National Aeronautics and Space Administration

NASA Advisory Committee

NASA Headquarters (HQ)

Greg Williams
Deputy Associate Administrator
Human Exploration and Operations
NASA Headquarters

July 28, 2015

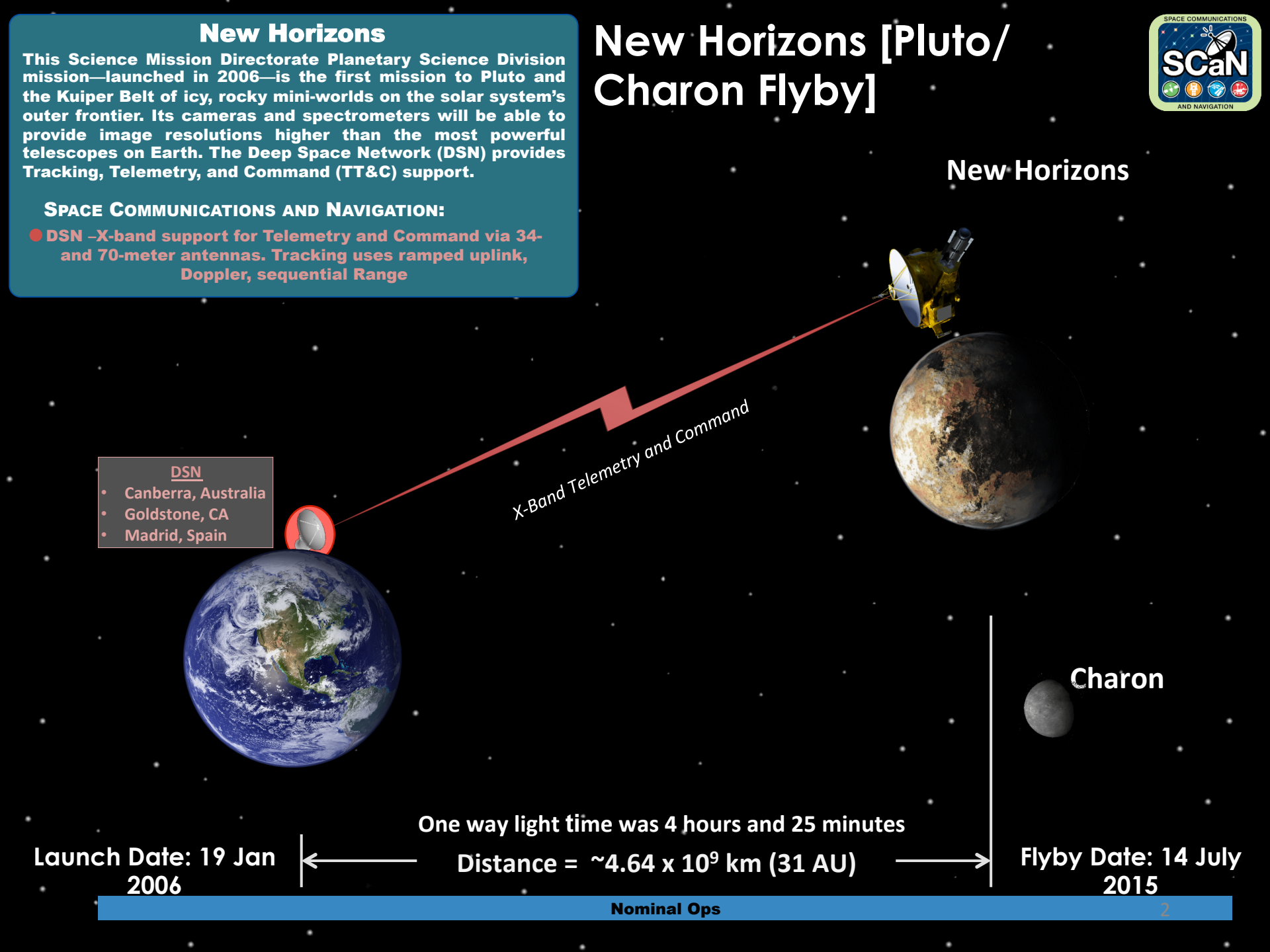
New Horizons [Pluto/ Charon Flyby]

New Horizons

This Science Mission Directorate Planetary Science Division mission—launched in 2006—is the first mission to Pluto and the Kuiper Belt of icy, rocky mini-worlds on the solar system's outer frontier. Its cameras and spectrometers will be able to provide image resolutions higher than the most powerful telescopes on Earth. The Deep Space Network (DSN) provides Tracking, Telemetry, and Command (TT&C) support.

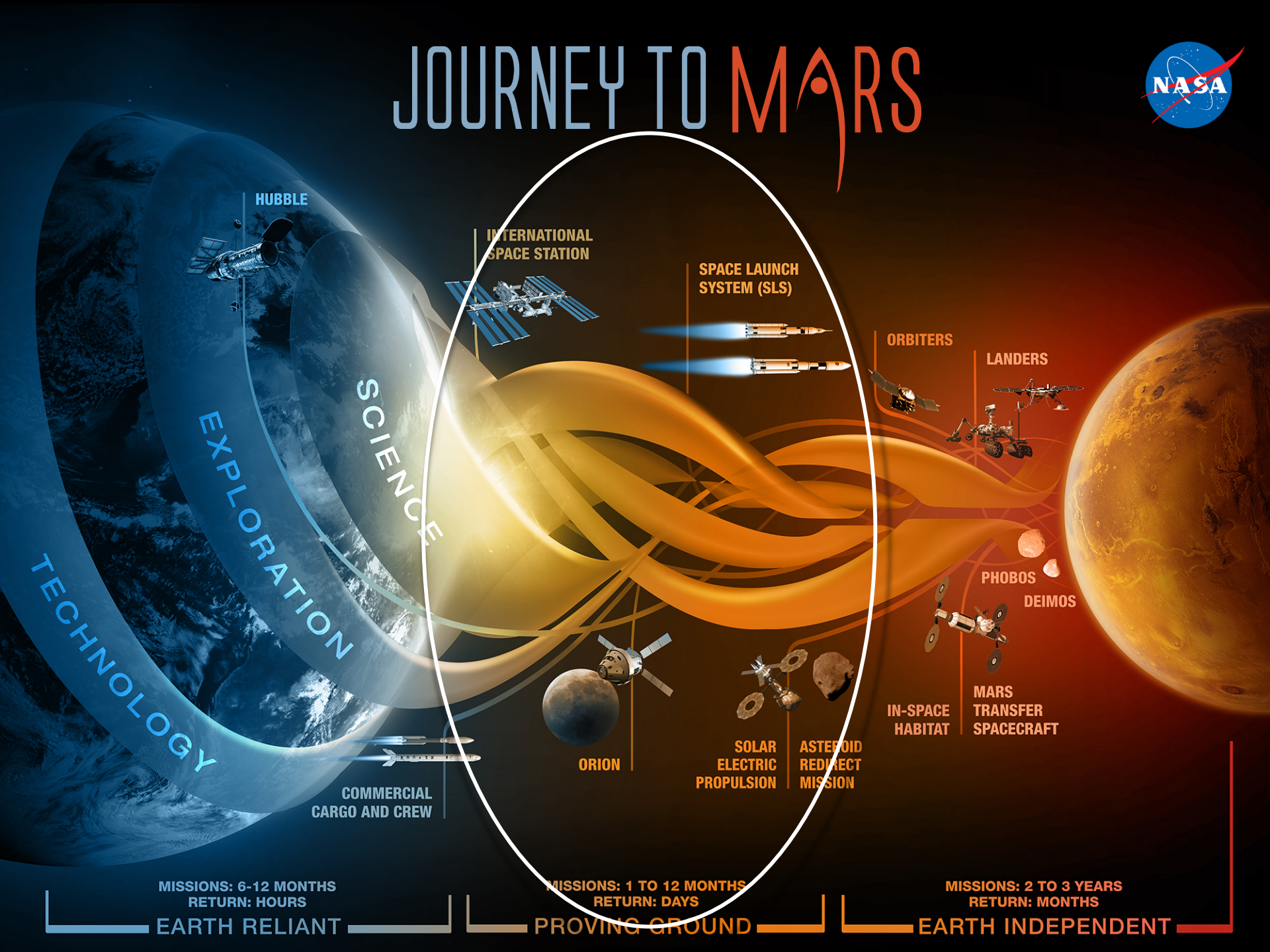
Space Communications and Navigation:

- **DSN –X-band support for Telemetry and Command via 34- and 70-meter antennas. Tracking uses ramped uplink, Doppler, sequential Range**



From Mountains to Moons: Multiple Discoveries from NASA's New Horizons Pluto Mission

JOURNEY TO MARS



43 Soyuz Launch/Increment 44
July – December 2015

Vehicle: 43 Soyuz

Launch: July 22, 2015 (planned 4 orbit rendezvous)

Docking: July 23, 2015

Undock/Landing: December 22, 2015

42 Soyuz crew

Genady Padalka, Soyuz and Increment 44 Commander
Scott Kelly, Increment 45/46 Commander
Mikhail Kornienko, Flight Engineer

43 Soyuz Crew

Oleg Kononenko , Soyuz Commander
Kjell Lindgren, Flight Engineer
Kimiya Yui, (JAXA) Flight Engineer

CCP Overview

- **The Commercial Crew Program (CCP) is an essential element of the the broader strategy to achieve our nation's goals in space.**
- **CCP will re-establish the capability to launch astronauts from US soil.**
- **CCP will increase the ISS crew time available for research by an amount equivalent to one additional astronaut dedicated to research.**
  - This is critical to accomplishing the human research required for deep space exploration during the lifetime of ISS
- **Commercial transportation is vital to expanding the commercial market for low Earth orbit services, enabling NASA and its international and commercial partners to extend human presence into the solar system and to the surface of Mars.**

CCP Status

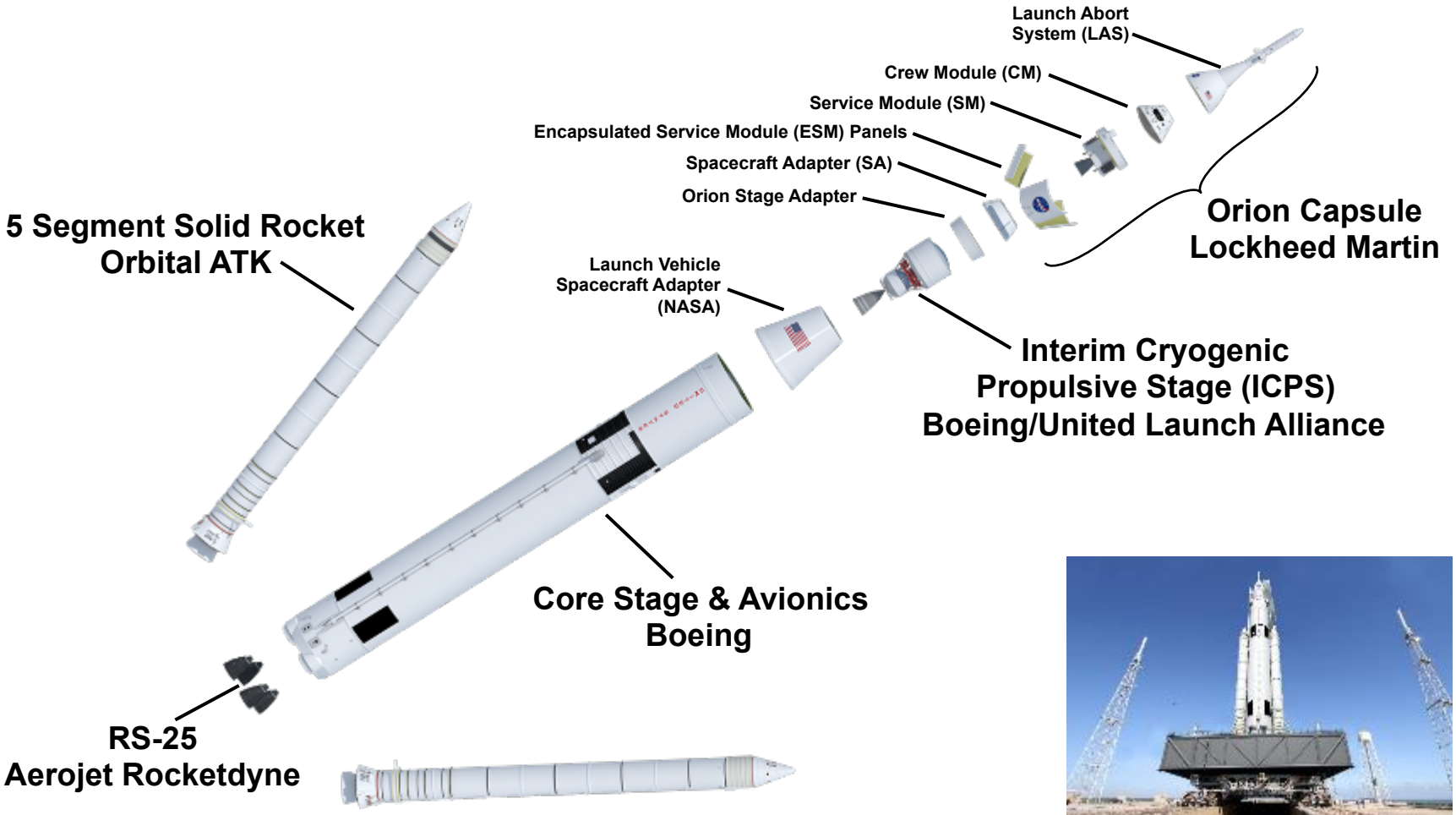
- **CCP remains committed to supporting our Space Act Agreement partners as they advance their concepts**
- **Both Boeing and SpaceX are advancing their CCtCap designs**
- **Hardware is actively being built and tested to inform design**
- **CCP is engaged in meaningful insight with the providers**
- **Important design challenges remain for both providers**
- **CCP is preparing for the flight phases of the program**

SpaceX: Pad Abort Test Static Test Firing

Boeing: Test 1 Water Landing and Rotation to Stable 2

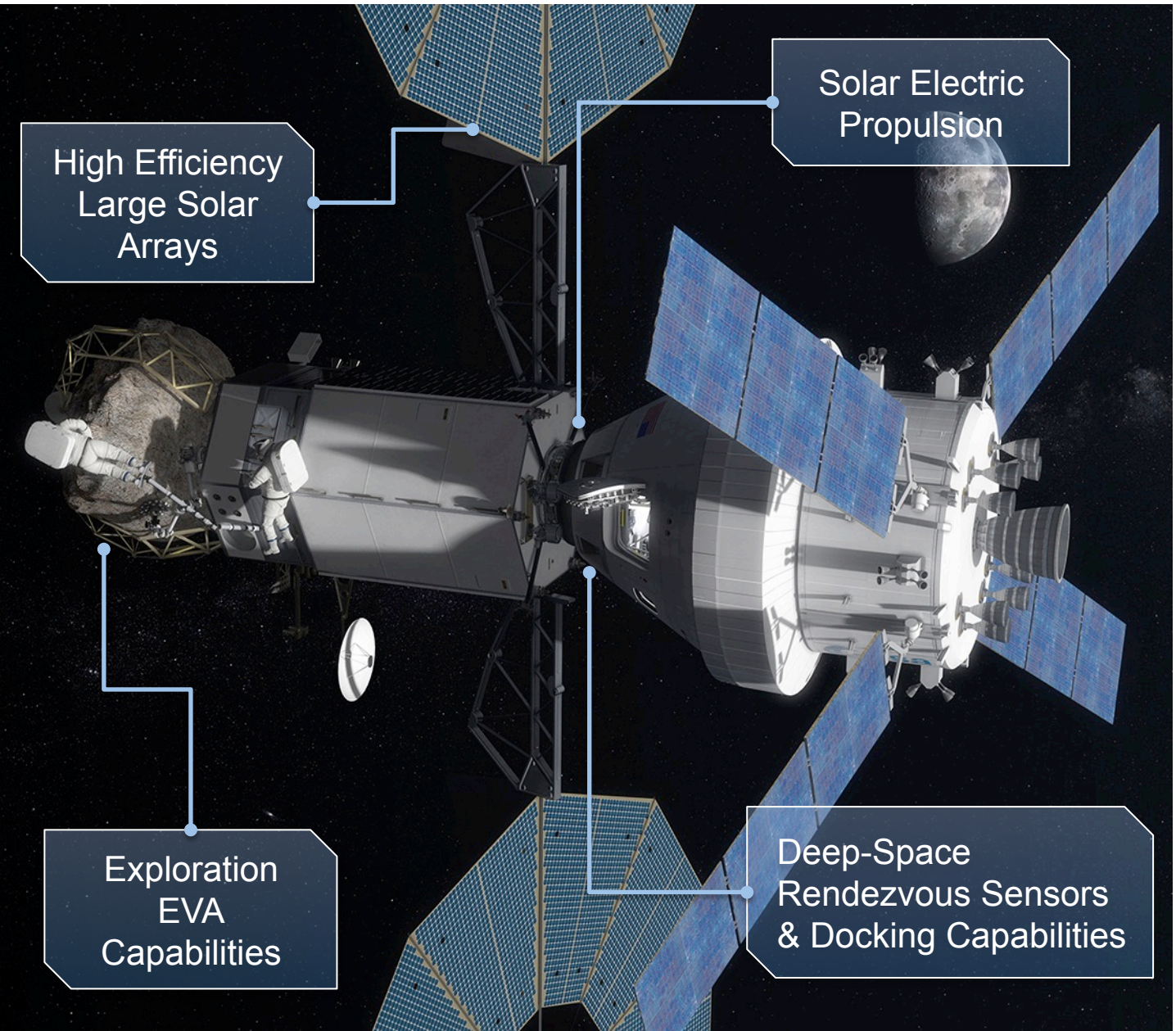
CCP is now at the point where all the preliminary work through the previous phases of the program is all paying off, and our two partners are off and running with effective NASA insight/oversight. We need to keep up the momentum with adequate funding to achieve safe, reliable, and cost effective commercial crew transportation services.

Exploration Systems Development



Ground Systems
Vencore Systems and Solutions
Jacobs Engineering Group
Hensel Phelps

ARM: A Capability Demonstration Mission



IN-SPACE POWER & PROPULSION:

- High efficiency 40kW SEP extensible to Mars cargo missions
- Power enhancements feed forward to deep-space habitats and transit vehicles

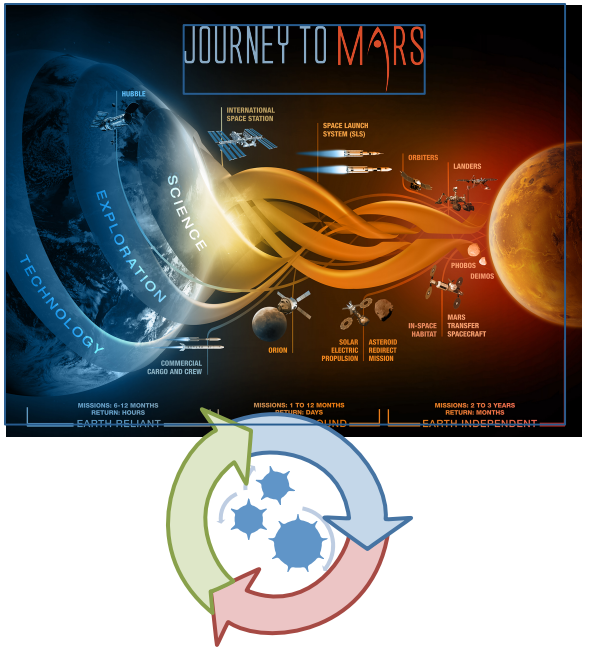
EXTRAVEHICULAR ACTIVITIES:

- Primary Life Support System design accommodates Mars
- Sample collection and containment techniques
- Follow-on missions in DRO can provide more capable exploration suit and tools

TRANSPORTATION & OPERATIONS:

- Capture and control of non-cooperative objects
- Rendezvous sensors and docking systems for deep space
- Cis-lunar operations are proving ground for deep space operations, trajectory, and navigation

Study Refinement Process



Body of Previous Architectures, Emerging Studies and New Discoveries

- Internal NASA and other Government
- (nternational Partners
- Commercial and Industrial
- Academic
- Technology developments
- Science discoveries

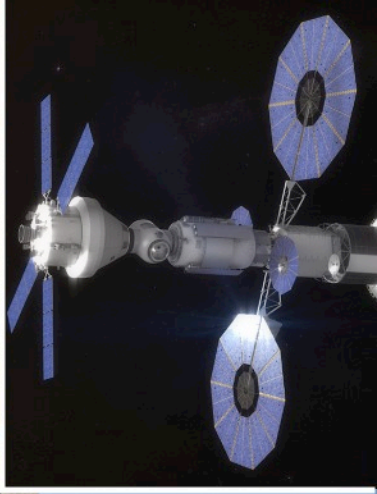
Evolvable Mars Campaign

- An ongoing series of architectural trade analyses that we are currently executing to define the capabilities and elements needed for a sustainable human presence on Mars
- Builds off of previous studies and ongoing assessments
- Provides clear linkage of current investments (SLS, Orion, etc.) to future capability needs

Comparison of Recent Mars Study Philosophies

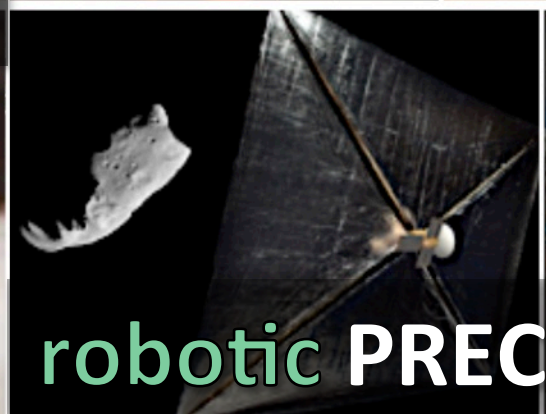
DRA 5.0: Global science driven approach for the human exploration of Mars. Emphasis placed on mission return with reasonable risk.	**EMC: An ongoing series architectural trade analyses that we are currently executing to define the capabilities and elements needed for a sustainable human presence on Mars.**
• A reference architecture (circa 2009)	• A series of on-going studies which provide strong linkage between possible future with current investments (SLS, Orion)
• Science driven, all expendable architecture	• balanced approach with emphasis on the "ilities" - affordability, sustainability, and reusability
• Assumed full lunar and test program prior to Mars missions	• CisA lunar Proving Ground and dedicated pathfinder missions to reduce risk and develop capabilities
• Simultaneous crew and cargo missions drives high launch rate and cost profile	• Cadence of missions spread by assuming pre-emplacement to reduce to manageable flight rate and buget profile
• Aggressive and simultaneous technology investment portfolio	• Progressive technology advancement and demonstration
• Emphasis on minimizing crew and systems exposure to deep-space environment	• Long-duration exposure to deep space considered manageable. Radiation Assessment Detector data returns indicate radiation levels in transit, and on the surface less than previously thought.
• Pre-deployment of landers and surface systems	• Pre-deployment of landers, surface systems, and return stages
• Vehicle assembly and departure from LEO	• Vehicle assembly and departure from cisA lunar space provides lunar opportuni ies for commercial and interna ional
• Orion (6 crew) to Mars and back	• Orion (4 crew) in cis-lunar space only
• Ares V (~130 t) with a peak of 6/year flight rate	• SLS (~130 t) with a peak of 3/year flight rate
• Zero Boil-off Nuclear Thermal Propulsion	• Solar Electric/Chemical
• Mars ascent via ISRU (O_2)	• Mars ascent via ISRU (O_2) with ongoing analysis for additional opportunities

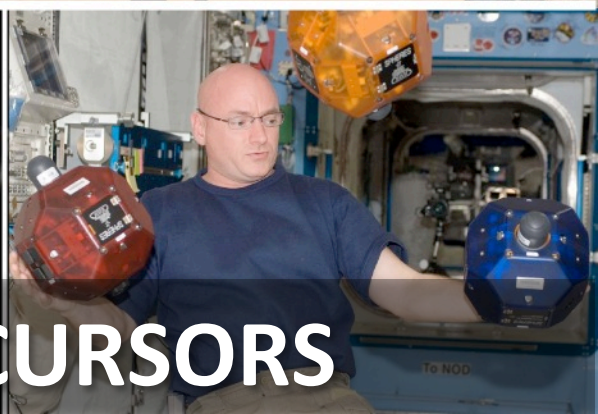
DEEP SPACE habitation



CREW mobility

VEHICLE Systems





robotic PRECURSORS

Successful Launch of the SMAP and MMS

2015 Activity

Advisory Role

EFT-1
Launched Dec 2014

SMAP
Launched Jan 2015

Advisory Role

DSCOVR
Launched Feb 2015

MMS
Launched
Mar 2015

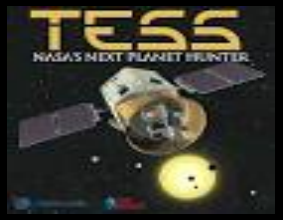
Jason-3
TBD

Fleet Support

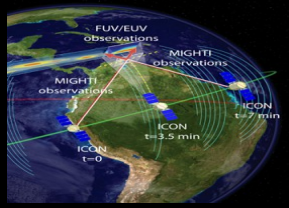
- Advanced Mission Planning
- Certification of vehicles
- Programmatic Studies
- Strategic Investments

Acquisitions

Awarded:



TESS
Aug 2017
Falcon 9

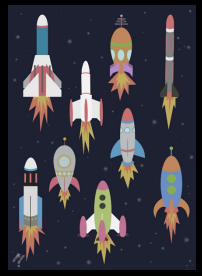


ICON
June 2017
Pegasus

Solar Probe Plus
Jul 2018
Delta IV

In Work:

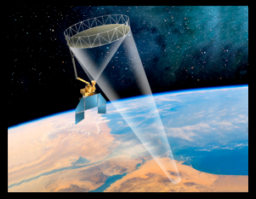
TDRS-M
TBD 2017



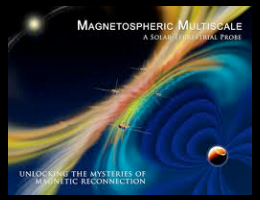
Venture Class
TBD 2018

2015-2016 Launch Schedule

2015



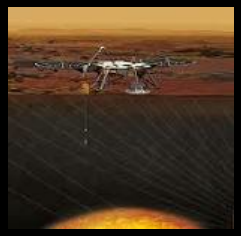
SMAP
Soil Moisture Active Passive
Successfully Launched!
January 31, 2015



MMS
Magnetospheric MultiScale
Successfully Launched!
March 12, 2015

Jason-3
TBD

2016



INSIGHT
Interior Exploration using Seismic Investigations, Geodesy and Heat Transport
March 2016!

GOES-R – Geostationary Operational Environmental Satellite
March 2016!

OSIRIS-Rex - Origins Spectral Interpretation Resource Identification Security Regolith Explorer
September 2016!

CYGNSS - Cyclone Global Navigation Satellite System
October 2016

JPSS-1 – Joint Polar Satellite System
November 2016!

NASA Communications Priorities

Earth Right Now.
Your planet is changing.
We're on it.
#EarthRightNow

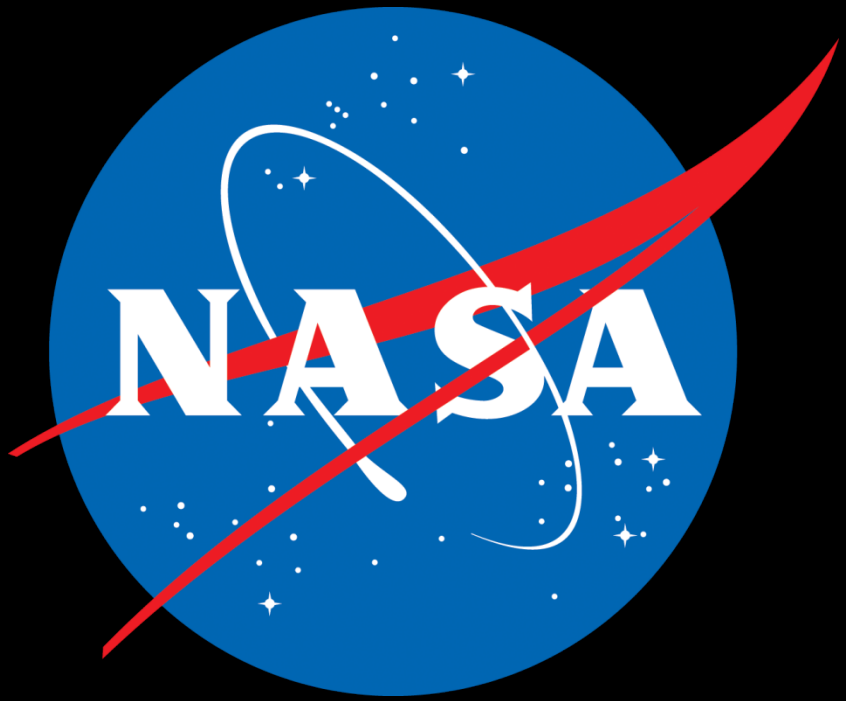
Technology.
Technology drives exploration.
#321TechOff

ISS.
Off the Earth, for the Earth.
#ISS

Aeronautics.
NASA is with you when you fly.
#FlyNASA

Mars.
Join us on the journey.
#JourneytoMars

Solar System and Beyond.
NASA: We're Out There.
#NASABeyond


NASA