Commercial Orbital Transportation Services

Space Exploration Technologies

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SpaceX Overview

- Founded in mid-2002 with the goal of providing high reliability, low cost space transportation.
- Over 450 employees — growing at minimum 50% per year.
- HQ has 550,000 sq ft of manufacturing production and offices.
  State of the art propulsion and structural test facility in Texas.
- Launch complexes at Kwajalein, the Cape and Vandenberg AFB.
- SpaceX recently has become an approved NASA Launch Services provider

Southern California Headquarters

Kwajalein

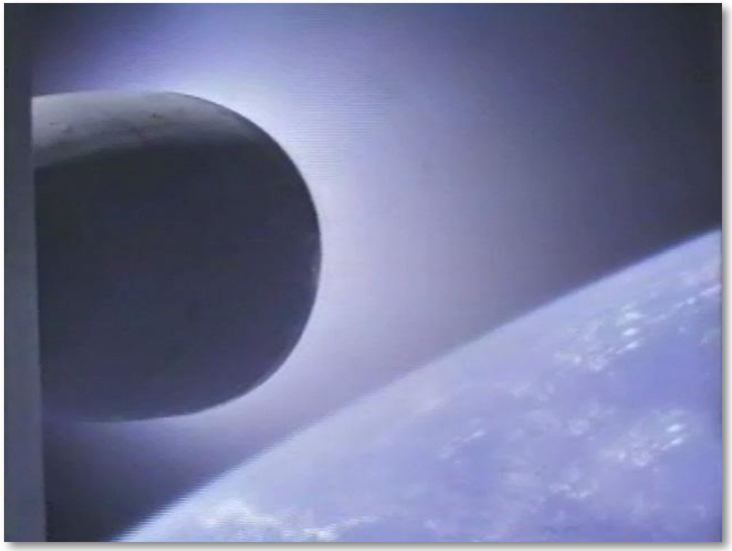
Central Texas

Cape Canaveral

Falcon 1 Rocket

- 2003 – Began detailed design & development
- 25 March 2006 - Maiden demonstration launch – 29 seconds
- 21 March 2007 - Second launch reached 297 km altitude & 5.1 km / sec
- End of June 2008 - Next flight with DoD ORS Office as primary payload

Omelek Island Pacific Launch Site



Falcon 1 - View from 297 km altitude

Liftoff!

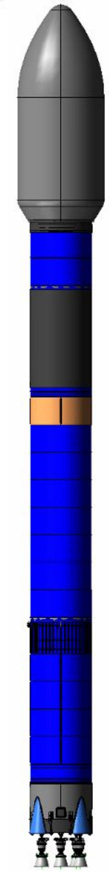
Falcon Launch Vehicle Evolution

Falcon 1
Demo Flight 1
3/2006

Falcon 1
Demo Flight 2
3/2007

Falcon 1
Flight 3
2Q 2008

Falcon 1e
(2010)



Falcon 9
5m Fairing
(2009)

Falcon 9
Dragon
(2009)

- F1 and F9 share similar architecture
- F9 uses nearly the same Merlin 1C engine
- Similar software and avionics
- Similar launch and ground operations
- Lessons learned from Falcon 1 applied to F9

- Initial vehicle

- Improved vehicle robustness
- Better procedures & added personnel
- Improved software health monitoring & launch automation

- Improved vehicle robustness
- Added slosh baffles
- Upgraded engine from Merlin 1A to Merlin 1C
- Lighter weight 2014 Al upper stage

- Higher thrust engine
- Lengthened first stage
- Larger payload fairing
- Al-Li upper stage
- Available starting 2010

Common first and second stages (including engines, interstage, etc.) Dragon used for Space Station servicing missions, up and down crew and cargo transport, orbital experiments, etc.

NASA COTS Program

Commercial Cargo and Crew Program (C3P0) or “COTS”

- Demonstrate ISS servicing with possible follow-on business of ISS servicing after Shuttle retirement
- Encourage the growth of the commercial space industry, resulting in lower costs to all buyers
- Fixed Price, Commercial Milestone-based “Space Act Agreement”

COTS Capabilities (A-C = cargo; D = manned)

A: External Cargo supply
B: Internal Cargo supply
C: Internal Cargo return
D: Crew Supply/Return

COTS Capability-D (crew option) exists under the SpaceX SAA

COTS Phase II RFP process: proposals due in June 2008; awards expected in November 2008

November 2002

May 2008

Cape Canaveral Launch Facility

SpaceX SLC-40

Demolition of legacy Umbilical Tower (8 January 2008)

Ben Cooper/Spaceflight Now

Demolition of legacy Mobile Service Tower (27 April 2008)

Falcon 9 Rocket

- Designed to NASA man-rating safety margins
- Engine out reliability similar to Saturn I & Saturn V
- Lift off mass is 325 tons standard, 885 tons for heavy
- 10 tons to LEO, 5 tons to GTO
- Pricing starts at $37M all inclusive

Thrust frame & plumbing for nine engines

Raising first stage tank on to test stand

Falcon 9 first stage tank in production - Same diameter and length as a Boeing 737

First stage mated with thrust frame

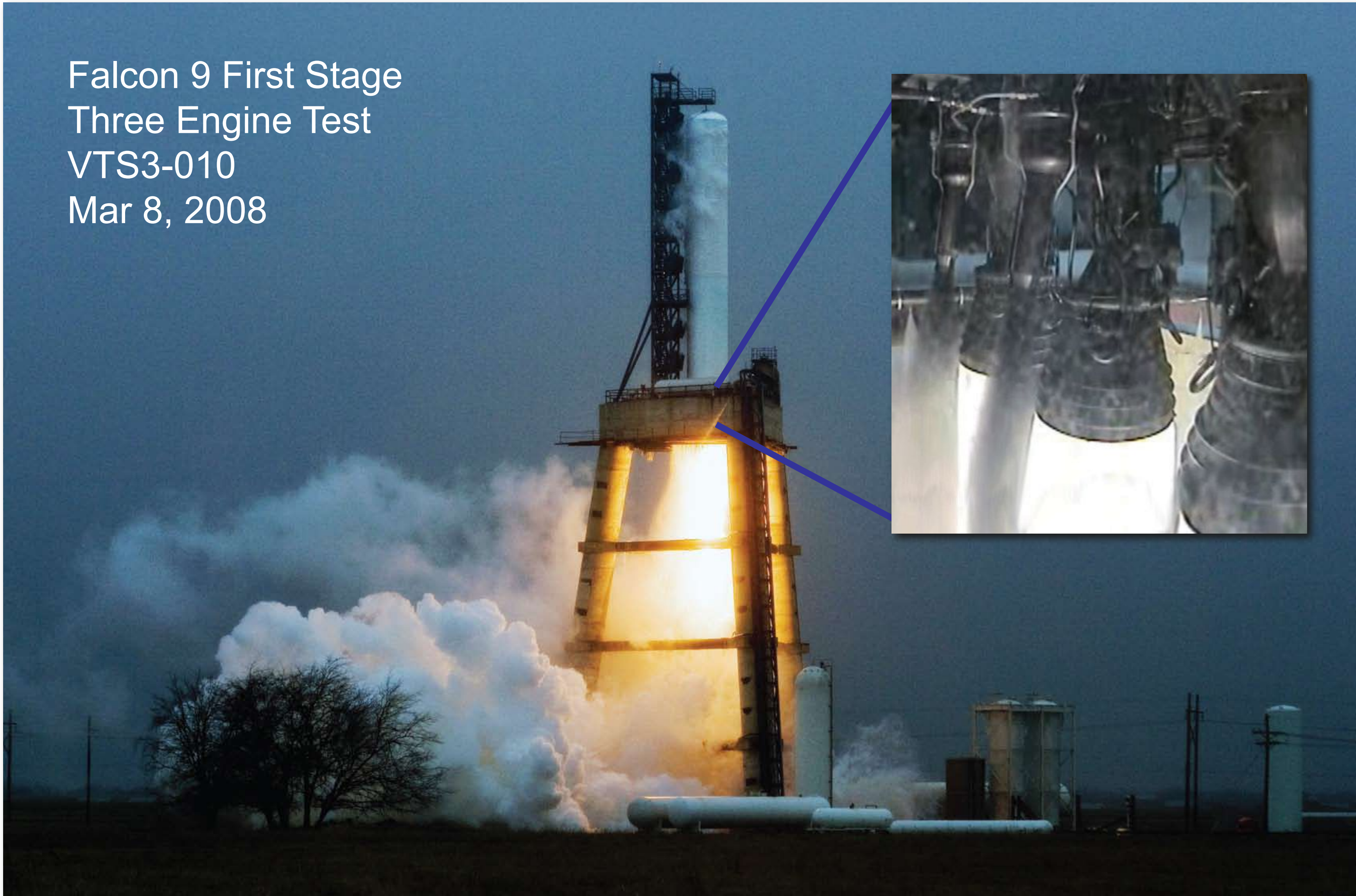
Falcon 9 Progress

Merlin development complete

Texas Test Stand Complete

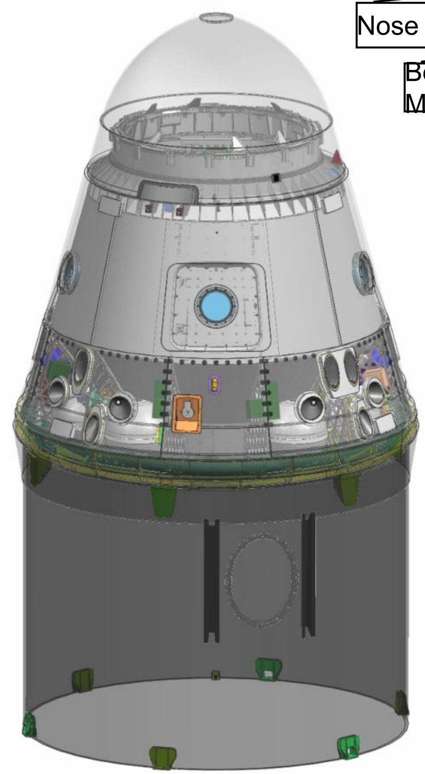
1st stage test firing with multiple engines

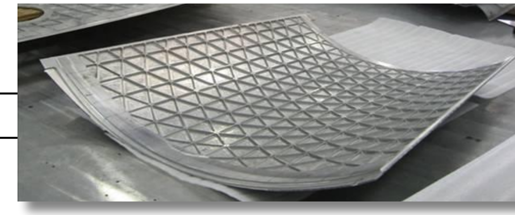
Falcon 9 – Preparing for First Flight



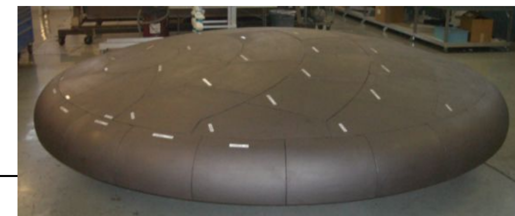
Dragon Spacecraft

Dragon Engineering Model





Isogrid Pressure Vessel Panel



Dragon Heat Shield Prototype

Trunk Structure Composite Sample

Maximum Diameter	3.7 m
Capsule Length w/ Nose Cone	4.5 m
Capsule Length (w/o Nose Cone)	3.1 m
Trunk Length	3.0 m
Total Cargo Mass	2590 kg

1:3 scale Model Splash Test

SpaceX COTS Overall Progress

- Met all contractual COTS deadlines (10) to date – a mix of techinical and financial milestones;
- Five engine test fire coming up; Nine engines in September
- Successful Draco thruster hotfire in March; Demo 3 PDR set for June;
- Launch dates for cargo missions adjusted as follows:

  June 2009: Dragon Demo C1: Core Functionality - Five-hour "up-and-back" mission tests fundamentals

  November 2009: Dragon Demo C2: ISS Flyby - Five-day mission in which Dragon flies within 10 km of ISS and closes space-to-space communications link

  March 2010: Dragon Demo C3: ISS Berthing - Execute a demonstration of delivery of sim-cargo to ISS and return safely to Earth

- Passed NASA ISS Safety Review Panel (SRP) in record time.
- Pursuing FAA Commercial Licenses for COTS Launches and Reentries.
- Per FAA regs, will pursue TPL insurance for COTS flights.
- Cash-flow positive (14 contracted launches, including a mix of domestic and international customers.

Current Launch Manifest

Customer	Launch	Vehicle	Departure Point
DARPA Demo Flight 1 - *Launched*	March 24, 2006	Falcon 1	Kwajalein
DARPA Demo Flight 2 - *Launched*	March 20, 2007	Falcon 1	Kwajalein
DoD ORS Office & ATSB (Malaysia)	Q2 2008*	Falcon 1	Kwajalein
ATSB (Malaysia)	Q3 2008*	Falcon 1	Kwajalein
US Government	Q4 2008*	Falcon 9	Cape
MDA Corporation (Canada)	2009	Falcon 9	Cape
Avanti Communications (UK)	2009	Falcon 9	Cape
NASA COTS – Demo 1	2009	Falcon 9	Cape
NASA COTS – Demo 2	2009	Falcon 9	Cape
SpaceDev	2009	Falcon 1	Cape or Kwajalein
NASA COTS – Demo 3	2010	Falcon 9	Cape
MDA Corporation (Canada)	2010	Falcon 1	Kwajalein
Swedish Space Corporation	2010	Falcon 1	Kwajalein
Bigelow Aerospace	2011	Falcon 9	Cape

* Hardware at launch site.

Summary

SPACEX

- SpaceX is committed to being a reliable launch service provider for the long term
  - Significant expansion of capability with investment in new headquarters, manufacturing systems and launch sites
  - Proven state-of-the-art facility that provides test-like-you-fly capabilities
  - Growing workforce of skilled engineers and technicians with flight hardware experience
- Current contracts with government and commercial customers demonstrate a confidence in the Falcon 1, Falcon 9, Dragon and SpaceX
- SpaceX is now an approved NASA Launch Services provider offering reliable, low cost access to Earth orbit and beyond
- SpaceX stands poised to help close the imminent gap in domestic cargo and crew transportation to the International Space Station

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