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## Commercial Crew: Progress Toward Flights

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*Director of Crew Mission Management*

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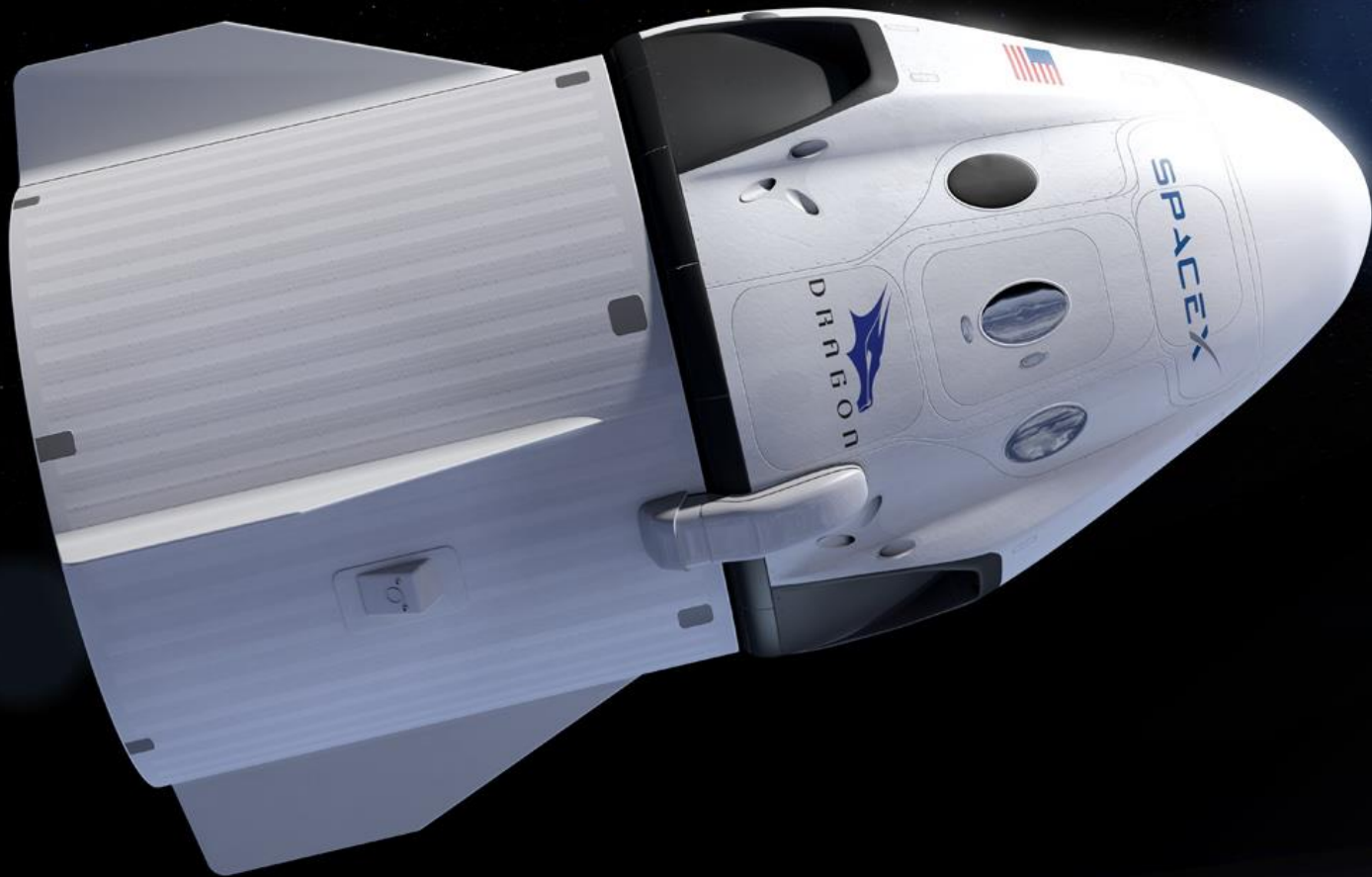
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# SPACEX



## Commercial Crew: Progress Toward Flights

May 2016 | Benjamin Reed, Director of Crew Mission Management

# SpaceX Overview

- SpaceX designs, manufactures, launches, and lands advanced rockets and spacecraft
- Founded in 2002 to revolutionize space technology, with the ultimate goal of enabling people to live on other planets
- World's fastest growing launch provider
- Over 70 missions on manifest representing more than \$10 billion in contracts
- Over 4,500 full-time employees
- Honored to partner with NASA to provide cargo services and return American crew carrying capability



# SpaceX Vehicles

## Falcon 9



## Falcon Heavy



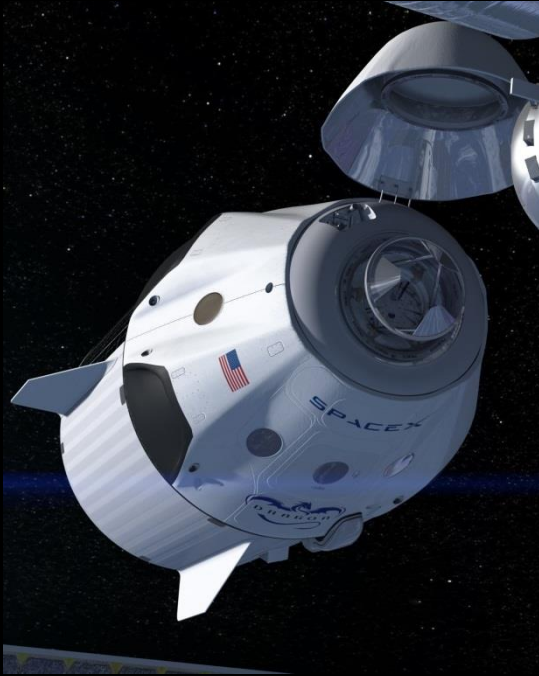
## Dragon





# Ongoing and Future Developments

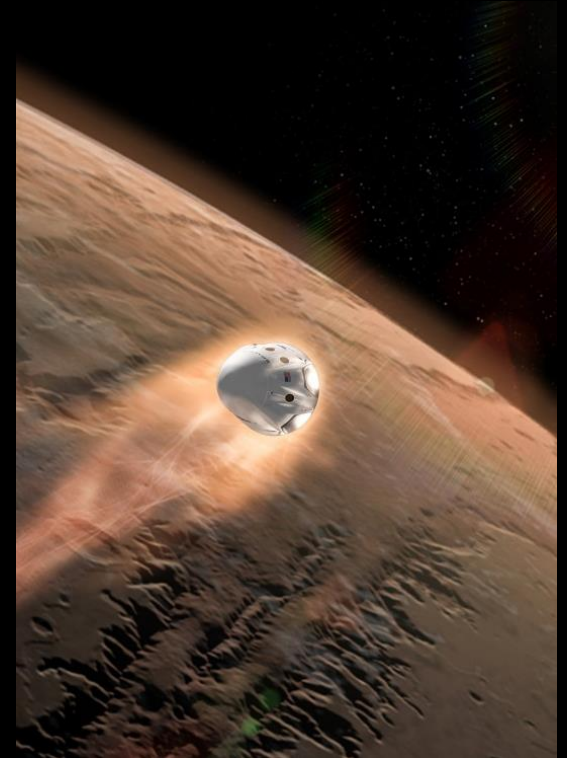
## Commercial Cargo & Crew



## Reusability



## Mars



# The Falcon Has Landed

- In December 2015, SpaceX landed the first stage of the Falcon 9 after successfully delivering 11 commercial satellites to orbit
- Historic milestone in spaceflight and reusability
- Major step toward lowering costs to access space and improve reliability

Video: The Falcon Has Landed

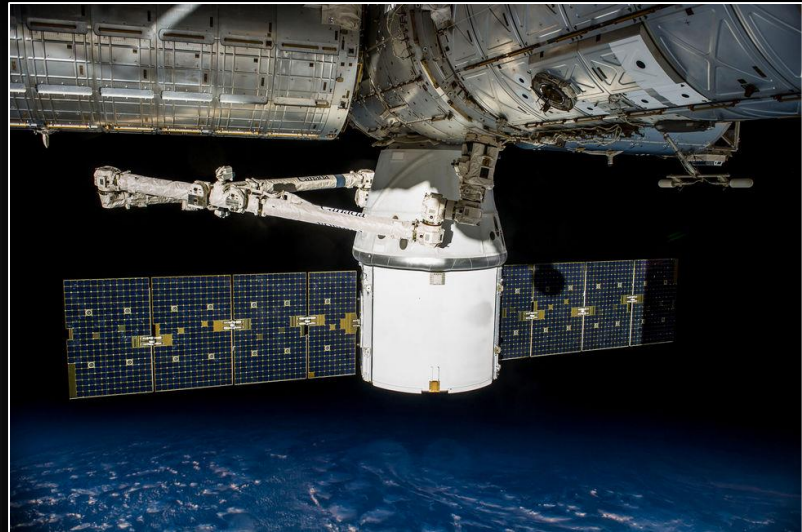


# December 21, 2015 – Falcon 9 Stage 1 Recovery



# Partnership with NASA

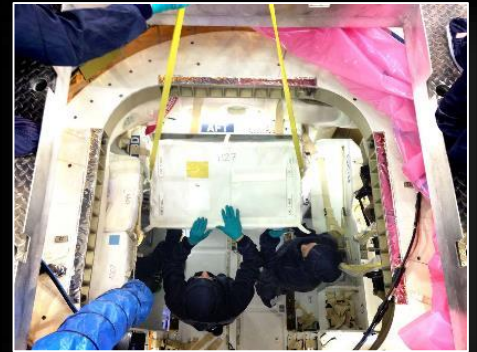
SpaceX and NASA have developed a strong partnership through the Commercial Crew & Cargo programs





# Cargo Program Overview

- SpaceX has provided ongoing cargo services to the International Space Station since 2012
- Dragon is the first commercial spacecraft in history to deliver cargo to the International Space Station and return it to Earth
- 9 missions successfully completed including 2 demonstrations and 7 operational missions
- 20 total missions on current Commercial Resupply Services (CRS) contract
- SpaceX awarded cargo resupply services through 2024 under the new CRS2 program



# Crew Program Overview

- SpaceX is developing a safe, reliable and complete Crew Transportation System certified to fly humans
- All key elements will be certified for crew, including Dragon, Falcon 9, ground systems, and all operations (Ground, Launch, Mission, Crew, and Recovery)
- Crew Dragon has SuperDraco thrusters for safety aborts and for propulsive landing
- Upcoming Crew Missions:
  - ✓ Demonstration 1 to International Space Station (ISS) without crew
  - ✓ In-Flight Abort Test
  - ✓ Demonstration 2 to ISS with crew
  - ✓ Multiple ongoing operational missions



# Crew System Architecture

- Spacecraft Segment (Dragon)
  - Crew Module, Service Section and Trunk
  - Launch Abort System (internally integrated into Dragon)
- Launch Segment (F9)
  - Merlin engines
  - LOX & RP-1 propellants
  - Landing legs (stowed in ascent)
- Ground and Operation Segment
  - Ground Systems
    - Launch Pad (LC-39A), Launch Pad facility, Ground software, ground communications & Launch Control Center
  - Operations System
    - Mission Control Center, Crew Operations, Training & Simulations, & Recovery



Crew Dragon Vehicle



Falcon 9



Mission Control in Hawthorne, CA



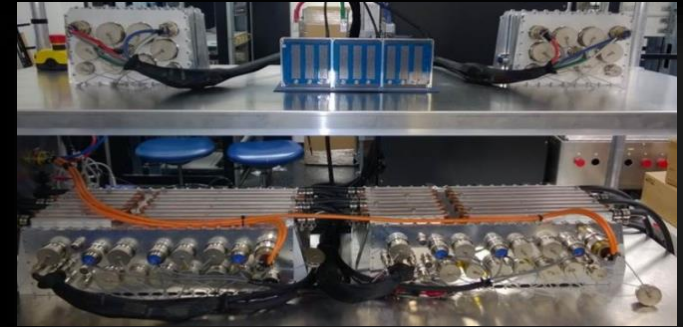
Launch Control Cape Canaveral, FL



LC-39 Cape Canaveral, FL

# Program Milestones & Status

- Recent completions:
  - **Certification Baseline Review**
  - **Pad Abort Test**
  - **Avionics Test Bed Activation**
  - Initial Propulsion Module Testing
  - Docking system qualification
  - Critical Design Review
  - Launch Site Operational Readiness (LSORR)
  - Propulsive Descent Testing
  - Post-Certification Mission 1 Initiation Review
  - Delta Critical Design Review
- Major upcoming milestones
  - **Delta Critical Design Review 2 (dCDR2)**
  - LSORR for Crew
  - Environmental Control and Life Support System (ECLSS) Integrated Test
  - Validation Propulsion Module Testing
  - Space Suit Qualification
  - **Flight Test without Crew Certification Review (FTCR)**
  - **Demo 1 autonomous flight to ISS**
  - Parachute Qualification Complete
  - **In-Flight Abort Test**
  - Design Certification Review (DCR)
  - Flight Test Readiness Review (FTRR)
  - **Demo 2 crewed flight to ISS**
  - Operations Readiness Review (ORR)
  - Certification Review (CR)
  - **Post Certification Missions**





# Dragon Precision Propulsive Hover Test

