Commercial Crew Program Overview

Masters Forum 20

Maria Collura
April 22, 2011
CCP is leading NASA’s efforts to develop an American-made commercial capability for crew transportation and rescue services to the ISS following this year's retirement of the space shuttle fleet.

- Kennedy Space Center will host the program office dedicated to enabling commercial human spaceflight capabilities.
  - Program Manager (PM) will reside at KSC
  - Deputy Program Manager located at JSC

**Program Mission**

- Manage the investment in the development of commercial end-to-end space transportation systems
- Manage the CTS (Crew Transportation System) certification process
- Lead the technical and programmatic partner integration and approval functions
Crew Transportation Design Standard Guidelines - provides expectations, and criteria used in evaluation of technical standards

Crew Transportation Operations Standard Guidelines - provides expectations for minimum criteria and practices for operations

Crew Transportation System DRMs – potential reference missions for current and evolvable systems architecture designs
NASA will perform insight/oversight on the Commercial Partner’s design, development, and certification process to evaluate the end-to-end crew transportation system.
## Commercial Crew Structure and Timelines

<table>
<thead>
<tr>
<th>Title</th>
<th>Purpose</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013-2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCDev</td>
<td>Develop and demonstrate technologies that enable commercial human</td>
<td><a href="#">February Awards</a></td>
<td><a href="#">April All Agreements Complete</a></td>
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<td></td>
<td>spaceflight capabilities.</td>
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<tr>
<td>CCDev Round 2</td>
<td>Mature the Design and Development of elements of the system, such as</td>
<td><a href="#">October Announcement for Proposals</a></td>
<td><a href="#">April Awards</a></td>
<td><a href="#">May Agreements Complete</a></td>
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<tr>
<td></td>
<td>launch vehicles and spacecraft.</td>
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<tr>
<td>CCDev Round 3</td>
<td>Design of integrated commercial crew systems.</td>
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<tr>
<td>CCP</td>
<td>Mature Development, Test and Certification of end-to-end systems.</td>
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<td></td>
<td>Prepared for services to ISS by end of 2016.</td>
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*Under Development*
The NASA Recovery Act stimulus funding, included $50M to stimulate efforts within the private sector to develop and demonstrate technologies that enable commercial human spaceflight capabilities.

On February 1, 2010 five partners were announced and received funding:
- Blue Origin
- Boeing
- Paragon
- Sierra Nevada Corporation
- United Launch Alliance (ULA)

All Agreements were concluded by December 2010, with the exception of ULA and Boeing who received no-cost extensions to April 2011.
Commercial Crew Development Round 2
CCDev2
## CCDev 2 Summary

<table>
<thead>
<tr>
<th>Participant Name</th>
<th>Work Summary</th>
<th>NASA Funding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue Origin</td>
<td>Space Vehicle design to SRR, pusher escape ground and flight testing, and engine pump and thrust chamber testing</td>
<td>$22,005,000</td>
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<tr>
<td>Boeing</td>
<td>CST-100 design maturation to PDR and launch vehicle integration</td>
<td>$92,300,000</td>
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<tr>
<td>Sierra Nevada Corporation</td>
<td>Dream Chaser crew transportation system design maturation to PDR and component testing</td>
<td>$80,000,000</td>
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<tr>
<td>SpaceX</td>
<td>Side-mount LAS engine design maturation and partner-funded crew accommodation prototype</td>
<td>$75,000,000</td>
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**Total Funding** $269,305,000
Blue Origin

Total NASA funding
• $22M

Description & Features:
• Launch vehicles
  – Atlas V
  – Then on their own Reusable Booster System (RBS)
• Biconic shape capsule spacecraft
  • Composite structure
• Landing system trade study
• Pusher Escape System Testing
• Fully Reusable Booster System (RBS)
  • Post separation, RBS will either ballistic trajectory downrange or restart engines to return to launch site

Comments:
• Direct docking to ISS
• Vehicle Mass: 22,000 lbm

Design Reviews

<table>
<thead>
<tr>
<th>Design Reviews</th>
<th>SRR</th>
<th>PDR</th>
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<tr>
<td></td>
<td>May 2012</td>
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Capacity Summary

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<thead>
<tr>
<th>Capacity Summary</th>
<th>kg/Flt</th>
<th>Max Crew</th>
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<td>7</td>
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Subs/Suppliers:
NASA Ames Research Center
NASA Stennis Space Center
ULA
Aerojet
Lockheed Martin Missiles & Fire Control HSWT
U.S. Air Force Holloman High Speed Test Track
Boeing

Total NASA funding
• $92M

Description & Features:
• Launch vehicles
  – Atlas V 412, Delta IV
  – Compatible with Liberty and F9
• CST-100 is a reusable capsule spacecraft
• Land landing on airbags
• Integrated bi-propellant SM propulsion system

Comments:
• Direct docking to ISS
• 48 hours of autonomous flight operations
• Vehicle Mass: 30,430 lbs

Subs/Suppliers:
Airborne Systems United Space Alliance
BA United Launch Alliance
ILC Dover PWR
Spincraft

Design Reviews

<table>
<thead>
<tr>
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<th>Delta SDR</th>
<th>PDR</th>
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<td>1,164</td>
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Software Development and Integration

- Flight, Ground, Mission Ops SW Dev
- Avionics HW/SW and ISS Integration testing
- Mission / Vehicle Common Data System

Launch Abort Engine (LAE)
MMOD/Thermal Shield
LAS Roll Thrusters (8)
CM-SM Umbilical
Orbital Maneuvering, Attitude Control (OMAC)
Radiators (4) Thruster Doghouse (4)
Side Hatch
CM RCS Thrusters (12)
SM RCS Thrusters (28)
Ascent Cover Forward Heatshield
Forward Window Side Window

Pad operations
- Spacecraft arrival at launch pad
- Host and mate to launch vehicle
- Late cargo loading
- Crew ingress
- Countdown
- Launch

Pre-launch processing
- Cargo loading
- Final test and checkout
- Fueling
- Ordinance installation
- Encapsulation

Assembly, refurbishment and test
- Spacecraft element production
- Element test and checkout

Recovery
- Initial safing
- Crew egress
- Cargo removal
- Load on transporter
- Transport to manufacturing for potential reuse

Orbital Maneuvering, Attitude Control (OMAC)
Radiators (4) Thruster Doghouse (4)
Side Hatch
CM RCS Thrusters (12)
SM RCS Thrusters (28)
Ascent Cover Forward Heatshield
Forward Window Side Window
Sierra Nevada Corporation

Total NASA funding
• $80M

Description & Features:
• Launch vehicles
  – Atlas V-402
  – Investigating other options (ATK Booster)
• Dream Chaser is a Reusable – Piloted Lifting Body, Derived from NASA HL-20
  – Onboard hybrid propulsion & high lift provide runway landings for nominal missions and ascent aborts

Comments:
• Direct docking to ISS
• Vehicle Mass: 27,100 lbm
• Multiple & Flexible Abort Options (no black zones)

Design Reviews

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Capacity Summary

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<th>Cargo (kg/Flt)</th>
<th>w/Crew</th>
<th>Max Crew</th>
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<td>1,500</td>
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Subs/Suppliers:
United Launch Alliance
AEROTEK
Adam Works
Boeing
MDA
NASA LaRC

United Space Alliance
Draper Laboratory
SAS
Virgin Galactic
University of Colorado
SpaceX

Total NASA funding
• $75M

Description & Features:
• Dragon Capsule Spacecraft
  • Cargo version to evolve into crew version
  • Many systems identical in both
  • Integrated LAS development and crew accommodations are the focus for CCDev2
  • Water landing (helicopter recovery) for early missions and land landing for later missions

Comments:
• Falcon 9 Launch Vehicle
  • Two-stage – LOX and kerosene
• Falcon 9/Dragon launches
  • Successful COTS launch 12/8/10
  • 11 more scheduled before crew launch

Design Reviews

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<thead>
<tr>
<th>Design Reviews</th>
<th>LAS PDR</th>
<th>Concept Baseline Review</th>
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Subs/Suppliers:
ARES Corporation
Paragon SDC
Odyssey Space Research
ILC Dover
ATA Engineering
Ocean Sounding
Wyle Laboratories
Oceaneering
Information Systems Laboratories Inc.
Orbital Outfitters
• A successful Commercial Crew Program will:
  – Transform human spaceflight for future generations
  – Result in safe, reliable, cost effective crew transportation to LEO and in support of ISS
  – Free NASA’s limited resources for beyond-LEO capabilities
  – Reduce reliance on foreign systems