
Revolutionizing Access to Space
SPACEX
Space Exploration Technologies

# SpaceX Summary

- Founded in mid 2002 with the long term goal of providing high reliability, low cost human space transportation
- Initial target market is government & commercial satellites to minimize market risk
- Add human transportation capability as technology is proven
- Silicon Valley mode of operation – flat hierarchy, high engineer to manager ratio, rapid prototype iteration, best idea wins
- 250 employees
- Currently have 100,000 sqft of office and manufacturing space in Southern California
  - Moving to a Half million square foot facility in 6 months
- 300 acre propulsion and structural test facility in Texas
- Launch complexes in Kwajalein and Vandenberg

# 2006 Highlights

- SpaceX is ISO 9001 Certified
- Completed construction and activated Falcon launch site at RTS
- 4 Launch attempts with the final achieving lift off and ~30 seconds of powered flight
- Completed the government-led Falcon 1 Return to Flight investigation and vehicle upgrades
- Nominal F1 Return to Flight in January 2007
- Falcon 9 tooling 90% complete
- Falcon 9 engines, structure and avionics in fabrication
- Awarded NASA COTS

# McGregor Test Facility

**Fairing Test Stand**
- lateral and axial loads
- 128 strain gages
- 32 deflection gages

**Merlin Test Stand**
- 3-axis load measurement
- 420 data channels
- 64 hi-speed channels
- 64 control channels
- Dev and Qual
- 1.5 MDC

**Vehicle Test Stand**
- lateral and axial loads
- up to 200 Klbs
- 128 strain gages
- 32 deflection gages
- LN2 and RP-1 tanking
- tank pressurization

**McGregor Test Facility**
- Blockhouse
- Engine Assy Bldg
- Weld Fabrication Shop
- Lox, RP-1, Nitrogen, Helium, Tea-Teb
- Merlin and Kestrel Qual and Acceptance
- Vehicle Structural Facility
- Instrumentation and Control (I-bay)
- Large Scale Fabrication
- 3.2 million lb Thrust Stand!

**Kestrel Test Stand**
- Axial load measurement
- 356 data channels
- 32 hi-speed channels
- 64 control channels
- Dev and Qual
- 420 second MDC


**Thrust Frame Test Stand**
- axial load with gimbal
- TVC actuators
- up to 125Klbs
- 160 strain gages
- 32 deflection gages

**Large Scale Fabrication**

**Horizontal Test Stand**
- 100K axial load measurement
- 200 data channels
- 32 hi-speed channels
- 32 control channels
- Components Dev and Qual
- Thrust Chamber and pumps
- 1500 psi Lox and RP-1

# Omelek Launch Facility

Falcon 1 on the Pad

IBAY - Omelek

Fiber Room - Omelek

Falcon 1 in the Hangar

Falcon 1 Ready to Launch

# Lift Off—
# Marshall Islands March 2006

# Business Approach:
# Serve a current viable market while working towards Human space transportation

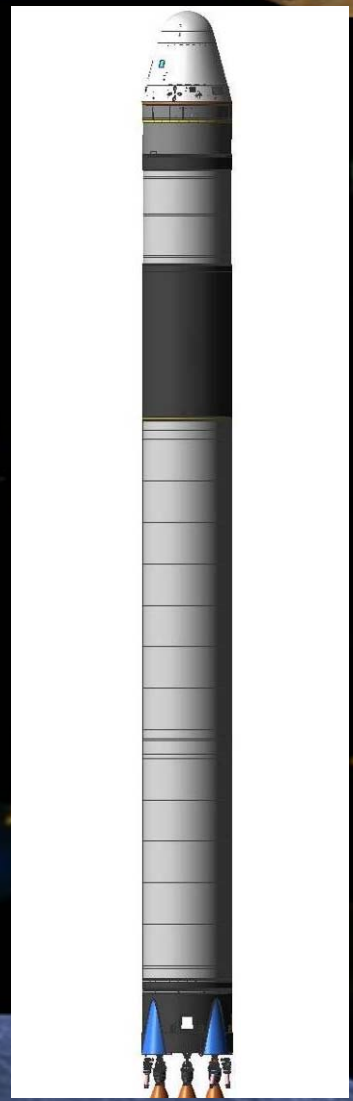
| Customer | Launch | Vehicle | Departure Point |
|---|---|---|---|
| DARPA Demo Launch 1* | Q1 2006 | Falcon I | Kwajalein |
| DARPA Demo Launch 2 | Q1 2007 | Falcon I | Kwajalein |
| OSD/NRL | Q2 2007 | Falcon I | Kwajalein |
| Malaysia | Q3 2007 | Falcon I | Kwajalein |
| US Government (Classified) | Q2 2008 | Falcon 9 | Kwajalein/Cape |
| MDA Corp (Canada) | Q3 2008 | Falcon 9 | Kwajalein/Cape |
| NASA | Q3 2008 | Falcon 9 | Kwajalein/Cape |
| NASA | Q2 2009 | Falcon 9 | Kwajalein/Cape |
| Bigelow Aerospace | Q2 2009 | Falcon 9 | Kwajalein/Cape |
| MDA Corp (Canada) | Q3 2009 | Falcon 1 | Vandenberg |
| NASA | Q3 2009 | Falcon 9 | Kwajalein/Cape |
| SpaceDev | Q4 2009 | Falcon 1 | Vandenberg |
| Swedish Space Corp | Q4 2009 | Falcon 1 | Vandenberg |

**Thirteen Launches Contracted**
**Plus $100 Million AF IDIQ Falcon I Contract**

* Launched

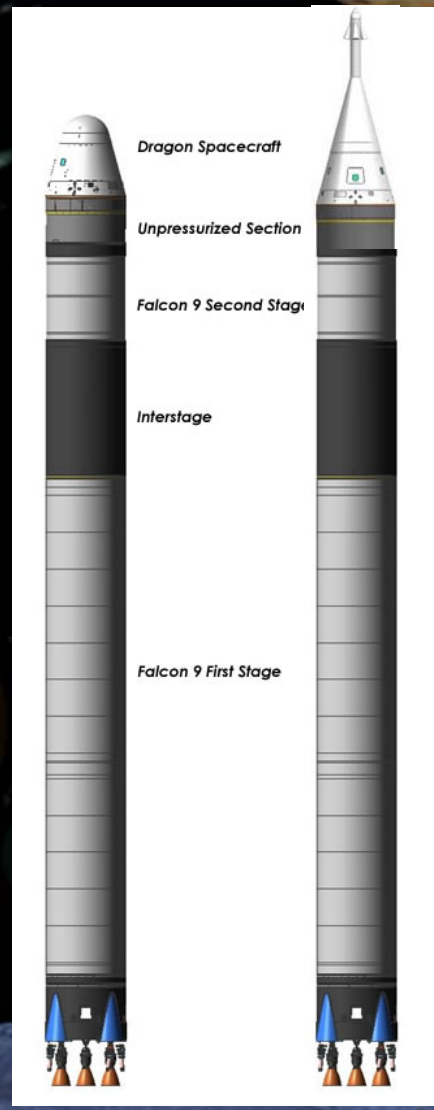
# Falcon 9 Summary

- NASA man-rating factor of safety (1.4 for Falcon 9 vs. 1.25 for typical expendable launch vehicle)
- Nine Merlin engines provide engine out reliability similar to Saturn I & Saturn V
- Upper stage also powered by a Merlin
- 2007 SpaceX engine production will be greater than all US booster engine production combined
- Additional Reliability Factors:
  - 10 Engines per F9 flight results in high production rate and engine run time
  - High level of fault tolerance—man rated
  - Higher flight rate, which also lowers cost
- Basic F9 performance is ten tons to LEO
- Approx. $30 Million per flight all inclusive
- Multi-engine stage hold down firing in Q1 2007



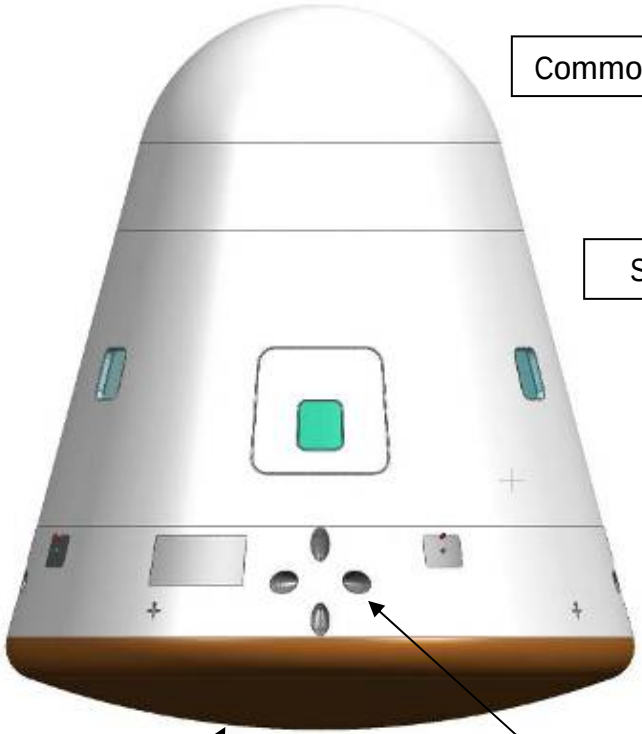
# COTS System Architecture

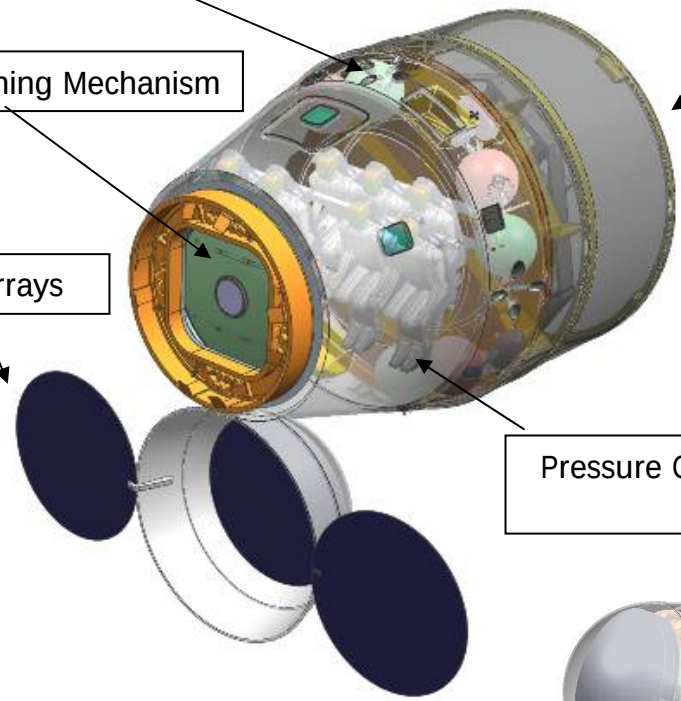
- Standard Falcon 9 booster
  - Identical to commercial LEO payload version
  - Human-rated when combined with a Dragon & LES
  - 8500 kg total payload capacity to ISS orbit
    - Allows ~3100 kg of cargo and/or crew total
- Dragon spacecraft
  - Identical whether cargo-only or crewed (except life-support & internal outfitting)
- Cargo accommodations
  - Pressurized cargo inside capsule
    - Standardized modular rack system, CTB/MLE based
  - Unpressurized cargo in the “trunk”
- Crew accommodations
  - Up to 7 crew per flight
  - Can trade mass between crew & cargo

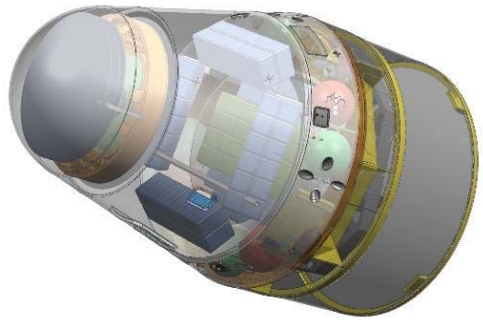


# Dragon Spacecraft

**Engineering Model to be complete in February 2007**







Service Compartment

Trunk (Unpressurized Cargo)

Common Berthing Mechanism

Solar Arrays

Pressure Compartment (Cargo or 2-7 Crew)

Heat Shield

NTO/MMH Thrusters (RCS, OMS, and De-Orbit)

# SpaceX is Here to Stay

- Customers are very supportive – unprecedented manifest for a new market entrant
- Completing the Falcon 1 organizational transition from development phase to operational phase
  - Focusing on process management, risk management and mission assurance
- Proceeding with the Falcon 9 development and qualification
  - Applying lessons learned from Falcon 1
  - First flight in 2008
- SpaceX is evolving from a purely development capability to both development and operational capability

# Thoughts for Closing

- There is substantial public engagement in the space industry right now to leverage
  - COTS with public hope of commercial Spaceflight
  - Bigelow Aerospace's recent on orbit success
  - Space Ship One's historic X-prize win
  - Spirit and Opportunity
- Human Exploration and commercial orbital Spaceflight will not become a "near term" reality without ubiquitous space launches
- Fundamentally a state change for the industry is required to develop a broader marketplace
  - Must expand the market beyond governments and large corporations
  - Requires a new approach to working reliability & cost
- With the advent of the Space Entrepreneurs, and willingness to do business differently within the US government, the future for Space Exploration and commercial spaceflight is positive

# Implementing the Vision

## Space Exploration Conference 2006