Commercial Crew and Cargo to ISS Enables Program for Exploration Beyond
3 Key Points

1. Commercial Crew and Cargo to ISS has always been a critical component of the Constellation Architecture.

2. Commercial Crew and Cargo to ISS is good for Exploration and good for Alabama.

3. SpaceX is here to stay.
Consistent Support for Commercial Crew/Cargo

U.S. Space Exploration Policy, January 2004:
“Develop a new crew exploration vehicle [Orion] to provide crew transportation for missions beyond low Earth orbit
“Acquire crew transportation to and from the International Space Station, as required, after the Space Shuttle is retired from service
“Pursue commercial opportunities for providing transportation and other services supporting the International Space Station and exploration missions beyond low Earth orbit”

2008 NASA Authorization Bill:
“NASA shall make use of United States commercially provided International Space Station crew transfer and crew rescue services to the maximum extent practicable…[and]limit, to the maximum extent practical, the use of the Crew Exploration Vehicle [Orion] to missions carrying astronauts beyond low Earth orbit.”

FY 2008 NASA Appropriations Report:
“The Committee encourages NASA to consider exercising its option for the Commercial Cargo Capability (COTS) Capability D (crew transport) as soon as possible from unallocated, uncommitted, or otherwise available funds…”
Top 3 Myths About Commercial Crew

1. **Myth:** The only companies advocating for a more commercial approach to crew transportation are small entrepreneurs with “paper rockets.”

2. **Myth:** Crew transportation is too risky to outsource to commercial industry.

3. **Myth:** Commercial crew is in competition with Orion/Ares.
SpaceX Overview

- Founded in mid-2002 with the singular goal of providing highly reliable, low cost space transportation for both cargo and crew
- Over 800 employees and growing
- 51,000 sq m (550,000 sq ft) of offices, manufacturing and production in Hawthorne, California
- 300 acre (121 hectares) state-of-the-art Propulsion and Structural Test Facility in central Texas
- Launch sites at Kwajalein and Cape Canaveral
- Developing launch site at Vandenberg
SpaceX Vehicles

Falcon 1

Falcon 9

Dragon Spacecraft
SpaceX Accomplishments

• Designed, developed and qualified the world's lowest cost orbital launch system
  – Two complete engines, two launch sites, structures, avionics and software, ground systems and manufacturing and test facilities

• Successfully reached orbit, commanded payload separation and completed second stage re-ignition

• Nearly completed development on Falcon 9
  – Including the only modern-day boost phase propulsion system with engine out reliability

• Successfully passed Critical Design stage for Dragon — an ISS Visiting Vehicle

• Demonstrated a rapid mission integration process supporting a wide range of customer’s requirements

• Secured over $2 Billion worth of business (currently over 26 missions) including the NASA “Gold Standard” Launch Services contract
SpaceX Flight History

Falcon 1e Upgrades
- Higher thrust engines
- Lengthened first stage
- Larger payload fairing
- >2x payload mass capacity
- Al-Li upper stage
- Inaugural launch 4Q 2010

Powered by Merlin 1A
ablatively cooled engine

Powered by Merlin 1C
regeneratively cooled engine

Falcon 1 Demo 1
24 Mar 2006
Falcon 1 Demo 2
20 Mar 2007
Falcon 1 Flight 3
02 Aug 2008
Falcon 1 Flight 4
28 Sep 2008
Falcon 1 RazakSAT
14 Jul 2009
Falcon 1e Inaugural
2010
Falcon 9 Inaugural
2009
Falcon 9 5.2 m Fairing
2010
Falcon 9 Dragon Crew
T.B.D.
# SpaceX Manifest

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<td>NASA CRS3-12 (5 additional missions)</td>
<td>2014-15</td>
<td>F9/Dragon</td>
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SpaceX Falcon 9 Capabilities

• Inaugural flight from Cape Canaveral in 2009
• Lowest mission price in this vehicle class
  – Greater than a factor of 5 cost reduction compared to our domestic competitors
• Two-stage EELV-class launch vehicle
  – Designed to meet NASA man-rated safety margins and failure tolerances
  – Engine-out reliability
• 1st Stage powered by 9 Merlin engines
  – Over 4.9 MN (1.1 million lbf) thrust in vacuum
• 2nd Stage powered by Merlin Vacuum engine
  – 42.7 kN (96,000 lbf) thrust in vacuum
• Diameter 3.6 m (12 ft); Length 55 m (180 ft)
• Payload capability (Block 2)
  – 5.2 m (17 ft) fairing
  – 10,000 kg to LEO

All structures, engines, most avionics and all ground systems designed and mostly built by SpaceX
Falcon 9 – Designed for Reliability

- Falcon 9 based largely on the Falcon 1 design with additional improvements
- Designed for crew capability, and thus with additional human reliability ratings
  - Portions of the design incorporate increased factors of safety (1.4 versus 1.25)
  - Features a fault-tolerant avionics architecture
- The only current US launch vehicle with engine-out reliability
- Merlin engines being produced at a rate of >50 per year, which yields higher product/quality control (e.g. – out-of-family engines easily identified during ground testing)
Video: Falcon 9 First Stage Flight Article Firing
SpaceX Dragon Spacecraft Services

NASA’s “COTS” Program
- Commercial Orbital Transportation Services
- SpaceX receives $278M over 3.5 years
- Demonstrates cargo services to and from the ISS

NASA’s “CRS” Program
- Commercial Resupply Services
- SpaceX awarded $1.6B for 12 cargo missions, 2010 – 2015
- Minimum of 20,000 kg to be delivered
- Option for additional missions

SpaceX’s “DragonLab” Program
- Free-flying recoverable platform for microgravity research
- Regular, frequent, commercial access to space
- First mission in late 2010
SpaceX Crew Transport Capability

This is why SpaceX was founded

- From their inception both Falcon 9 and Dragon were designed to readily accommodate crew.
- SpaceX’s immediate focus remains on COTS and CRS cargo commitments, BUT...
- In every design decision, the ability to attain human rating rapidly AND at low additional cost is paramount.

Note that the cargo carrying version of Dragon includes many human-rating requirements, as it must be safe for ISS crew.
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