Commercial Crew Program Overview

Rick Russell

Materials Science Division

Kennedy Space Center

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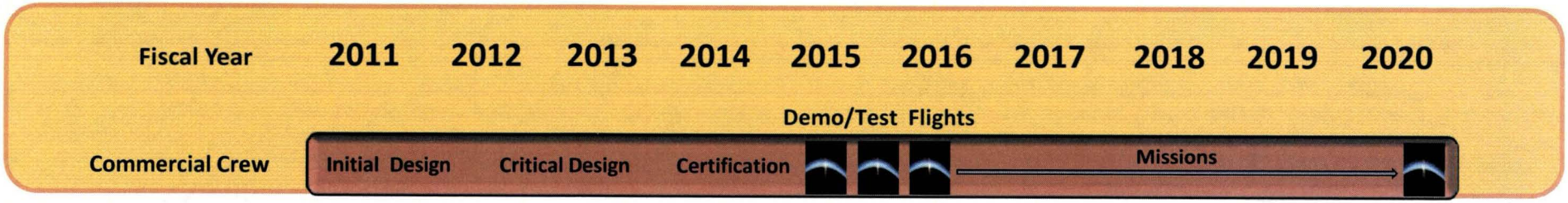
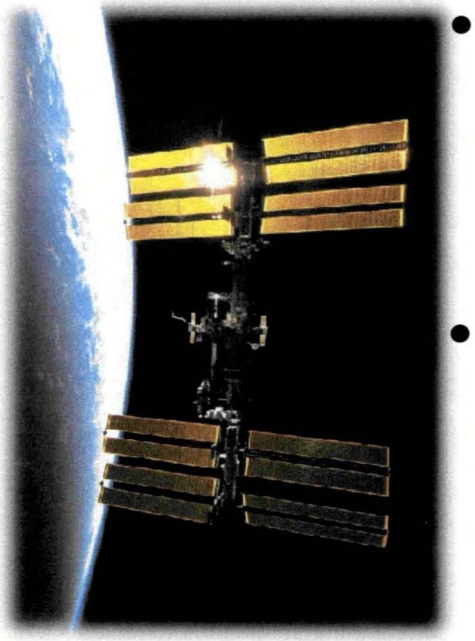
Agenda

- Program Goals and Objectives
- List of Partners
- Requirements Structure
- Materials and Processes Requirements and Verfication
- Overview of Space Act Agreements for Spacecraft

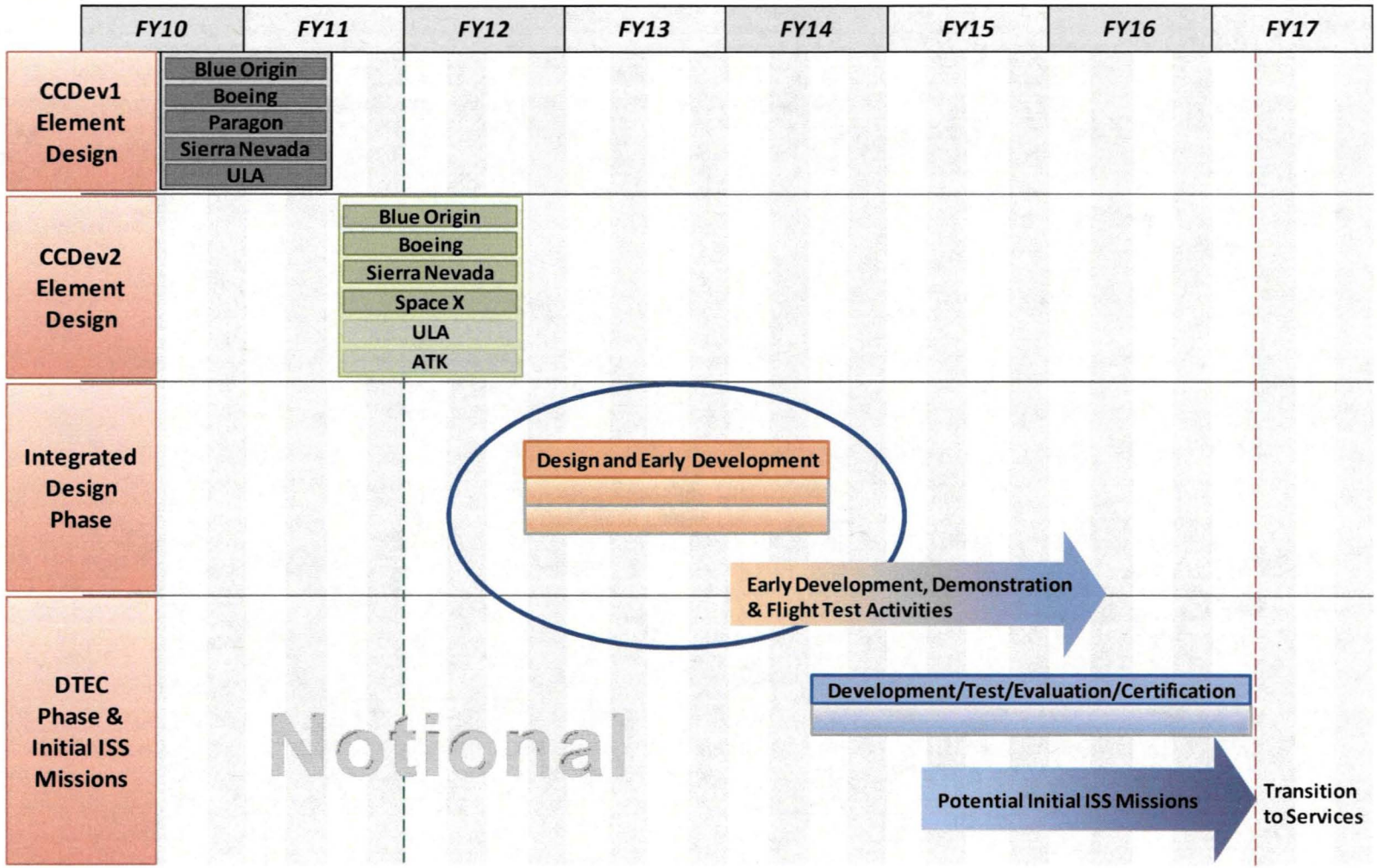
CCP Approach





- Goals:
  - Facilitate the development of a U.S. commercial crew space transportation capability
  - Stimulates U.S. space transportation industry and encourages the availability of space transportation services to NASA and others
- Objectives:
  - Safe, reliable, and cost effective access to and from low Earth orbit (LEO) and the International Space Station (ISS) by mid-decade
  - Investing in U.S. aerospace industry crew transportation system (CTS) design and development
  - Mature the design and certify U.S. CTS capabilities

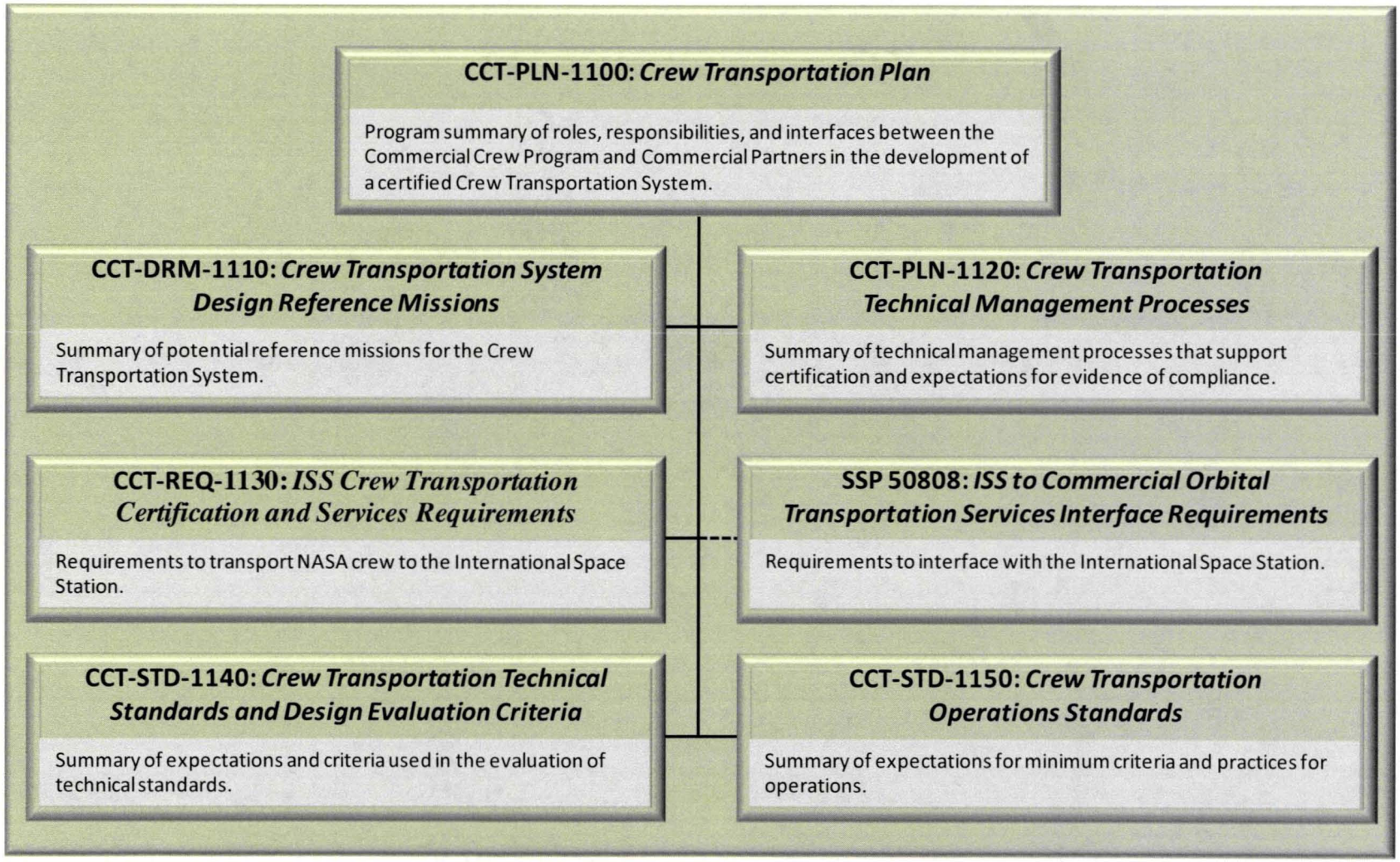
Roadmap


FY10
FY11
FY12
FY13
FY14
FY15
FY16
FY17
CCDev1 Element Design
Blue Origin
Boeing
Paragon
Sierra Nevada
ULA
CCDev2 Element Design
Blue Origin
Boeing
Sierra Nevada
Space X
ULA
ATK
Integrated Design Phase
Design and Early Development
Early Development, Demonstration & Flight Test Activities
DTEC Phase & Initial ISS Missions
Development/Test/Evaluation/Certification
Potential Initial ISS Missions
Transition to Services
Notional

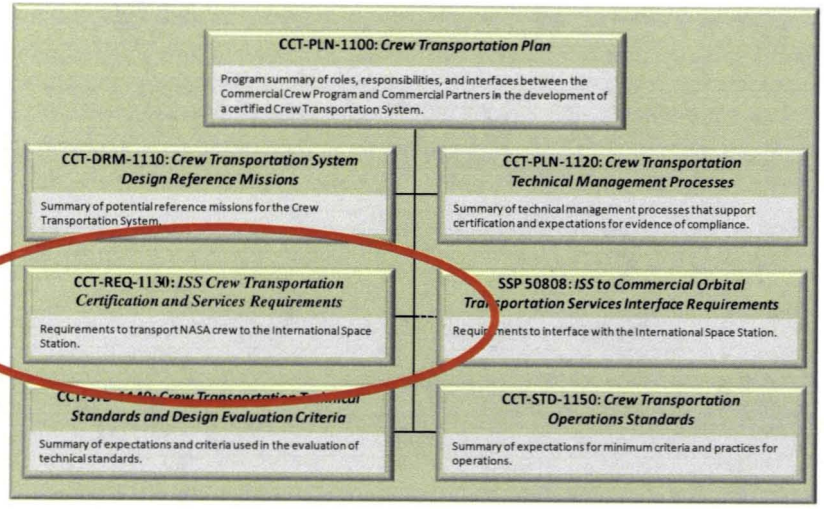
Space Act Agreements

- Partnerships for CCDev1 and CCDev2 were established via Space Act Agreements
- For CCDev2 there are 7 partners
  - Funded
    - Blue Origin
    - Boeing
    - Sierra Nevada
    - SpaceX
  - Unfunded
    - United Launch Alliance
    - ATK
    - Excalibur Almaz, Inc.

Requirements Structure

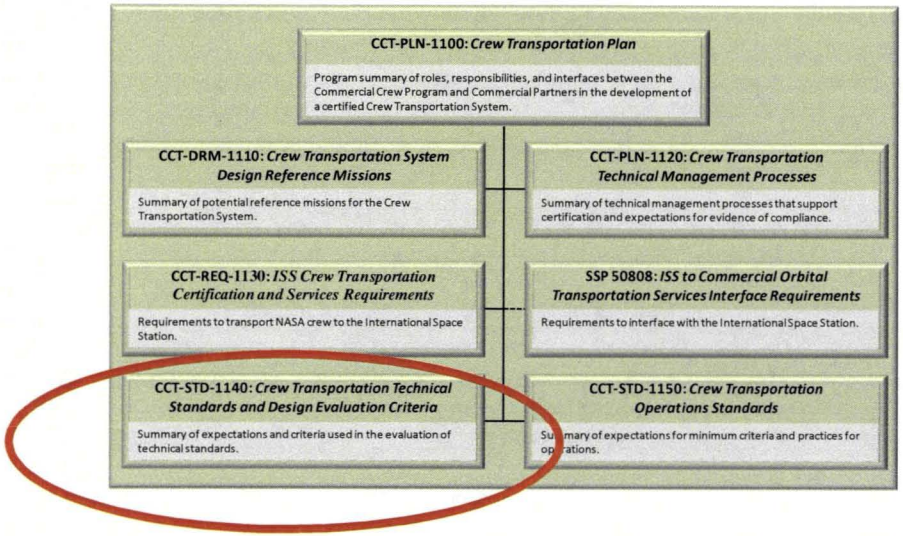


CCT-REQ-1130



- Provides the requirements for development of commercial services to deliver NASA crew and limited cargo to and from the ISS.
- Document defines 2 sets of requirements
  - ISS destination services
  - Transportation certification requirements
- 3 basic types of standards
  - "Meet" or "Comply with"
    - Followed completely with no deviation or alternative proposal
    - Mainly safety and security type s of documents
  - "Meet the intent of"
    - Requirements can be net by following the standard or by proposing alternate standards the meet or are consistent with the NASA standard
    - Most if not all engineering requirements
    - Includes M&P and Fracture Control
  - Reference documents
- Also contains verifications

CCT-STD-1140



- Purpose to inform potential Commercial Partners of the specifications, standards, processes and products/artifacts that NASA considers crucial to a successful development effort
- Provides the Commercial Partner with NASA expectations, essentially the technical criteria, used in assessing these items to ensure they meet the intent of CCT-PLN-1100 and CCT-REQ-1130.
- The verification of technical standard requirements that utilize the "meet the intent of" language are addressed and may be satisfied through the use of alternative standards instead of the NASA, military, or industry standard listed.
- Discipline specific technical work products/artifacts (e.g., plans, analyses, reports, etc.) are also called out, along with the criteria that will be used to evaluate them

NASA-STD-6016 -

Standard Manned Spacecraft Requirements for Materials and Processes

- **CCT-REQ-1130**
  - "Meets the intent" document
  - Deviations must be documented approved suing the intent of the Materials Usage Agreement (MUA) as defined in NASA-STD-6016.

- **CCT-STD-1140**
  - The Commercial Crew contractor will be responsible for demonstrating compliance with NASA-STD-6016 requirements. This may be accomplished through:
    - The development of a Materials and Processes Selection, Control and Implementation Plan or
    - By constructing a matrix of applicable paragraphs and paragraphs that are not applicable.
  - It is recommended that within the construct of the implementation plan or applicability matrix that the following subject matter be specifically addressed:
    - Nondestructive Evaluation Plan
    - Contamination Control Plan
    - Finishes Plan
    - Design Allowables
    - Material Usage Agreements (MUA)
    - Materials and Processes Identification and Usage List (MIUL)

NASA-STD-5019

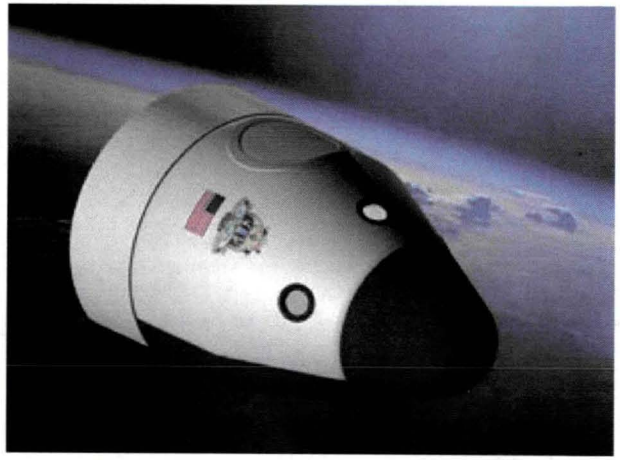
Fracture Control Requirements for Spacecraft

- **CCT-REQ-1130**
  - "Meets the intent" document
  - Also includes NASA-STD-5009 "NDE Requirements for Fracture Critical Metallic Elements"

- **CCT-STD-1140**
  - It is NASA policy that fracture control be imposed on all human-rated space flight hardware to ensure safety by mitigating the risk of catastrophic failure due to the presence of flaws.
  - Consistent with the intent of NASA-STD-5019 it is expect the following will be generated:
    - A Fracture Control Plan (FCP)
    - A Fracture Control Summary Report (FCSR)
  - The FCP will be evaluated to assure that specific fracture control methodology and procedures are in place for the prevention of catastrophic failure associated with propagation of cracks, flaws or damage during fabrication, testing, handling, transportation and operational life.
  - It is expected that the FCSR will provide the following information:
    - Sufficient information to ensure certification that fracture control requirements have been met.
    - Sufficient hardware descriptions including sketches and figures to convey a clear understanding of the hardware elements and their functions.
    - Supporting detailed documentation
    - An accounting of all parts and their disposition for fracture control.
    - For fail safe parts identification of NDE and inspection plans, Material usage agreements (MUAs), discrepancies or deviations from design that affect fracture control and flaw detections and their resolutions,
    - Identification of any flaws that may be accepted on risk by the program authority.

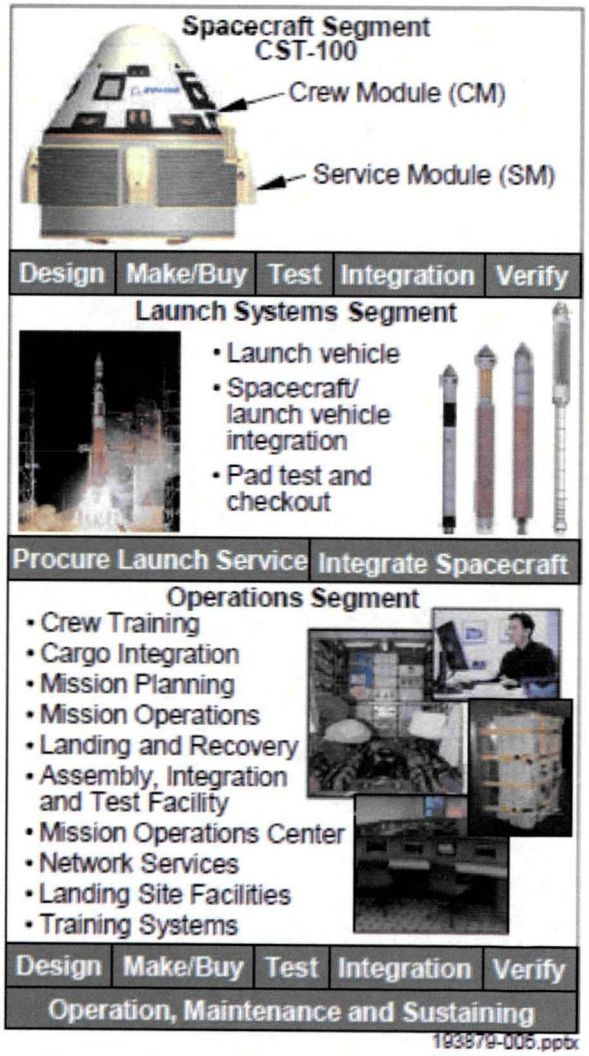
Blue Origin

- Developing a Crew Transportation System comprised of a Space Vehicle (SV) which will be launched first on an Atlas V and then on Blue Origin's own Reusable Booster System (RBS)
- Capable of carrying 7 astronauts and will transfer NASA crew and cargo to and from the ISS, serve as an ISS emergency escape vehicle for up to210 days, and perform a land landing to minimize the costs of recovery and reuse.



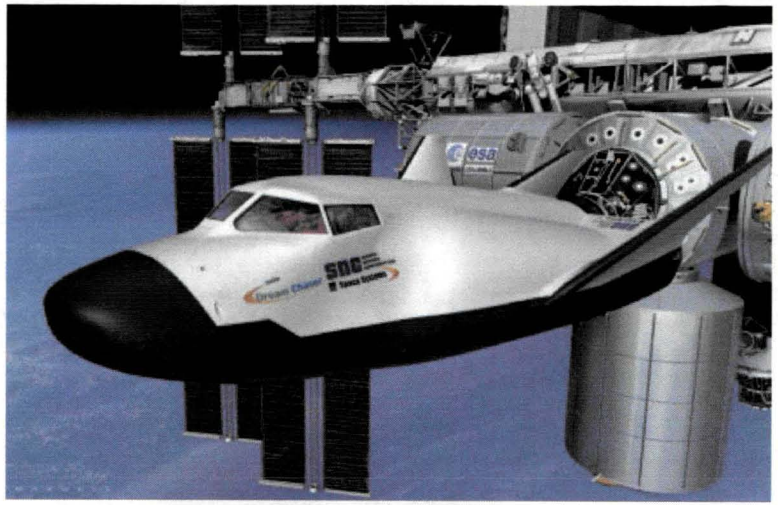
Boeing

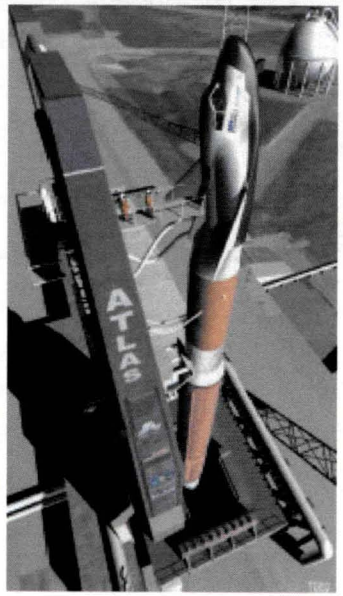
- Developing a “full service” system for both NASA and commercial customers to LEO destinations.
- CST-100 spacecraft is configured to carry up to 7 crew members and/or cargo to LEO destinations including ISS and BA Sundancer space complex
- Compatible with multiple launch vehicles
- Designed for land landings and can be reused for up to 10 missions



Sierra Nevada

- Developing the Dream Chaser Space System (DCSS).
- Provides LEO access to the ISS and commercial customers needing suborbital services
- Third generation design derived from extensive NASA Langley research providing a reusable, pressurized, lifting-body vehicle that lands on a conventional runway.
- Will most likely utilize an Atlas V launch vehicle





SpaceX

- SpaceX's Dragon crew vehicle was the first commercial spacecraft to return from orbit
- Maturation of the Falcon9/Dragon transportation system with a particular focus on developing an integrated Launch Abort System.
- Developing prototypes of the crew cabin, crew seats and restraints, crew control panel and life support system.