](/index.php?title=(none)&action=edit&section=15)]

[Template:Main](/wiki/Template:Main) [thumb|The first](/wiki/File:SpaceX_Falcon_vertical_on_the_launch_pad.jpg) [Falcon 1](/wiki/Falcon_1) at [Vandenberg AFB](/wiki/Vandenberg_AFB_Space_Launch_Complex_3). This vehicle was removed from VAFB due to delays and eventually launched from [Kwajalein](/wiki/Kwajalein).

SpaceX currently uses two [orbital](/wiki/Orbital_spaceflight) launch sites—[Cape Canaveral Air Force Station Space Launch Complex 40](/wiki/Cape_Canaveral_Air_Force_Station_Space_Launch_Complex_40) and [Vandenberg Air Force Base](/wiki/Vandenberg_Air_Force_Base), [Space Launch Complex 4](/wiki/Vandenberg_AFB_Space_Launch_Complex_4)—and have announced plans for two more. SpaceX has indicated that they see a niche for each of the four orbital facilities and that they have sufficient launch business to fill each pad.<ref name=sn20130802> [Template:Cite news](/wiki/Template:Cite_news)</ref> In addition, SpaceX utilizes two facilities for [suborbital](/wiki/Suborbital_spaceflight) launch operations and flight tests, the [SpaceX Rocket Development and Test Facility](/wiki/SpaceX_Rocket_Development_and_Test_Facility) in [McGregor, Texas](/wiki/McGregor,_Texas) and a high-altitude flight test facility at [Spaceport America](/wiki/Spaceport_America) in [New Mexico](/wiki/New_Mexico).

Cape Canaveral space launch complex 40 (SLC-40) was used to launch Falcon 9 into low-earth and geostationary orbits, while Vandenberg AFB SLC-4E was used for payloads to polar orbits. The Vandenberg site has also been intended for [Falcon Heavy](/wiki/Falcon_Heavy) launches, potentially starting in 2015.<ref name=nsf20110405>[Template:Cite web](/wiki/Template:Cite_web)</ref> As part of SpaceX's booster reusability program, the former Launch Complex 13 at Cape Canaveral, now renamed [Landing Zone 1](/wiki/Landing_Zone_1), has been designated for use for Falcon 9 [first-stage booster landings](/wiki/Falcon_9_first-stage_landing_tests).

All [Falcon 1](/wiki/Falcon_1) launches took place at the [Ronald Reagan Ballistic Missile Defense Test Site](/wiki/Ronald_Reagan_Ballistic_Missile_Defense_Test_Site), [Omelek Island](/wiki/Omelek_Island), [Kwajalein Atoll](/wiki/Kwajalein_Atoll), [Marshall Islands](/wiki/Republic_of_the_Marshall_Islands) (northern [Pacific Ocean](/wiki/Pacific_Ocean)). SpaceX abandoned Omelek when the [Falcon 1](/wiki/Falcon_1) was retired.

#### New commercial-only launch site[[edit](/index.php?title=(none)&action=edit&section=16)]

[Template:Main](/wiki/Template:Main) [thumb|](/wiki/File:Landing_Zone_1_(23787738692).jpg)[Landing Zone 1](/wiki/Landing_Zone_1) sign at the former Cape Canaveral Air Force Station Launch Complex 13 After considering potential locations including [Alaska](/wiki/Alaska), [California](/wiki/California), [Florida](/wiki/Florida),<ref name=ft20130403> [Template:Cite news](/wiki/Template:Cite_news)</ref> [Texas](/wiki/Texas), [Virginia](/wiki/Virginia),<ref name=sn20120416>[Template:Cite news](/wiki/Template:Cite_news)</ref> [Georgia](/wiki/Georgia_(U.S._state)),<ref name=tribune20121115> [Template:Cite news](/wiki/Template:Cite_news)</ref> and [Puerto Rico](/wiki/Puerto_Rico),<ref name=bh20120913> [Template:Cite news](/wiki/Template:Cite_news)</ref> on August 4, 2014 Texas Governor [Rick Perry](/wiki/Rick_Perry) and SpaceX CEO Elon Musk announced SpaceX selected a location near [Brownsville, Texas](/wiki/Brownsville,_Texas) for a [new commercial-only launch facility](/wiki/SpaceX_South_Texas_Launch_Site).[[68]](#cite_note-68) The proposed location for the new commercial-mission-only spaceport is in south Texas near [Brownsville](/wiki/Brownsville,_Texas).[[69]](#cite_note-69) The [FAA](/wiki/Federal_Aviation_Administration) released the draft [Environmental Impact Statement](/wiki/Environmental_impact_statement) for the proposed Texas facility in April 2013, and "found that 'no impacts would occur' that would force the Federal Aviation Administration to deny SpaceX a permit for rocket operations,"<ref name=bh201304/><ref name=bh201304> [Template:Cite news](/wiki/Template:Cite_news)</ref> and issued the permit in July 2014.[[70]](#cite_note-70) SpaceX started construction on the new launch facility in 2014 with production ramping up in the latter half of 2015,<ref name=sn20140922> [Template:Cite news](/wiki/Template:Cite_news)</ref> with the first launches from the facility no earlier than 2016.<ref name=tsr20130401> [Template:Cite news](/wiki/Template:Cite_news)</ref> Real estate packages at the location have been named by SpaceX with names based on the theme "[Mars Crossing](/wiki/Mars_Crossing)".[[71]](#cite_note-71)[[72]](#cite_note-72)

#### Crewed-mission leased launch site[[edit](/index.php?title=(none)&action=edit&section=17)]

[Template:Asof](/wiki/Template:Asof), SpaceX has entered negotiations to lease [Launch Complex 39A](/wiki/Kennedy_Space_Center_Launch_Complex_39) at the [Kennedy Space Center](/wiki/Kennedy_Space_Center) in [Florida](/wiki/Florida), following NASA's decision to lease the unused complex out as part of a bid to reduce annual operation and maintenance costs.[[73]](#cite_note-73)The SpaceX bid is for exclusive use of the launch complex to support their future [crewed missions](/wiki/Human_spaceflight). A competing bid for [commercial use](/wiki/Private_spaceflight) of the launch complex was submitted by [Jeff Bezos'](/wiki/Jeff_Bezos) [Blue Origin](/wiki/Blue_Origin), who was bidding for a shared non-exclusive use of the complex such that the launchpad can interface with multiple [vehicles](/wiki/Launch_vehicle), and costs can be shared over the long term. One potential shared user in the Blue Origin notional plan was [United Launch Alliance](/wiki/United_Launch_Alliance).<ref name=os20130818> [Template:Cite news](/wiki/Template:Cite_news)</ref>

## NASA collaborations[[edit](/index.php?title=(none)&action=edit&section=18)]

### Commercial cargo contracts[[edit](/index.php?title=(none)&action=edit&section=19)]

[Template:Main](/wiki/Template:Main) [right|thumb|The COTS 2 Dragon is berthed to the ISS by](/wiki/File:COTS2_Dragon_is_berthed.jpg) [Canadarm2](/wiki/Canadarm2). On 18 August 2006, NASA announced that SpaceX had won a NASA Commercial Orbital Transportation Services (COTS) contract to demonstrate cargo delivery to the International Space Station (ISS) with a possible option for crew transport.[[74]](#cite_note-74)This contract, designed by NASA to provide "seed money" for developing new boosters, paid SpaceX $278 million to develop the [Falcon 9](/wiki/Falcon_9) launch vehicle, with incentive payments paid at milestones culminating in three demonstration launches.[[75]](#cite_note-75)In December 2008 SpaceX and [Orbital Sciences Corporation](/wiki/Orbital_Sciences_Corporation) each won a [Commercial Resupply Services](/wiki/Commercial_Resupply_Services) (CRS) contract. That of SpaceX is for at least 12 missions for $1.6 billion to carry supplies and cargo to and [from](/wiki/Downmass) the ISS.<ref name=COTSwon>[Template:Cite press](/wiki/Template:Cite_press)</ref> On 9 December 2010, the launch of the [COTS Demo Flight 1](/wiki/COTS_Demo_Flight_1) mission, SpaceX became the first privately funded company to successfully launch, orbit and recover a [spacecraft](/wiki/Spacecraft).

The original NASA contract called for the COTS Demo Flight 1 to occur the second quarter of 2008;[[76]](#cite_note-76) this flight was delayed several times, occurring at 15:43 [UTC](/wiki/Coordinated_Universal_Time) on 8 December 2010.[[77]](#cite_note-77) Dragon was successfully deployed into orbit, circling the Earth twice, and then made a controlled reentry burn that put it on target for a splashdown in the Pacific Ocean off the coast of Mexico.[[78]](#cite_note-78) With Dragon's safe recovery, SpaceX become the first private company to launch, orbit, and recover a spacecraft; prior to this mission, only government agencies had been able to recover orbital spacecraft.[[78]](#cite_note-78) According to the original schedule, in [COTS Demo Flight 2](/wiki/COTS_Demo_Flight_2) the Dragon spacecraft would make its second flight and would rendezvous with the ISS but not be [berthed](/wiki/Spacecraft_docking_and_berthing_mechanisms). The third flight would see Dragon being berthed to the ISS.[[76]](#cite_note-76) However, after the success of the first mission, NASA conditionally agreed on 15 July 2011 that the two flights would be combined, and the next Dragon mission was to have Dragon being berthed with the ISS.[[79]](#cite_note-79) On 9 December 2011, NASA formally approved the merger of the COTS 2 and 3 missions into the [COTS 2](/wiki/Dragon_C2+) flight, but yet again delayed the tentative launch date by another month to 7 February 2012.[[80]](#cite_note-80) However, on 16 January 2012, SpaceX announced it needed more time for engineering tests, and postponed the launch date again, with no replacement date initially announced.[[81]](#cite_note-81) On 19 May at approximately 4:55AM EDT the launch for the COTS 2+ mission was automatically aborted when the pressure in one of the engine chambers was higher than expected. The COTS Demo Flight 2 launch was postponed to 22 May 2012, at which point it succeeded in putting the Dragon spacecraft into orbit. Several days later, the Dragon capsule successfully berthed with the International Space Station, marking the first time that a private spacecraft had accomplished this feat.[[82]](#cite_note-82)[[83]](#cite_note-83)

### Commercial crew contracts[[edit](/index.php?title=(none)&action=edit&section=20)]

[Template:Main](/wiki/Template:Main) SpaceX is planning a crewed Dragon/[Falcon 9](/wiki/Falcon_9) flight in future years when it expects to have a fully certified, human-rated launch escape system incorporated into the spacecraft.[[84]](#cite_note-84) NASA's Commercial Crew Development (CCDev) program intends to develop commercially operated manned spacecraft that are capable of delivering crew to the ISS. SpaceX did not participate during the first round, however during the second round of the program NASA awarded SpaceX with a contract worth $75 million to further develop their [launch escape system](/wiki/Launch_escape_system), test a crew accommodations mock-up and to further progress the [Falcon 9](/wiki/Falcon_9)/Dragon crew transportation design.[[85]](#cite_note-85)<ref name=aw20110422>[Template:Cite news](/wiki/Template:Cite_news)</ref> SpaceX later submitted a proposal for the third round of the CCDev program which became Commercial Crew Integrated Capability ([CCiCap](/wiki/CCiCap)).[[86]](#cite_note-86) On 3 August 2012, NASA announced new agreements with SpaceX and two other companies to design and develop the next generation of U.S. human spaceflight capabilities, enabling a launch of astronauts from U.S. soil in the next five years. Advances made by these companies under newly signed Space Act Agreements through the agency's CCiCap initiative are intended to ultimately lead to the availability of commercial human spaceflight services for government and commercial customers. As part of this agreement, SpaceX was awarded $440 million, to continue development and testing of its [Dragon V2](/wiki/Dragon_V2) spacecraft.<ref name=August2012>[Template:Cite web](/wiki/Template:Cite_web)</ref>

On 16 September 2014, NASA chose SpaceX and Boeing as the two companies that will be funded to develop systems to transport U.S. crews to and from the space station. SpaceX won $2.6B to complete and certify [Dragon V2](/wiki/Dragon_V2) by 2017. (Boeing won $4.2B to complete and certify their [CST-100](/wiki/CST-100).) The contracts include at least one crewed flight test with at least one NASA astronaut aboard. Once Crew Dragon achieves NASA certification, the contract requires SpaceX to conduct at least two, and as many as six, crewed missions to the space station.<ref name=September2014>[Template:Cite web](/wiki/Template:Cite_web)</ref>

### "Red Dragon" Mars mission concept[[edit](/index.php?title=(none)&action=edit&section=21)]

[Template:Main](/wiki/Template:Main) In addition to SpaceX's privately funded plans for an eventual [Mars mission](/wiki/Exploration_of_Mars), NASA [Ames Research Center](/wiki/Ames_Research_Center) had developed a concept called Red Dragon: a low-cost Mars mission that would use [Falcon Heavy](/wiki/Falcon_Heavy) as the launch vehicle and trans-Martian injection vehicle, and the [Dragon capsule](/wiki/Dragon_(spacecraft)) to [enter](/wiki/Atmospheric_entry) the [Martian atmosphere](/wiki/Martian_atmosphere). The concept was originally envisioned for launch in 2018 as a [NASA Discovery mission](/wiki/Discovery_Program), then alternatively for 2022, but [Template:Asof](/wiki/Template:Asof) it has not been yet formally submitted for funding within NASA.[[87]](#cite_note-87) The objectives of the mission would be return the samples from Mars to Earth at a fraction of the cost of the NASA own return-sample mission now projected at 6 billion dollars.[[87]](#cite_note-87) On 27 April 2016, SpaceX announced its plan to launch a modified Dragon lander to Mars by 2018. This project is part of a public-private partnership contract between NASA and SpaceX.[[88]](#cite_note-88)

## Other contracts[[edit](/index.php?title=(none)&action=edit&section=22)]

On 2 May 2005, SpaceX announced that it had been awarded an [Indefinite Delivery/Indefinite Quantity](/wiki/IDIQ) (IDIQ) contract for Responsive Small Spacelift (RSS) launch services by the [United States Air Force](/wiki/United_States_Air_Force), which could allow the Air Force to purchase up to $100 million worth of launches from the company.[[89]](#cite_note-89) On 22 April 2008, [NASA](/wiki/NASA) announced that it had awarded an IDIQ Launch Services contract to SpaceX for [Falcon 1](/wiki/Falcon_1) and [Falcon 9](/wiki/Falcon_9) launches. The contract will be worth up to $1 billion, depending on the number of missions awarded. The contract covers launch services ordered by 30 June 2010, for launches through December 2012.[[90]](#cite_note-90) Musk stated in the same 2008 announcement that SpaceX has sold 14 contracts for flights on the various [Falcon](/wiki/Falcon_(rocket_family)) vehicles.[[90]](#cite_note-90) In December 2012, SpaceX announced its first two launch contracts with the [United States Department of Defense](/wiki/United_States_Department_of_Defense). "The [United States Air Force](/wiki/United_States_Air_Force) [Space and Missile Systems Center](/wiki/Space_and_Missile_Systems_Center) awarded SpaceX two [Evolved Expendable Launch Vehicle](/wiki/Evolved_Expendable_Launch_Vehicle) (EELV)-class missions:" [Deep Space Climate Observatory](/wiki/Deep_Space_Climate_Observatory) (DSCOVR) and [Space Test Program 2](/wiki/Space_Test_Program_2) (STP-2), to be launched in 2014 and 2015, respectively. DSCOVR was launched on a [Falcon 9](/wiki/Falcon_9) launch vehicle while STP-2 will be launched on a [Falcon Heavy](/wiki/Falcon_Heavy).<ref name=nsw20121205>[Template:Cite news](/wiki/Template:Cite_news)</ref>

SpaceX announced on 15 March 2010 that it would launch [SES-8](/wiki/SES-8), a medium-sized communications satellite for [SES](/wiki/SES_S.A.), on a Falcon 9 vehicle, and it was successfully launched on 3 December 2013.<ref name=SESlaunchcontract>[Template:Cite news](/wiki/Template:Cite_news)</ref> SES was SpaceX's first contract for a geostationary communications satellite launch.<ref name=sfn-20131203>[Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=SESlaunchcontract/> In June 2010, SpaceX was awarded the largest-ever commercial space launch contract, worth $492 million, to launch [Iridium satellites](/wiki/Iridium_satellites) using Falcon 9 rockets.[[91]](#cite_note-91) On 26 May 2015, the United States Air Force announced that the Falcon 9 was certified for launching "national security space missions," which allows SpaceX to contract launch services to the Air Force for any payloads classified as national security. The first anticipated contract available to SpaceX will be in June 2015, with the GPS III satellite built by Lockheed Martin.<ref name=usaf20150526>[Template:Cite web](/wiki/Template:Cite_web)</ref> According to Fox News, United Launch Alliance is currently the only provider other than SpaceX equipped and certified to launch national security payloads.<ref name=fn20150527>[Template:Cite web](/wiki/Template:Cite_web)</ref> In a statement, United Launch Alliance responded to the newly certified company “We welcome today’s announcement and look forward to competing with SpaceX and other new entrants," and followed by writing "The fact is, we could not be more passionate and proud of our work, our people and our record of success."[[92]](#cite_note-92)<ref name=wp20150536>[Template:Cite web](/wiki/Template:Cite_web)</ref>

On 14 September 2015, SpaceX announced in a press release two new orders:[[93]](#cite_note-93)\* Launch of a communications satellite for [HISPASAT](/wiki/HISPASAT) on a Falcon 9

* Launch of Saudi Arabian [Arabsat 6A](/wiki/Arabsat_6A) communications satellite on a Falcon Heavy

In the press release, SpaceX also stated they currently have over 60 missions on manifest representing over $7B under contract.

On April 27, 2016, the Pentagon announced that SpaceX has been awarded an $82.7 million contract from the U.S. Air Force to launch a next-generation GPS satellite aboard its Falcon 9 rocket in May 2018.[[94]](#cite_note-94)

### Launch market competition and pricing pressure[[edit](/index.php?title=(none)&action=edit&section=23)]

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SpaceX's low launch prices (less than $2,500 per pound ($5,500 per kg) to orbit for [Falcon 9 v1.1](/wiki/Falcon_9_v1.1) and $1,000 ($2,200 per kg) for [Falcon Heavy](/wiki/Falcon_Heavy)),[[95]](#cite_note-95) especially for [communication satellites](/wiki/Commsat) flying to [geostationary](/wiki/Geostationary_transfer_orbit) (GTO) orbit, have resulted in [market pressure](/wiki/Competition_(economics)) on its competitors to lower their own prices. The communications satellites launch market had been dominated in the years preceding 2013 by [Europe's](/wiki/ESA) [Arianespace](/wiki/Arianespace) (flying [Ariane 5](/wiki/Ariane_5)) and [International Launch Services](/wiki/International_Launch_Services) (ILS) (flying [Russia's](/wiki/Russia) [Proton](/wiki/Proton_(rocket_family)) vehicle).<ref name=bbc20131203> [Template:Cite news](/wiki/Template:Cite_news)</ref> By late 2013, with a published price of [Template:USD](/wiki/Template:USD) per launch to [low Earth orbit](/wiki/Low_Earth_orbit), "Falcon 9 rockets [were] already the cheapest in the industry. Reusable Falcon 9s could drop the price by an order of magnitude, sparking more space-based enterprise, which in turn would drop the cost of access to space still further through [economies of scale](/wiki/Economies_of_scale)."<ref name=fp20131209> [Template:Cite news](/wiki/Template:Cite_news)</ref>

SpaceX capabilities and prices are affecting the global market considerably. [Arianespace](/wiki/Arianespace) requested in early 2014 that European governments provide additional [subsidies](/wiki/Subsidy) to face the competition from SpaceX.<ref name=aw20140211> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=sn20140414>[Template:Cite news](/wiki/Template:Cite_news)</ref> European [satellite operators](/wiki/Comparison_of_communication_satellite_operators) are pushing the [ESA](/wiki/European_Space_Agency) to reduce [Ariane 5](/wiki/Ariane_5) and the future [Ariane 6](/wiki/Ariane_6) rocket launch prices as a result of competition from SpaceX. According to one [Arianespace](/wiki/Arianespace) managing director, "It's quite clear there's a very significant challenge coming from SpaceX," he said. "Therefore things have to change ... and the whole European industry is being restructured, consolidated, rationalised and streamlined."<ref name=smh20150519>[Template:Cite web](/wiki/Template:Cite_web)</ref>

By November 2014, space media reported that SpaceX had "already begun to take market share" from Arianespace.<ref name=sn20141120> [Template:Cite news](/wiki/Template:Cite_news)</ref> In 2014, Falcon 9 GTO mission pricing was approximately [Template:USD](/wiki/Template:USD) less than a launch on a [Chinese](/wiki/China_National_Space_Administration) [Long March 3B](/wiki/Long_March_3B).<ref name=aw20140310>[Template:Cite news](/wiki/Template:Cite_news)</ref> However, the Chinese Government and the [Great Wall Industry](/wiki/Great_Wall_Industry_Corporation) company—which markets the Long March for [commsat](/wiki/Commsat) missions—made a policy decision to maintain commsat launch prices at approximately [Template:USD](/wiki/Template:USD).<ref name=ps20130928> [Template:Cite news](/wiki/Template:Cite_news)</ref> SpaceX capabilities and lower launch prices have also begun to affect the market for launch of US military payloads, where for nearly a decade the large US launch provider [United Launch Alliance](/wiki/United_Launch_Alliance) (ULA) had faced no competition for the military launches.<ref name=lat20141125> [Template:Cite news](/wiki/Template:Cite_news)</ref> In October 2014 ULA announced a major restructuring of processes and workforce in order to decrease launch costs by half, in part as a result of competition from SpaceX.<ref name=dbj20141016> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=lat20141212> [Template:Cite news](/wiki/Template:Cite_news)</ref> In May 2015, ULA stated that it would go out of business unless it won commercial and civil satellite launch orders to offset an expected slump in U.S. military and spy launches.[[96]](#cite_note-96) Jean Botti, Director of innovation for Airbus (which makes the [Ariane 5](/wiki/Ariane_5)) warned that "those who don't take [Elon Musk](/wiki/Elon_Musk) seriously will have a lot to worry about."[[97]](#cite_note-97) When the final numbers were in for 2014, SpaceX had won nine contracts out of 20 that were [competed](/wiki/Space_launch_market_competition) worldwide in 2014 at commercial launch service providers.<ref name=sn20150112> [Template:Cite news](/wiki/Template:Cite_news)</ref> This was the first year in some time that no commercial launches were booked on the [Russian](/wiki/Russia) ([Proton](/wiki/Proton_(rocket_family))) and Russian-[Ukrainian](/wiki/Ukraine) ([Zenit](/wiki/Zenit-3SL)) launch service providers.<ref name=sn20150112/> SpaceX launched their first [communication satellite](/wiki/Commsat) to geosynchronous orbit only in late 2013.

SpaceX has publicly indicated that if they are successful with developing the [reusable technology](/wiki/SpaceX_reusable_rocket), launch [prices](/wiki/Market_price) in the [Template:USD](/wiki/Template:USD) range for the reusable Falcon 9 are possible.<ref name=ps20140114/>

On April 27, 2016, the Pentagon announced its decision to award an $82.7 million contract to SpaceX from the U.S. Air Force to launch a next-generation GPS satellite aboard its Falcon 9 rocket in May 2018. The estimated cost was approximately 40% less than the estimated cost for previous missions.[[98]](#cite_note-98)

## Commercial and government launch contracts summary[[edit](/index.php?title=(none)&action=edit&section=24)]

[Template:Asof](/wiki/Template:Asof), SpaceX has a purely commercial launch manifest of "23 missions scheduled over the next 4 years, exclusive of [US government](/wiki/Federal_government_of_the_United_States) flights, [Dragonlab](/wiki/DragonLab) flights and the anticipated demo flight for [Falcon Heavy](/wiki/Falcon_Heavy)"—of a total of 40 flights scheduled through 2017."<ref name=idn20130130>[Template:Cite news](/wiki/Template:Cite_news)</ref>

On 3 December 2013 SpaceX launched its first satellite into geostationary orbit, [SES-8](/wiki/SES-8), entering the major commercial launch market.<ref name=sfn-20131203/> SpaceX prices undercut its major competitors, the [Ariane 5](/wiki/Ariane_5) and [Proton](/wiki/Proton_(rocket_family)), in this market,<ref name=sfn-20131124/> and SpaceX has at least 10 further geostationary orbit flights on its books.<ref name=sfn-20131203/> Moreover, SpaceX prices for Falcon 9 and Falcon Heavy are much lower than the projected prices for the new [Ariane 5 ME](/wiki/Ariane_5#Ariane_5_ME) upgrade and its [Ariane 6](/wiki/Ariane_6) successor, projected to be available in 2018 and 2021, respectively.<ref name=pa20140118> [Template:Cite news](/wiki/Template:Cite_news)</ref> [Template:Asof](/wiki/Template:Asof), SpaceX has a total of 50 future launches under contract; two-thirds of them are for commercial customers.<ref name=usat20131204/>

SpaceX is, however, making a concerted effort to be able to make competitive bids for [US military](/wiki/US_military) launches of [EELV](/wiki/Evolved_Expendable_Launch_Vehicle)-class payloads. The government certified the [Falcon 9 v1.1](/wiki/Falcon_9_v1.1) for national security launches in May 2015,[[99]](#cite_note-99) and the earliest EELV launches that could be contracted with SpaceX [Template:Asof](/wiki/Template:Asof) would be in late 2016.<ref name=tss20140321a> [Template:Cite AV media](/wiki/Template:Cite_AV_media)</ref>

## Space vehicles[[edit](/index.php?title=(none)&action=edit&section=25)]

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SpaceX is currently manufacturing two main space launch vehicles: the large [Evolved Expendable Launch Vehicle](/wiki/Evolved_Expendable_Launch_Vehicle) (EELV)-class [Falcon 9](/wiki/Falcon_9),<ref name=sfi20150527>[Template:Cite web](/wiki/Template:Cite_web)</ref> which flew successfully into orbit on its maiden launch on 4 June 2010[[100]](#cite_note-100) and the [super-heavy](/wiki/Super-heavy_lift_vehicle) class [Falcon Heavy](/wiki/Falcon_Heavy), which is scheduled to make its first flight in early 2016. SpaceX also manufactures the [Dragon](/wiki/Dragon_(spacecraft)), a pressurized orbital spacecraft that is launched on top of a Falcon 9 booster to carry cargo to low-Earth orbit, and the follow-on [Dragon V2](/wiki/Dragon_V2) spacecraft, currently in the process of being human-rated through a variety of design reviews and [flight tests](/wiki/Test_flight) that began in 2014.[[101]](#cite_note-101)<ref name=sdc20140529> [Template:Cite news](/wiki/Template:Cite_news)</ref>

It formerly built and flew the [Falcon 1](/wiki/Falcon_1) launch vehicle, which made its first successful flight on 28 September 2008,[[100]](#cite_note-100)[[102]](#cite_note-102) A [Falcon 5](/wiki/Falcon_5) and [Falcon 9 Air](/wiki/Falcon_9_Air) launcher were also planned, but development was stopped on both vehicles before hardware was manufactured, in favor of pursuing development on other launch vehicles.[[103]](#cite_note-103)

### Falcon launch vehicles[[edit](/index.php?title=(none)&action=edit&section=26)]

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[thumb|The](/wiki/File:SpaceX_falcon_in_warehouse.jpg) [Falcon 1](/wiki/Falcon_1) prototype at SpaceX's assembly facilities.

SpaceX has flown, or is developing, several orbital launch vehicles: the [Falcon 1](/wiki/Falcon_1), [Falcon 9](/wiki/Falcon_9), and [Falcon Heavy](/wiki/Falcon_Heavy). As of May 2015, the Falcon 9 v1.1 is in active use and the Falcon Heavy is under development. [thumb|300px|left|From left to right,](/wiki/File:Falcon_rocket_family2.svg) [Falcon 1](/wiki/Falcon_1), [Falcon 9 v1.0](/wiki/Falcon_9_v1.0), three versions of [Falcon 9 v1.1](/wiki/Falcon_9_v1.1), and two versions of [Falcon Heavy](/wiki/Falcon_Heavy).

The [Falcon 1](/wiki/Falcon_1) was a small rocket capable of placing several hundred kilograms into low earth orbit.[[100]](#cite_note-100) It functioned as an early test-bed for developing concepts and components for the larger [Falcon 9](/wiki/Falcon_9).[[100]](#cite_note-100) Falcon 1 made five flights in 2006–2009. On 28 September 2008, the Falcon 1 succeeded in reaching orbit on its fourth attempt, becoming the first privately funded, liquid-fueled rocket to do so.[[104]](#cite_note-104) The Falcon 1 carried its first successful commercial payload, [RazakSAT](/wiki/RazakSAT), into orbit on 13 July 2009, on its fifth launch.[[105]](#cite_note-105) SpaceX has now retired the Falcon 1 and transferred Falcon 1 class payloads to be [secondary payloads](/wiki/Secondary_payload) on the Falcon 9, which proved to be more efficient.

* [Falcon 1e](/wiki/Falcon_1e)
* [Falcon 5](/wiki/Falcon_5)

The [Falcon 9](/wiki/Falcon_9) is an [EELV](/wiki/Evolved_Expendable_Launch_Vehicle)-class [medium-lift](/wiki/Comparison_of_medium_lift_launch_systems) vehicle capable of delivering up to 10,450 kilograms (23,000 lb) to orbit, and is intended to compete with the [Delta IV](/wiki/Delta_IV_rocket) and the [Atlas V](/wiki/Atlas_V_rocket) rockets, as well as other launch providers around the world. It has nine [Merlin](/wiki/Merlin_(rocket_engine)) engines in its first stage.[[106]](#cite_note-106) The Falcon 9 rocket successfully reached orbit on its first attempt in June 2010. The second flight for the Falcon 9 vehicle was the [COTS Demo Flight 1](/wiki/COTS_Demo_Flight_1) on 8 December 2010, the first launch under the NASA [Commercial Orbital Transportation Services](/wiki/Commercial_Orbital_Transportation_Services) (COTS) contract, and was similarly successful.[[90]](#cite_note-90) Its third flight, [COTS Demo Flight 2](/wiki/COTS_Demo_Flight_2), launched on 22 May 2012, and was the first [commercial](/wiki/Private_spaceflight) spacecraft to reach and dock with the International Space Station.[[107]](#cite_note-107) Further launches have continued through 2013-15 with a total of [20 successful launches](/wiki/List_of_Falcon_9_and_Falcon_Heavy_launches) and one [failure](/wiki/SpaceX_CRS-7).

* [Falcon 9 Air](/wiki/Falcon_9_Air)
* [Falcon 9 v1.0](/wiki/Falcon_9_v1.0)
* [Falcon 9 v1.1](/wiki/Falcon_9_v1.1)
* [Falcon 9 Full Thrust](/wiki/Falcon_9_Full_Thrust)
* [Grasshopper](/wiki/Grasshopper_(rocket)), [F9R Dev1](/wiki/F9R_Dev1), and [F9R Dev2](/wiki/F9R_Dev2) prototype [VTVL](/wiki/VTVL) test vehicles

The [Falcon Heavy](/wiki/Falcon_Heavy) began development as a [heavy-lift](/wiki/Comparison_of_heavy_lift_launch_systems) configuration using a cluster of three Falcon 9 first stage [cores](/wiki/Modular_rocket) with a total 27 [Merlin 1D](/wiki/Merlin_1D) engines and [propellant crossfeed](/wiki/Propellant_crossfeed) in 2011.<ref name=sxfh2011> [Template:Cite web](/wiki/Template:Cite_web) </ref><ref name=nsw20130103> [Template:Cite news](/wiki/Template:Cite_news)</ref> [[108]](#cite_note-108)SpaceX is aiming for the first demonstration flight of the Falcon Heavy in November 2016.[[109]](#cite_note-109)

### Dragon[[edit](/index.php?title=(none)&action=edit&section=27)]

[right|thumb|The Dragon spacecraft approaching the ISS](/wiki/File:ISS-31_SpaceX_Dragon_commercial_cargo_craft_approaches_the_ISS_-_crop.jpg) [thumb|The interior of the COTS 2 Dragon](/wiki/File:Inside_the_Dragon_(capsule).jpg) [Template:Main](/wiki/Template:Main) In 2005, SpaceX announced plans to pursue a human-rated commercial space program through the end of the decade.[[110]](#cite_note-110) The Dragon spacecraft is intended to carry up to seven astronauts into orbit and beyond.[[111]](#cite_note-111) It is a conventional blunt-cone ballistic capsule, which is capable of carrying 7 people or a mixture of personnel and cargo to and from low Earth orbit.[[111]](#cite_note-111) It is launched atop a [Falcon 9](/wiki/Falcon_9) launch vehicle. The spacecraft's nosecone is jettisoned shortly after launch in the cargo version, but is expected to be kept during the full flight of the crewed version.

In 2006, NASA announced that the company was one of two selected to provide crew and cargo resupply demonstration contracts to the ISS under the COTS program.[[112]](#cite_note-112) SpaceX demonstrated cargo resupply and eventually crew transportation services using the Dragon.[[107]](#cite_note-107) NASA's original plan called for COTS demonstration flights between 2008 and 2010.[[113]](#cite_note-113)[[114]](#cite_note-114) SpaceX was not able to meet that schedule, but eventually began test-flights in 2010.

The first flight of a Dragon structural test article took place 4 June 2010, from Launch Complex 40 at Cape Canaveral Air Force Station during the maiden flight of the [Falcon 9](/wiki/Falcon_9) launch vehicle; the [mock-up](/wiki/Boilerplate_(spaceflight)) Dragon lacked avionics, heat shield, and other key elements normally required of a fully operational spacecraft but contained all the necessary characteristics to validate the flight performance of the launch vehicle.<ref name=COTS1presskitSpaceX>[Template:Cite web](/wiki/Template:Cite_web)</ref> An operational Dragon spacecraft was launched on 8 December 2010 aboard [COTS Demo Flight 1](/wiki/COTS_Demo_Flight_1), the Falcon 9's second flight, and safely returned to Earth after two orbits, completing all its mission objectives.[[101]](#cite_note-101) In 2012, Dragon began conducting regular resupply services to the ISS with a contract for 12 flights.

In 2009 and 2010, Musk suggested on several occasions that plans for a human-rated variant of Dragon were proceeding and had a 2- to 3-year time line to completion.[[115]](#cite_note-115)[[116]](#cite_note-116) On 18 April 2011, NASA issued a $75 million contract, as part of its second-round [commercial crew development](/wiki/CCDev) (CCDev) program, for SpaceX to develop an integrated launch escape system for Dragon in preparation for human-rating it as a crew transport vehicle to the ISS.<ref name=sdc20110418>[Template:Cite news](/wiki/Template:Cite_news)</ref> This Space Act Agreement runs from April 2011 until May 2012, when the next round of contracts are to be awarded.[[117]](#cite_note-117) NASA approved the technical plans for the system in October 2011, and SpaceX began building prototype hardware.[[84]](#cite_note-84) In 2012, Dragon became the first commercial spacecraft to deliver cargo to the International Space Station.[[107]](#cite_note-107) SpaceX delivered cargo to the ISS in March 2013 and again in April 2014.[[118]](#cite_note-118) SpaceX plans to launch its first crew-occupied Dragon spacecraft in a test flight by 2017.[[119]](#cite_note-119) Elon Musk has stated the personal goal of eventually enabling human exploration and settlement of [Mars](/wiki/Mars).[[47]](#cite_note-47)

### Other concepts under development[[edit](/index.php?title=(none)&action=edit&section=28)]

[Template:Further](/wiki/Template:Further)

Several modifications or additions to the [Falcon rocket family](/wiki/Falcon_(rocket_family)) are currently being developed by SpaceX. These include three vehicles that further technology development objectives toward [reusable](/wiki/Reusable_launch_system) launch systems: the [Grasshopper](/wiki/Grasshopper_(rocket)) test vehicle and the [commercial launch vehicles](/wiki/Private_spaceflight) [Reusable Falcon 9](/wiki/Reusable_Falcon_9) and [Reusable Falcon Heavy](/wiki/Reusable_Falcon_Heavy).

[*DragonFly*](/wiki/DragonFly_(rocket)) is a test vehicle to develop propulsive and propulsive-assist landing technologies in a series of low-altitude flight tests planned to be conducted in 2015-2016.<ref name=nbc20140521>[Template:Cite news](/wiki/Template:Cite_news)</ref>

A major goal of SpaceX has been to develop a [rapidly reusable launch system](/wiki/SpaceX_reusable_launch_system_development_program). [Template:Asof](/wiki/Template:Asof), the publicly announced aspects of this technology development effort include an active test campaign of the low-altitude, low-speed [Grasshopper](/wiki/Grasshopper_(rocket)) [vertical takeoff, vertical landing](/wiki/VTVL) (VTVL) technology demonstrator rocket,<ref name=satspot20110926> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=sfn20120709> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=msnbc20110927> [Template:Cite news](/wiki/Template:Cite_news)</ref> and a high-altitude, high-speed [Falcon 9](/wiki/Falcon_9) post-mission booster return test campaign where—beginning in mid-2013, with the sixth overall flight of Falcon 9—every [first stage](/wiki/First_stage_(rocketry)) will be instrumented and equipped as a controlled descent test vehicle to accomplish [propulsive-return over-water tests](/wiki/Flight_test).<ref name=nsw20130328> [Template:Cite news](/wiki/Template:Cite_news)</ref> SpaceX COO Gwynne Shotwell said at the Singapore Satellite Industry Forum in summer 2013 "If we get this [reusable technology] right, and we’re trying very hard to get this right, we’re looking at launches to be in the [Template:USD](/wiki/Template:USD) range, which would really change things dramatically."<ref name=ps20140114>[Template:Cite news](/wiki/Template:Cite_news)</ref>

[right|thumb|Comparison of rocket core diameters for SpaceX launch vehicles: (from left)](/wiki/File:Falcon_9_v1.0,_Falcon_9_v1.1_and_SHLV_comparison.svg) [Falcon 9 v1.0](/wiki/Falcon_9_v1.0) (2010), [Falcon 9 v1.1](/wiki/Falcon_9_v1.1) (2013), and the 10-meter diameter, 9-Raptor, first-stage booster for the [Mars Colonial Transporter](/wiki/Mars_Colonial_Transporter).

SpaceX has announced the high-level description of a future super-heavy lift launch vehicle that will consist of one or three [Template:Convert](/wiki/Template:Convert)-diameter [cores](/wiki/Modular_rocket) and use nine [Raptor](/wiki/Raptor_(rocket_engine)) [LOX](/wiki/Liquid_oxygen)/[methane](/wiki/Liquid_methane) engines to power each core.<ref name=pbt20140219> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=nsf20140307/><ref name=tss20140321m> [Template:Cite AV media](/wiki/Template:Cite_AV_media)</ref> The [MCT launch vehicle](/wiki/MCT_launch_vehicle) is also intended to be [reusable](/wiki/SpaceX_reusable_rocket) and will produce approximately [Template:Convert](/wiki/Template:Convert) of [thrust](/wiki/Thrust) at liftoff.<ref name=nsf20140307> [Template:Cite news](/wiki/Template:Cite_news)</ref> Development of the [Mars Colonial Transporter](/wiki/Mars_Colonial_Transporter) and its super-heavy launch vehicle will be the major focus of SpaceX once Falcon Heavy and DragonCrew are flying regularly.<ref name=tss20140321m/>

On June 15, 2015, SpaceX announced that they would sponsor a [Hyperloop](/wiki/Hyperloop) [competition](/wiki/Hyperloop_pod_competition), and would build a [Template:Convert](/wiki/Template:Convert) [subscale](/wiki/Scale_model) test track near SpaceX's headquarters for the competitive events, which could be held as early as June 2016.<ref name=nbc20150615> [Template:Cite news](/wiki/Template:Cite_news)</ref><ref name=spacex-competition201506> [Template:Cite web](/wiki/Template:Cite_web)</ref>

## Rocket engines[[edit](/index.php?title=(none)&action=edit&section=29)]

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Since the founding of SpaceX in 2002, the company has developed three families of [rocket engines](/wiki/Rocket_engine) — [Merlin](/wiki/Merlin_(rocket_engine)) and [Kestrel](/wiki/Kestrel_(rocket_engine)) for [launch vehicle](/wiki/Launch_vehicle) propulsion, and the [Draco](/wiki/Draco_(rocket_engine_family)) [RCS](/wiki/Reaction_Control_System) control thrusters. SpaceX is currently [developing](/wiki/New_product_development) two further rocket engines: [SuperDraco](/wiki/SuperDraco_(rocket_engine)) and [Raptor](/wiki/Raptor_(rocket_engine)).

Merlin is a family of rocket engines developed by SpaceX for use on its [Falcon rocket family](/wiki/Falcon_(rocket_family)) of launch vehicles. Merlin engines use [LOX](/wiki/Liquid_oxygen) and [RP-1](/wiki/RP-1) as propellants in a gas-generator power cycle. The Merlin engine was originally designed for sea recovery and reuse. The injector at the heart of Merlin is of the pintle type that was first used in the [Apollo Program](/wiki/Apollo_Program) for the lunar module landing engine. Propellants are fed via a single shaft, dual impeller [turbo-pump](/wiki/Turbo-pump). Kestrel is a LOX/RP-1 [pressure-fed](/wiki/Pressure-fed_engine_(rocket)) rocket engine, and was used as the Falcon 1 rocket's second stage main engine. It was built around the same [pintle](/wiki/Pintle_injector) architecture as SpaceX's Merlin engine but does not have a [turbo-pump](/wiki/Turbo-pump), and is fed only by [tank pressure](/wiki/Pressure-fed_engine_(rocket)). Its nozzle was [ablatively](/wiki/Ablation) cooled in the chamber and throat and [radiatively cooled](/wiki/Radiative_cooling), and is fabricated from a high strength [niobium](/wiki/Niobium) alloy.

Draco are [hypergolic](/wiki/Hypergolic) liquid-propellant rocket engines that utilize a mixture of [monomethyl hydrazine](/wiki/Monomethyl_hydrazine) [fuel](/wiki/Fuel) and [nitrogen tetroxide](/wiki/Nitrogen_tetroxide) [oxidizer](/wiki/Oxidizer). Each Draco thruster generates [Template:Convert](/wiki/Template:Convert) of thrust.<ref name=sxu20071210> [Template:Cite web](/wiki/Template:Cite_web)</ref> They are used as [reaction control system](/wiki/Reaction_control_system) (RCS) thrusters on both the [Dragon spacecraft](/wiki/Dragon_(spacecraft)) and the [Falcon 9 launch vehicle second-stage](/wiki/Falcon_9_second-stage).<ref name=sxF9LVPUG2009>[Template:Cite web](/wiki/Template:Cite_web)</ref> [SuperDraco](/wiki/SuperDraco) are a much more powerful version of the Draco thrusters, which will be initially used as landing and [launch escape system](/wiki/Launch_escape_system) engines on the version 2 Dragon spacecraft, [Dragon V2](/wiki/Dragon_V2).

SpaceX has signaled on multiple occasions that it is interested in developing much larger engines than it has done to date. A conceptual plan for the [Raptor](/wiki/Raptor_(rocket_engine)) project was first unveiled in a June 2009 AIAA presentation.<ref name=hs20090707>[Template:Cite web](/wiki/Template:Cite_web)</ref> In November 2012, Musk announced a new direction for propulsion side of the company: developing [LOX](/wiki/Liquid_oxygen)/[methane](/wiki/Liquid_methane) rocket engines for launch vehicle main and upper stages.<ref name=fg20121120> [Template:Cite news](/wiki/Template:Cite_news)</ref> The [Raptor](/wiki/Raptor_(rocket_engine)) [LOX](/wiki/Liquid_oxygen)/[methane](/wiki/Liquid_methane) engine will use the more efficient [staged combustion](/wiki/Staged_combustion_cycle_(rocket)) cycle,<ref name=fg20121122>[Template:Cite news](/wiki/Template:Cite_news)</ref> a departure from the [open cycle](/wiki/Open_cycle_gas_turbines) [gas generator cycle](/wiki/Gas-generator_cycle_(rocket)) system and [LOX](/wiki/Liquid_oxygen)/[RP-1](/wiki/RP-1) propellants that the current Merlin 1 engine series uses."<ref name=fg20121122/> The rocket would be more powerful than previously released publicly, with over [Template:Convert](/wiki/Template:Convert) of thrust.[[120]](#cite_note-120) Raptor engine component-level testing will begin in 2014.<ref name=sn20131025>[Template:Cite news](/wiki/Template:Cite_news)</ref> The Raptor engine will likely be the first in a family of methane-based engines SpaceX intends to build.<ref name=sn20131025/>

## See also[[edit](/index.php?title=(none)&action=edit&section=30)]

[Template:Portal](/wiki/Template:Portal) [Template:Div col](/wiki/Template:Div_col)

* [Autonomous spaceport drone ship](/wiki/Autonomous_spaceport_drone_ship)
* [Colonization of Mars](/wiki/Colonization_of_Mars)
* [Human outpost](/wiki/Human_outpost)
* [List of Falcon 9 and Falcon Heavy launches](/wiki/List_of_Falcon_9_and_Falcon_Heavy_launches)
* [Falcon 9 first-stage landing tests](/wiki/Falcon_9_first-stage_landing_tests)
* [Manned mission to Mars](/wiki/Manned_mission_to_Mars)
* [Mars to Stay](/wiki/Mars_to_Stay)
* [Orbital Sciences Corporation](/wiki/Orbital_Sciences_Corporation)
* [Private spaceflight](/wiki/Private_spaceflight)
* [Space exploration](/wiki/Space_exploration)
* [Terraforming of Mars](/wiki/Terraforming_of_Mars)
* [Tourism on Moon](/wiki/Tourism_on_Moon)
* [United Launch Alliance](/wiki/United_Launch_Alliance)
* [Mars One](/wiki/Mars_One)

[Template:Div col end](/wiki/Template:Div_col_end)

## References[[edit](/index.php?title=(none)&action=edit&section=31)]

[Template:Reflist](/wiki/Template:Reflist)

## Further reading[[edit](/index.php?title=(none)&action=edit&section=32)]

* Vance, Ashlee. *Elon Musk : How the Billionaire CEO of SpaceX and Tesla is Shaping our Future*. Virgin Books (2015). ISBN 9780753555620

## External links[[edit](/index.php?title=(none)&action=edit&section=33)]

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* [Template:Official website](/wiki/Template:Official_website)
* [SpaceX forum hosted by co-founder Jimmy Cantrell and writer Ashlee Vance](http://www.falconheavy.net)
* [*Kwajalein Atoll and Rockets*](http://kwajrockets.blogspot.com/) (Candid and highly unofficial blog by Elon Musk's brother [Kimbal](/wiki/Kimbal_Musk), with on-site pictures and reporting.)
* [Template:PDFlink](/wiki/Template:PDFlink)
* [Michael Belfiore's notes from SpaceX pre-launch conference in 2005](http://michaelbelfiore.com/blog/2005/11/spacex-prelaunch-conference.html)
* [Template:YouTube](/wiki/Template:YouTube)

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