



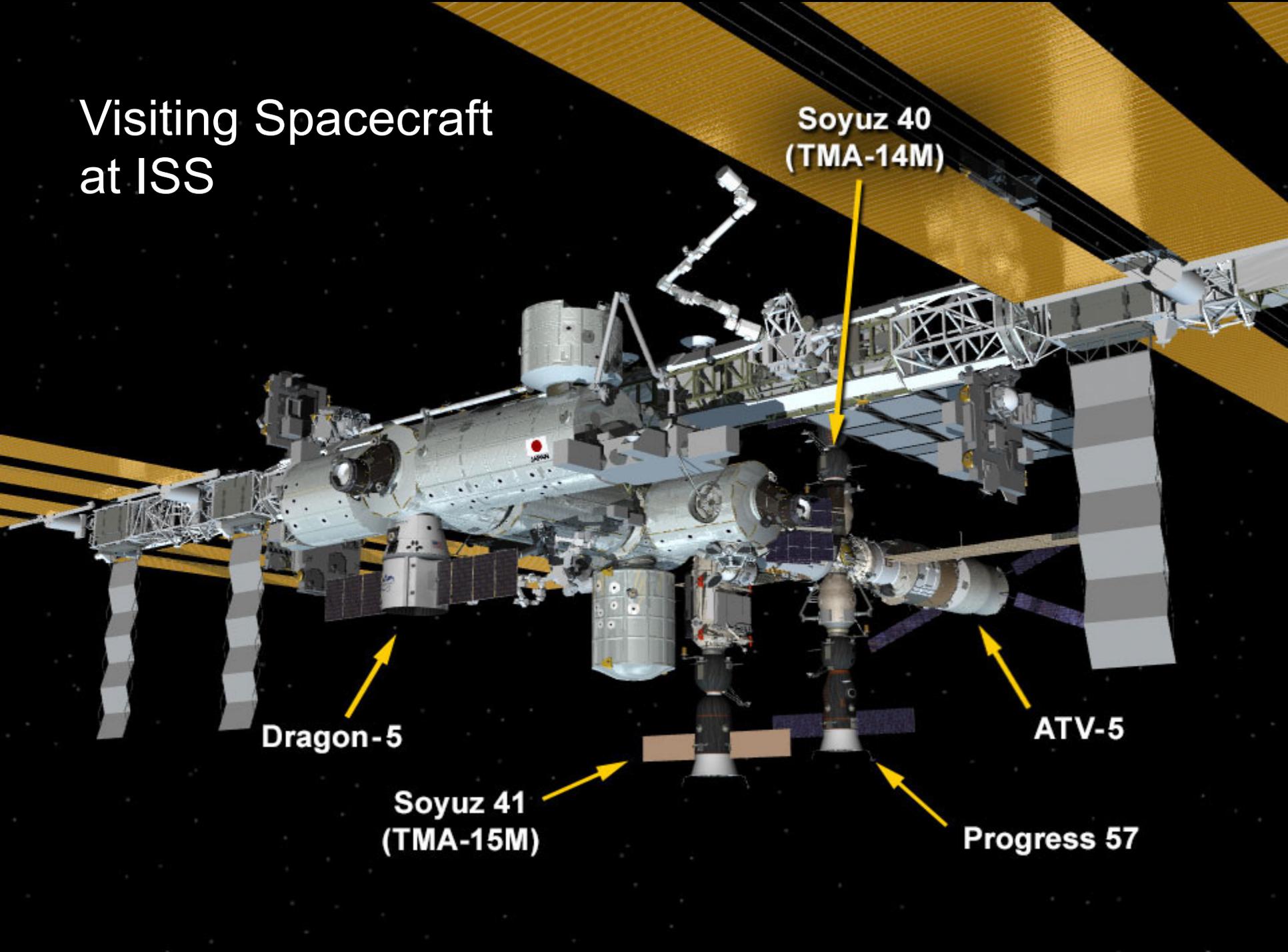
# NASA Advisory Council Human Exploration and Operations

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**January 13, 2015**



# Visiting Spacecraft at ISS



Soyuz 40  
(TMA-14M)

Dragon-5

ATV-5

Soyuz 41  
(TMA-15M)

Progress 57

# CCiCap/CCtCap Milestone Status



## • Boeing (all CCtCap milestones)

- Certification Baseline Review Complete
- Ground Segment Critical Design Review (CDR) Complete
- Phase II Safety Review Dec 2014
- Delta Integrated Critical Design Review Jan 2015



CST-100 water contingency landing scenario testing.

Launch abort engine hot-fire test in California.

## • SpaceX

- Certification Baseline Review (CCtCap) Complete
- Interim Crew Vehicle Delta CDR (CCiCap) Complete
- Pad Abort Test (CCiCap) Jan 2015
- In-Flight Abort Test (CCiCap) Mar 2015



Astronaut fit-check of the Dragon spacecraft.

Dragon test article used for parachute testing.

## • Sierra Nevada Corporation (all CCiCap)

- Main Propulsion & Reaction Control System Testing Complete
- RCS Risk Reduction & Tech Advancement Testing Complete
- RCS Test Incremental Test Complete
- Engineering Test Article flight Under Review



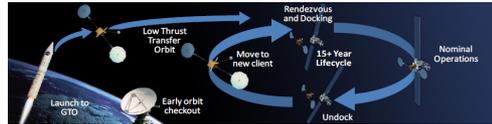
Captive-carry flight of the Dream Chaser engineering test article.

First free-flight of the Dream Chaser.

# Collaborations for Commercial Space Capabilities



- **Objective:** Advance private sector development of space capabilities so that the emerging products or services are commercially available to government and non-government customers within approximately the next five years.
- **Outcome:** No exchange of funds Space Act Agreements awarded to four companies which will give them access to NASA's vast spaceflight resources including technical expertise, assessments, and lessons learned.



- Development of space logistics, hosted payload, and other space transportation capabilities.



- Development of intra-vehicular activity space suits for high altitude and space flight.

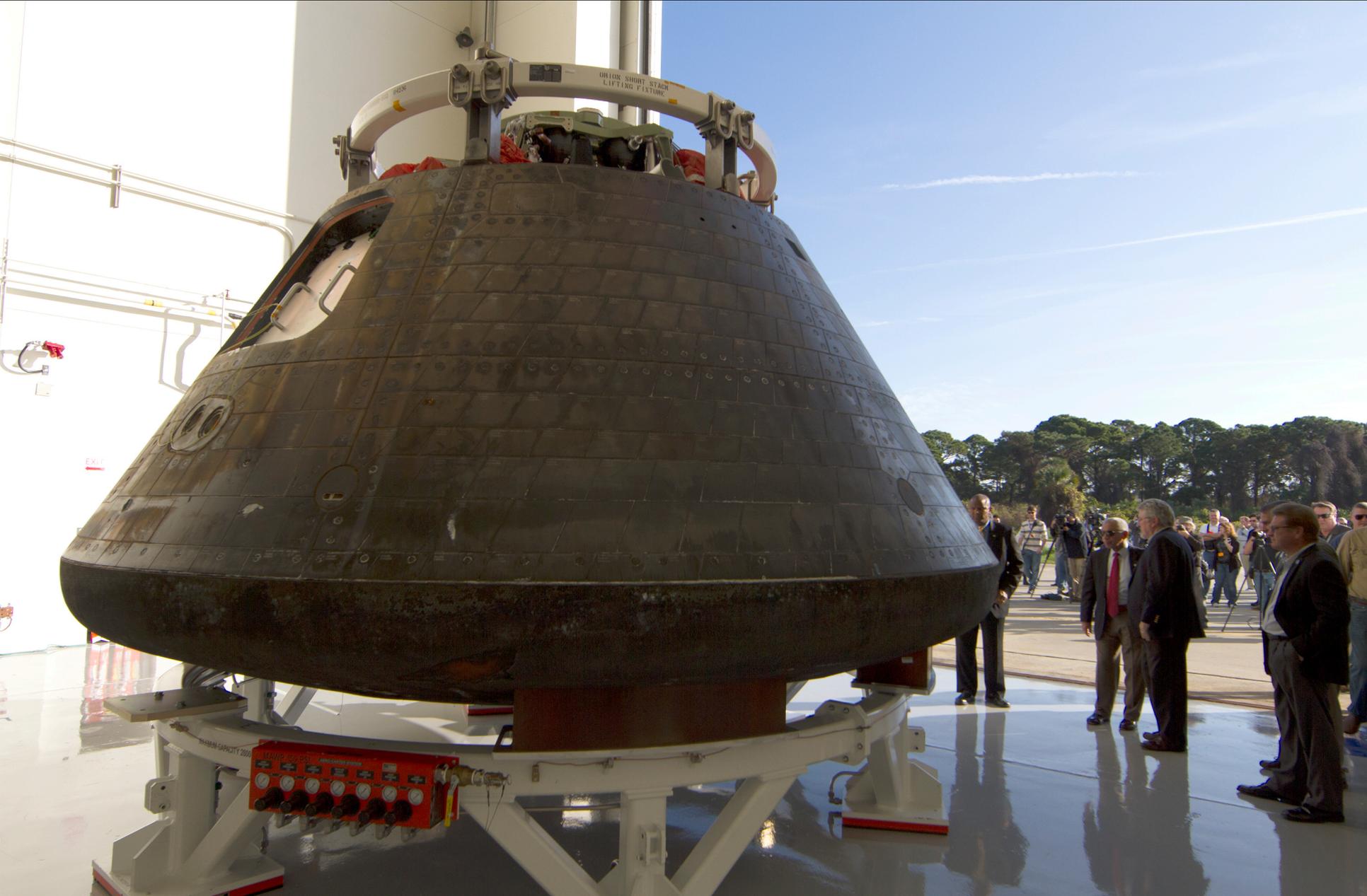


- Development of space transportation capabilities to and from deep space for unmanned and ultimately crew missions.

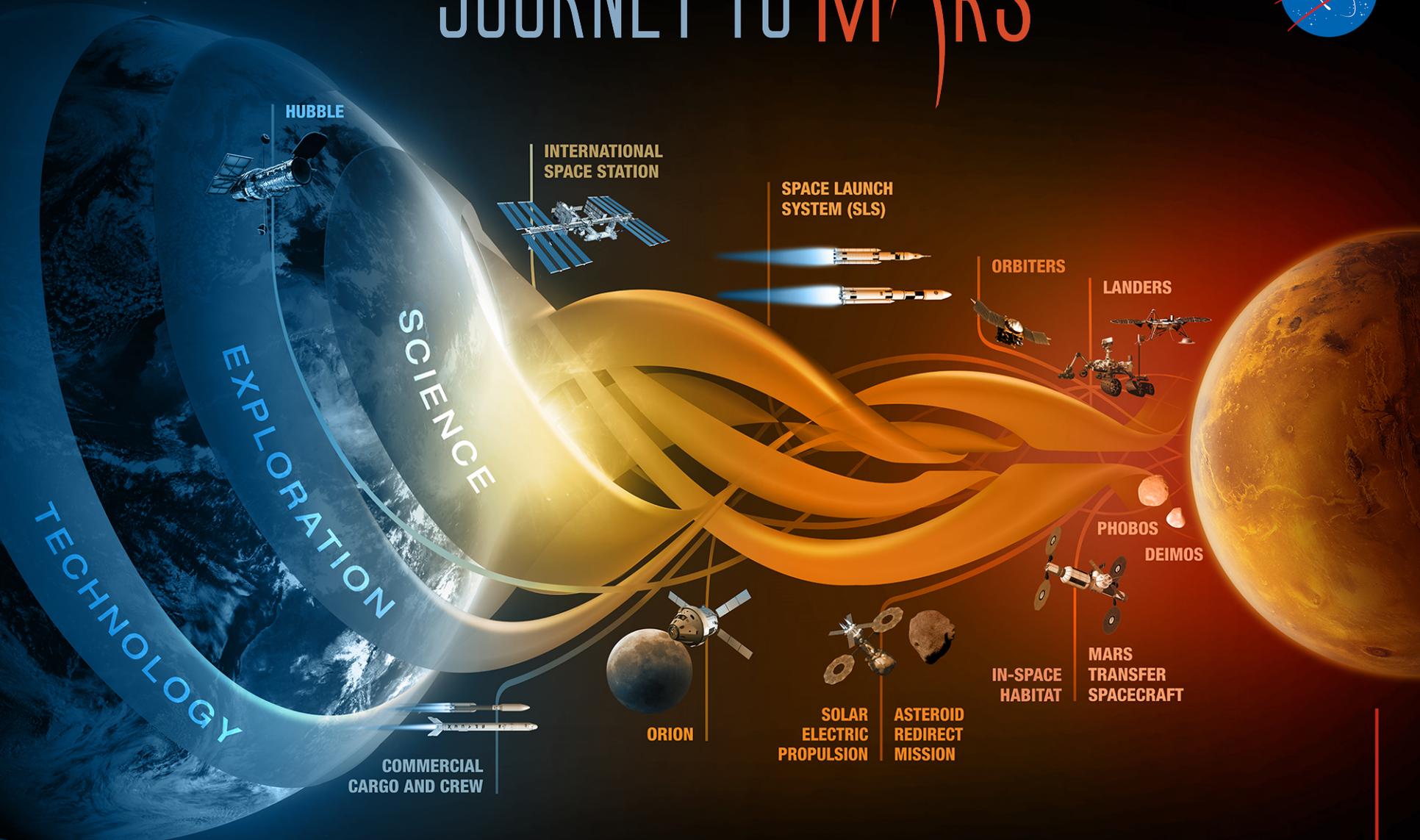


- Development of launch vehicle technologies that enable new capabilities while substantially reducing costs.

# Orion Back Home at KSC



# JOURNEY TO MARS



HUBBLE

INTERNATIONAL SPACE STATION

SPACE LAUNCH SYSTEM (SLS)

ORBITERS

LANDERS

SCIENCE

EXPLORATION

TECHNOLOGY

PHOBOS  
DEIMOS

MARS TRANSFER SPACECRAFT

IN-SPACE HABITAT

SOLAR ELECTRIC PROPULSION

ASTEROID REDIRECT MISSION

ORION

COMMERCIAL CARGO AND CREW

MISSIONS: 6-12 MONTHS  
RETURN: HOURS

EARTH RELIANT

MISSIONS: 1 TO 12 MONTHS  
RETURN: DAYS

PROVING GROUND

MISSIONS: 2 TO 3 YEARS  
RETURN: MONTHS

EARTH INDEPENDENT

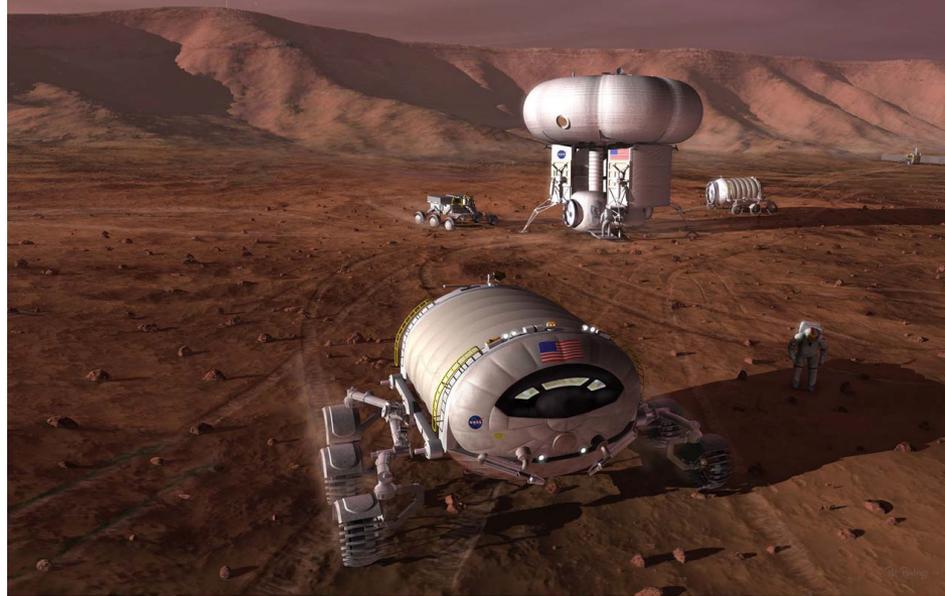
# Point of Departure for Planning Human Mars Missions: Design Reference Mission 5



National Aeronautics and Space Administration



## *Human Exploration of Mars Design Reference Architecture 5.0*



July 2009

NASA-SP-2009-566

# Not ready for another Design Reference Mission



- **Asteroid redirect mission has shown the benefits of:**
  - Solar Electric propulsion to move large masses in space
  - Lunar vicinity as a staging point for Mars and solar system
  - Advantages of a split mission concept cargo goes first and then crew
- **Recent papers are showing large benefit to lunar resources to be used as propellant**
- **Science results show water availability at Mars and possibly moon**
- **Buzz Aldrin cyler study shows potential advantages of modularity and building a sustainable architecture**
- **Recent study of Mars One shows difficulty of sustaining humans on Mars**
- **ISS confirms difficulty in maintaining continuous presence beyond Earth**
  - Life support system fragility
  - Adaptive manufacturing on ISS to build spares shows advantages over sparing
  - High reliability may not be as helpful as thought

**We are not ready for another design reference mission or pathway; we need to better understand the trades and framework---This is the Evolvable Mars Campaign**

# Evolvable Mars Campaign

**EMC Goal: Define a pioneering strategy and operational capabilities that can extend and sustain human presence in the solar system including a human journey to explore the Mars system starting in the mid-2030s.**

- **Identify a plan that:**

- Expands human presence into the solar system to advance exploration, science, innovation, benefits to humanity, and international collaboration.
- Provides different future scenario options for a range of capability needs to be used as guidelines for near term activities and investments
  - In accordance with key strategic principles
  - Takes advantage of capability advancements
  - Leverages new scientific findings
  - Flexible to policy changes
- Identifies linkages to and leverage current investments in ISS, SLS, Orion, ARM, EAM, technology development investments, science activities
- Emphasizes repositioning and reuse/repurposing of systems when it makes sense
  - Use location(s) in cis-lunar space for aggregation and refurbishment of systems

Internal analysis team members:

- ARC, GRC, GSFC, HQ, JPL, JSC, KSC, LaRC and MSFC
- HEOMD, SMD, STMD, OCT, OCS

External inputs from:

- International partners, industry, SKG analysis groups

# We have: Principles for Sustainable Exploration



- Implementable in the ***near-term with the buying power of current budgets*** and in the longer term with budgets commensurate with economic growth;
- ***Exploration enables science and science enables exploration, leveraging robotic expertise for human exploration of the solar system***
- Application of ***high Technology Readiness Level*** (TRL) technologies for near term missions, while focusing sustained investments on ***technologies and capabilities*** to address challenges of future missions;
- ***Near-term mission opportunities*** with a defined cadence of compelling and integrated human and robotic missions providing for an incremental buildup of capabilities for more complex missions over time;
- Opportunities for ***U.S. commercial business*** to further enhance the experience and business base
- ***Multi-use, evolvable*** space infrastructure, minimizing unique major developments;
- Substantial ***international and commercial participation***, leveraging current International Space Station and other partnerships.

# We Need: NAC's Advice and Assistance in Articulating “A Plan for the Plan”



- **Sustainability**

- Is there a level of regular milestones of recognized value within budget levels that can be compelling and makes real progress?
  - Use existing plan (EFT-1, SSME tests, Booster tests, EM-1, and EM-2 as a basis)
  - Can one flight per year after EM-2 be sustainable with active ISS private sector flight rate for ISS as well?
- ISS is critical; how do we demonstrate the criticality?
- How do show we show the role of the private sector in human spaceflight?

- **Agility**

- How can we be responsive to changes in the national and international environment without appearing adrift?
- Avoid stop and start; Lower switching costs; timely decisions

- **Focus**

- How can we better articulate our long term goals?
- How can we better alignment of priorities among MDs, Centers, and across to contractors and partners? How do we achieve stable funding and efficient management of cross-directorate and cross-discipline activity

- **Affordability**

- How do we engage partners (commercial and International) to provide elements of the overall exploration architecture?
- How do we effectively establish and leverage a market for spaceflight?

- **Do not need another goal or design reference mission yet**

# Pioneering Space



***“Fifty years after the creation of NASA, our goal is no longer just a destination to reach. Our goal is the capacity for people to work and learn and operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite. And in fulfilling this task, we will not only extend humanity’s reach in space -- we will strengthen America’s leadership here on Earth.”***

***- President Obama, April 2010***

