Status of Commercial Programs at NASA

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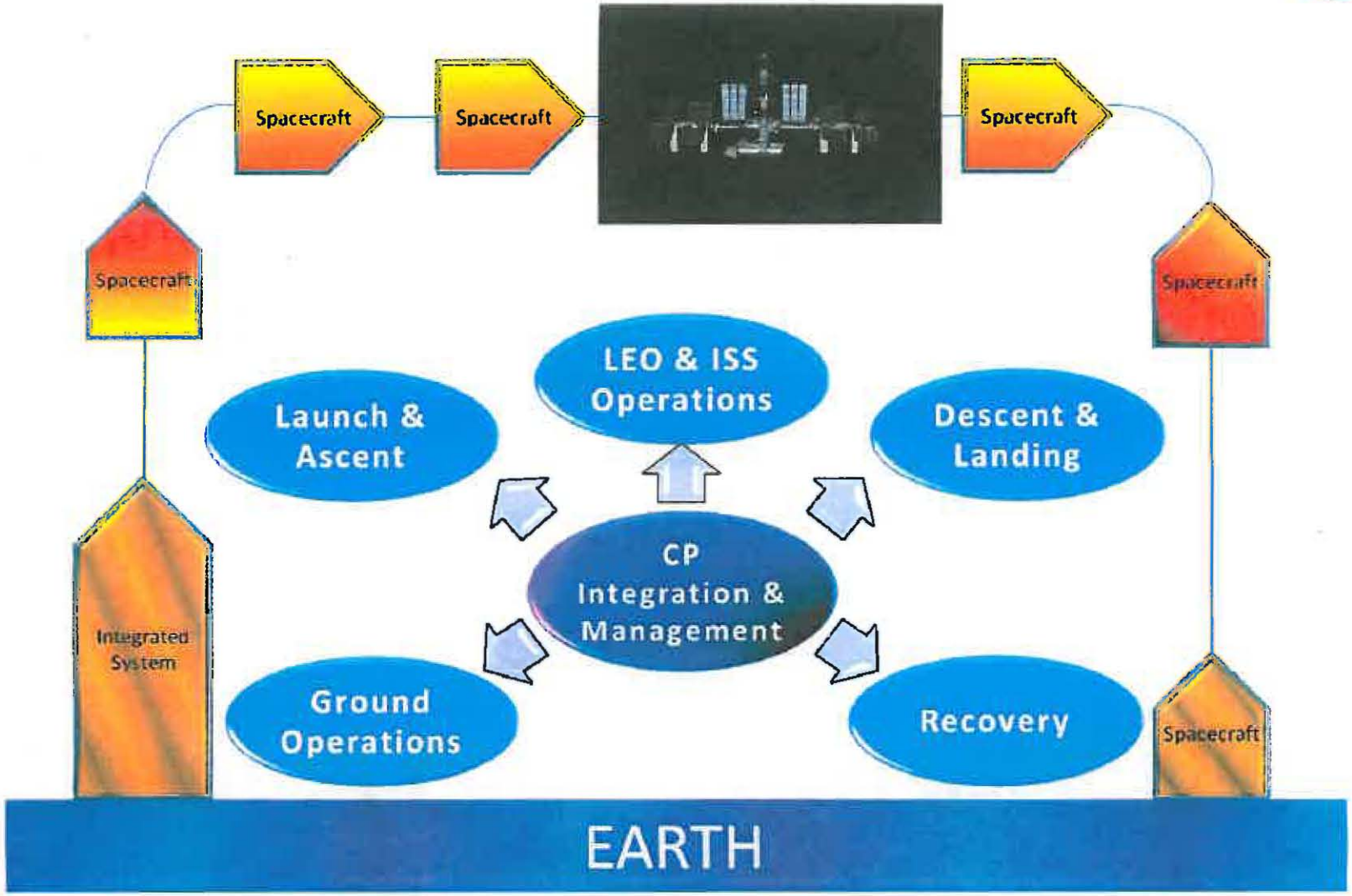
Disclaimer: presenter is not a representative of the NASA Commercial Crew Program

Design Reference Mission



Src: J. Bye, State of the Commercial Crew Program, 2011

Acquisition Strategy

- NASA's strategy is two-fold:
  - Use Space Act Agreements to support the development of commercial crew transportation capabilities.
  - Use FAR-based contracts for the certification of commercially developed capabilities and for the procurement of crew transportation services to and from the ISS to meet NASA requirements.
- Focus on reducing the risk and uncertainties of the development environment and on the incentives provided through competition by separating the design and early development content from the longer-term CTS Certification activities.
- CCP expects to develop, demonstrate, and certify U.S. commercial crew space transportation capabilities that meet ISS crew transportation needs by the end of FY 2017.

Src: NASA CCP Updated Acquisition Strategy, August 2012, http://commercialcrew.nasa.gov

CCiCap

- NASA's newest initiative, the Commercial Crew integrated Capability (CCiCap), facilitates industry's development of an integrated CTS. This activity is expected to result in significant maturation of commercial CTS.
- Facilitating development of this U.S. capability is expected to provide national economic benefit and support safe, reliable, and cost effective transportation to Low-Earth Orbit (LEO).
- NASA solicited proposals from U.S. space industry participants to mature the design and development of an integrated CTS which includes spacecraft, launch vehicle, ground and mission systems.
- Selected CCiCap participants received funded Space Act Agreements (SAAs) under NASA's Other Transactions Authority within the National Aeronautics and Space Act, 51 U.S.C. 20113.

src: http://commercialcrew.nasa.gov

Summary of CCiCAP Portfolio

- Diversity of spacecraft types and launch vehicles
  - Two basic types of Spacecraft
    - Capsules and Lifting Body
  - Two different Launch Vehicles
    - Falcon 9 and Atlas V
- The portfolio of companies maintains competition for future phases of the program which should produce "best value" for the government
- Significant progress planned for the base period with analysis, integrated design, development, and hardware testing
- Total set of milestones provide insight into the cost and schedule required to achieve a crewed demonstration flight to low Earth orbit

Src: CCiCap Announcement Summary Portfolio, August 2012

Sierra Nevada Corporation

- **Descriptions & Features**
  - Dream Chaser spacecraft is a reusable, piloted, lifting body, derived from NASA HL-20 concept
    - Carries up to 7 crew members
    - Utilizes non-toxic propellants
    - Primary Launch Site: Cape Canaveral, Florida
    - Primary Landing Site: Shuttle Landing Facility, Florida
    - Abort scenario leverages primary propulsion system with an ability to abort to a runway landing
  - Atlas V vehicle launched from the Space Launch Complex 41 launch pad

Artist rendition of Dream Chaser in low Earth orbit

Artist rendition of Dream Chaser and Atlas V on launch pad

- **Base Period**
  - $212.5M total NASA funding for 9 milestones
  - Significant progress toward completion of critical design
  - Two major safety reviews and significant subsystem technology maturation and hardware testing

Artist rendition of Dream Chaser landing on a runway

Src: CCiCap Announcement Summary Portfolio, August 2012

Space Exploration Technologies Corporation

- **Descriptions & Features**
  - Spacecraft uses a crewed version of the SpaceX Dragon capsule
    - Carries up to 7 Crew
    - Primary Launch Site: Cape Canaveral, Florida
    - Primary Landing Site: "On land" landing, specific landing site in work
    - Integrated, side-mounted launch abort system utilizing SuperDraco engines
  - Upgraded Falcon 9 vehicle launched from the Space Launch Complex 40 launch pad
  - Mid calendar year 2015 crewed test flight (dependent on funding and technical progress)

Artist rendition of Dragon attached to ISS

- **Base Period**
  - $440M total NASA funding for 14 milestones
  - Culminates in an integrated critical design review milestone
  - Includes a pad abort test and an in-flight abort test

Picture of Falcon 9 rocket on launch pad in Florida

Artist rendition of Dragon re-entering Earth's atmosphere

Src: CCiCap Announcement Summary Portfolio, August 2012

The Boeing Company

- **Descriptions & Features**
  - CST-100 spacecraft is a reusable capsule design utilizing many proven flight components
    - Carries up to 7 people
    - Primary Launch Site: Cape Canaveral, Florida
    - Primary Landing Site: "On Land" landing, specific landing site in work
    - "Pusher" launch abort system
  - Atlas V launch vehicle using the dual engine Centaur upper stage configuration and launched from the Space Launch Complex 41 launch pad
  - Late calendar year 2016 crewed test flight (dependent on funding and technical progress)

- **Base period**
  - $460M total NASA funding for 19 milestones
  - Culminates in an integrated critical design review milestone
  - Significant propulsion system, avionics, and wind tunnel development and testing

Artist rendition of the CST-100 spacecraft

Artist rendition of CST-100 and Atlas V on the launchpad

Successful parachute drop test accomplished during CCDev2

Src: CCiCap Announcement Summary Portfolio, August 2012

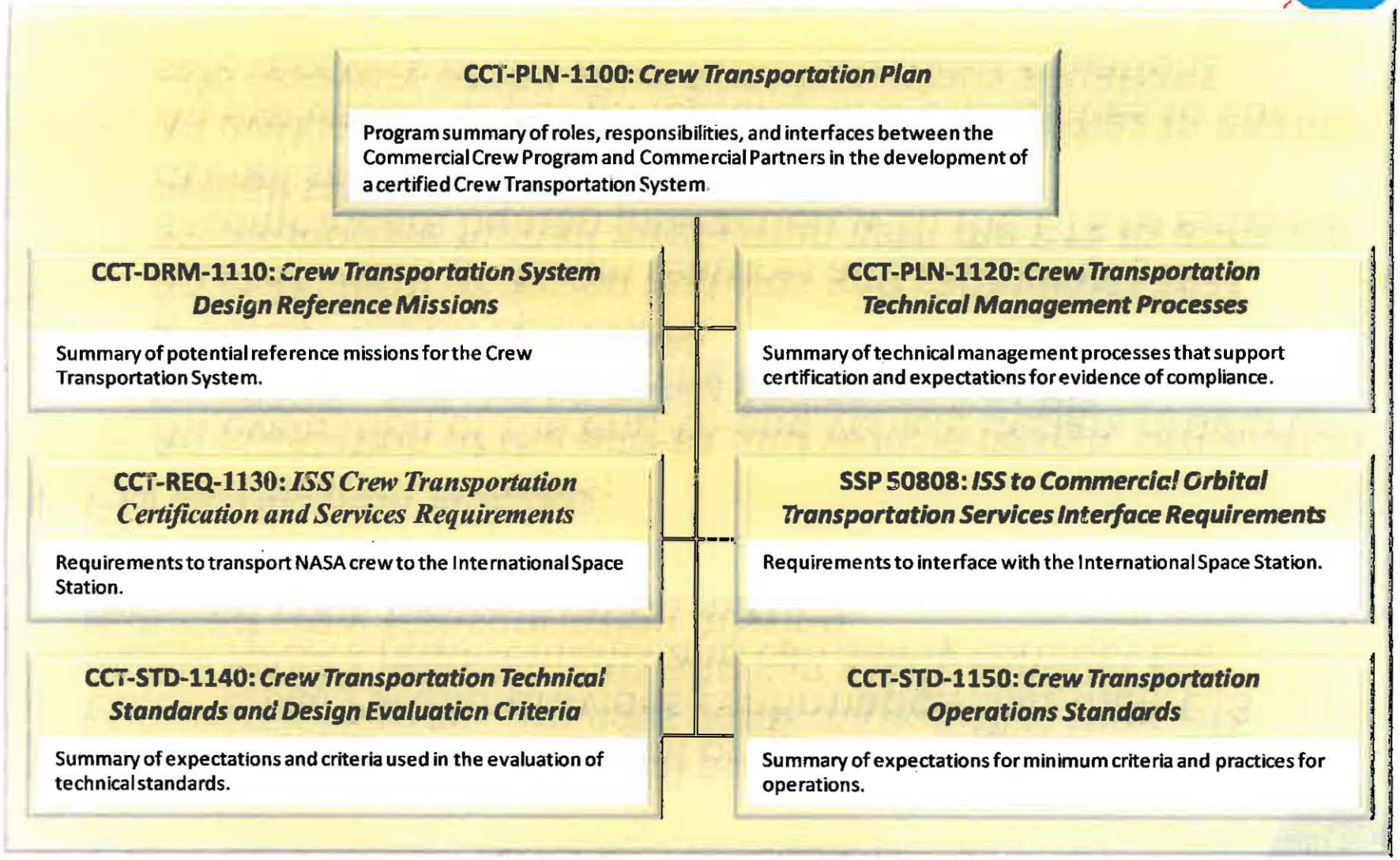
CTS Certification

- CTS certification is the formal process through which the Commercial Partner provides confirmation that their CTS meets NASA's requirements and can safely conduct the required crew transportation mission.

- CTS certification includes:
  - An evaluation of the end-to-end vehicle design, production processes, and the planning and processes for ground/mission operations
  - An evaluation of design features and capabilities that accommodate human interaction with the CTS to enhance overall safety and mission success
  - An evaluation of design features and capabilities to enable safe recovery of the crew from hazardous situations

src: CCP Requirements Workshop, October 2011

Requirements



src: CCP Requirements Workshop, October 2011

Safety Review Process

- Updated the Safety Review Process in CCT-PLN-1120
  - Describes NASA's participation in Commercial Provider processes and the integrated safety review
  - Acknowledges the ISS Safety Review Process
  - Describes approval and update process for hazard analyses
  - Added Crew Survivability Assessment

- An integrated safety review has been established prior to CDR (or similar review) to establish the level of system risk

src: CCP Requirements Workshop, October 2011

Safety Review Process

- Safety analysis employs a suite of systems engineering tools used to characterize and control safety risk throughout the development and operation of a system.
  - Hazard Analysis, FMEA/CIL, Probabilistic Safety Analysis (PSA), and other techniques work together to achieve this understanding and must be deployed early in the system's engineering process to achieve the lowest risk within system constraints
  - Hazard Reports and PSA products communicate safety risk and operational limitations to stakeholders

- The Program is working to develop a plan for the safety approval of hazards to avoid duplication of CCP and ISS review boards.

src: CCP Requirements Workshop, October 2011

Probabilistic Safety Analysis

- The Agency established thresholds for LOC/LOM are specified by the present release of CCT-REQ-1130.
- Paragraph 4.2.1 in CCT-PLN-1120 discusses NASA's expectations for the content and methods used in the PSA.
- Appendix E of CCT-PLN-1120 is offered as guidance for the methodology used to verify that LOC/LOM requirements are satisfied.
  - Commercial Providers are expected to describe their methodology in the Safety Plan and show how the analysis is used within their development process to influence decisions surrounding risk.

src: CCP Requirements Workshop, October 2011