

**Welcome to JSC**



# What's Going On Now At NASA?



# Human Spaceflight....



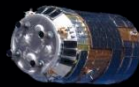
## Expedition 47



## Expedition 48



JAXA HTV



SpaceX  
Dragon

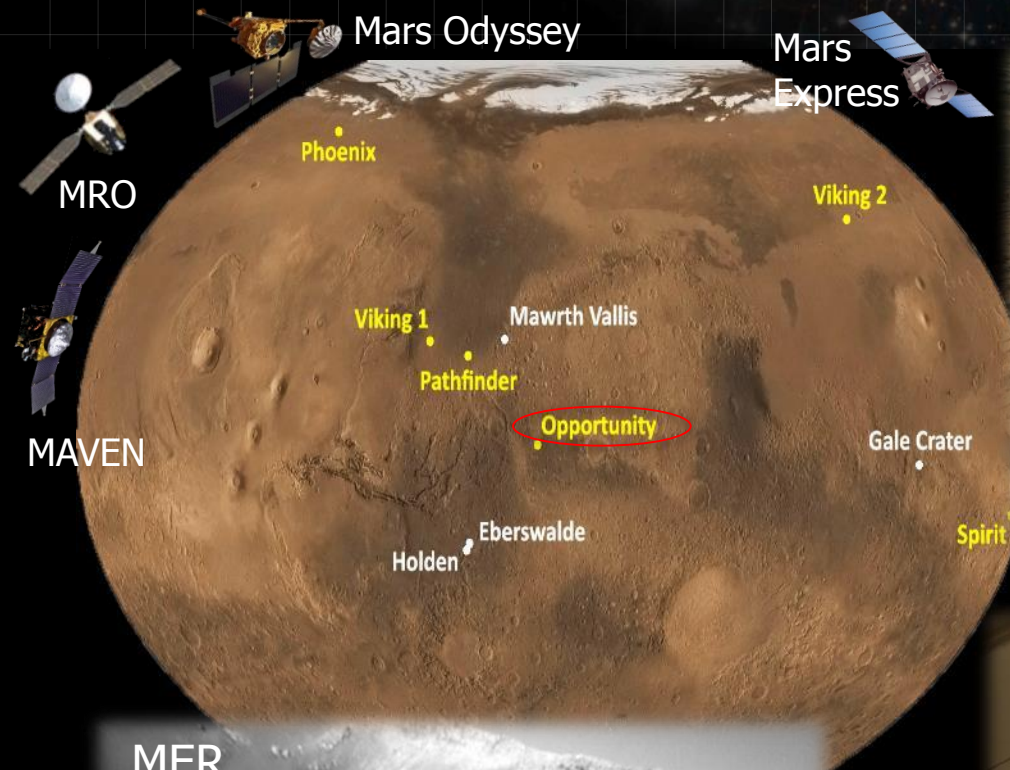


Orbital Sciences  
ATK Cygnus





# Planetary Missions, Mars is busy!...



MSL- Mars Science Laboratory  
"Curiosity"



MSL Selfie

MER  
Mars Exploration  
Rover—  
"Opportunity"



MSL Wear and Tear

# Many, many other cool missions...



Just a few to mention...



Cassini

Saturn orbit, last year of operation

Juno  
Arriving at Jupiter July 2016

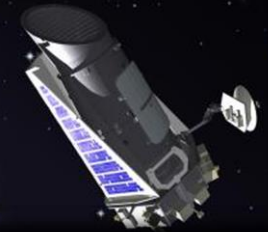


Hubble

Still researching origins of the universe



Kepler  
Planet Count  
Confirmed Planets: 977  
Planet Candidates: 4,234

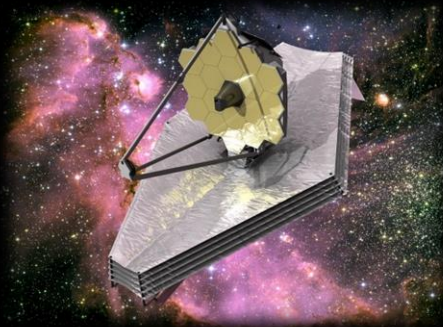


Voyager 1  
Has left the building...  
Traveling interstellar space



James Webb Telescope

Launch in 2018



Eyes on the Solar System

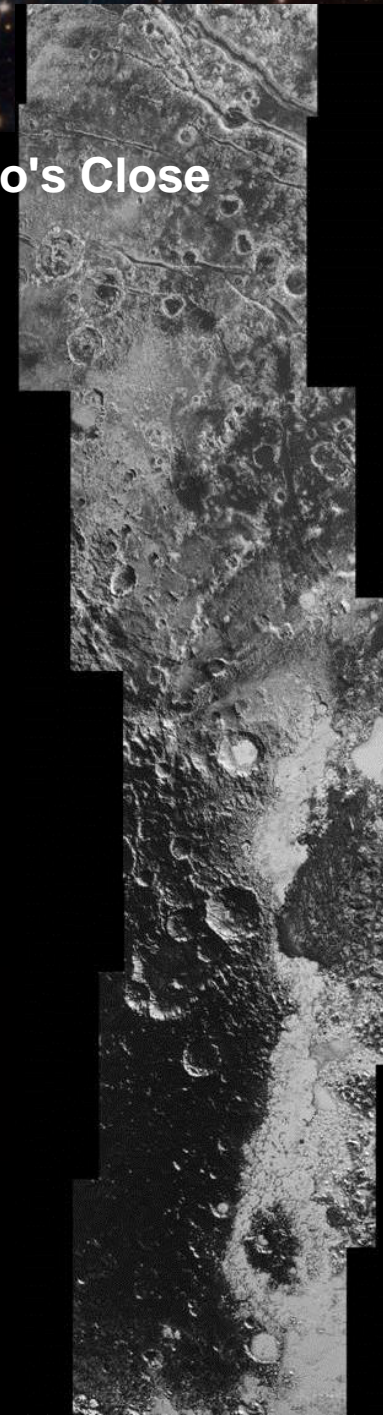
<http://eyes.nasa.gov/>



# New Horizons @ Pluto!

- New from NASA's New Horizons: Increasing Variety on Pluto's Close Approach Hemisphere, and a 'Dark Pole' on Charon

NASA's New Horizons spacecraft passed Pluto in July 2015

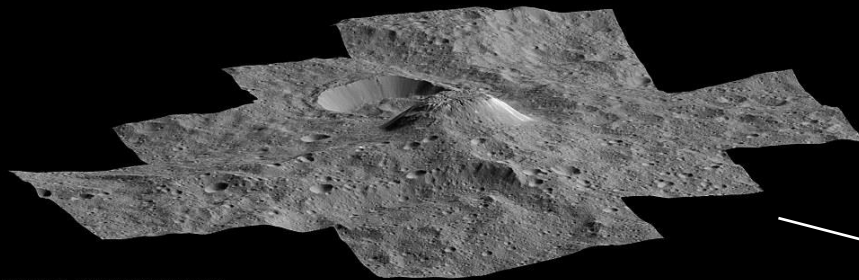
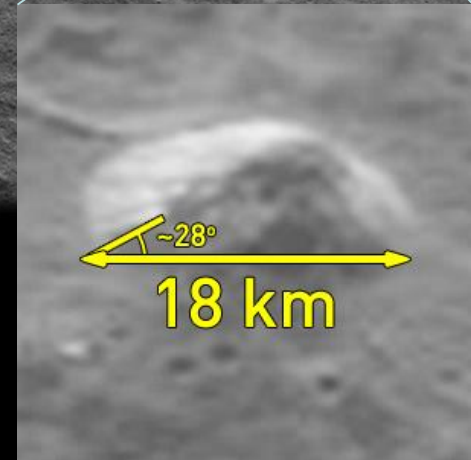
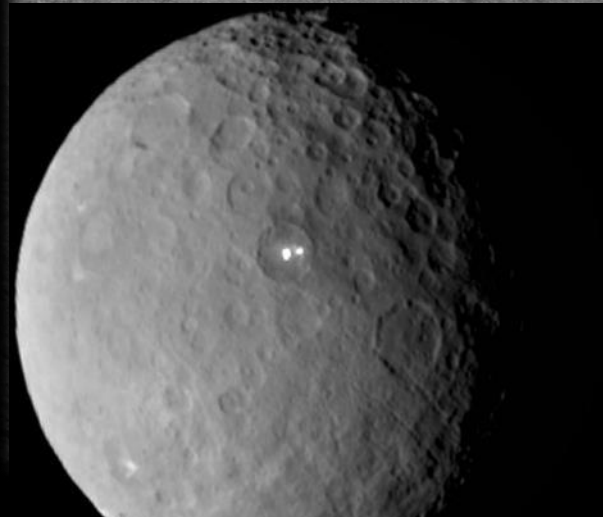
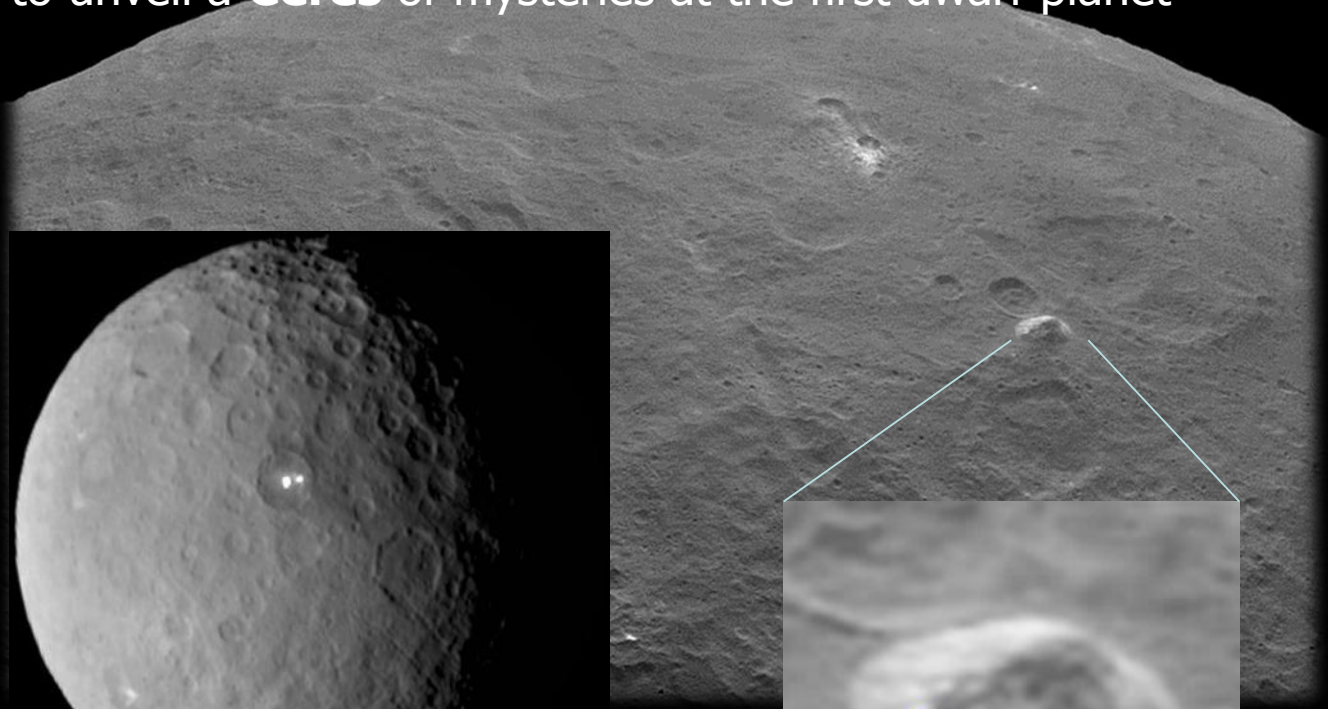


# Dawn Spacecraft @ Ceres



**Dawn** is continuing to unveil a **Ceres** of mysteries at the first dwarf planet discovered

**Dawn** spacecraft has continues to investigate bright spots on the surface of Ceres

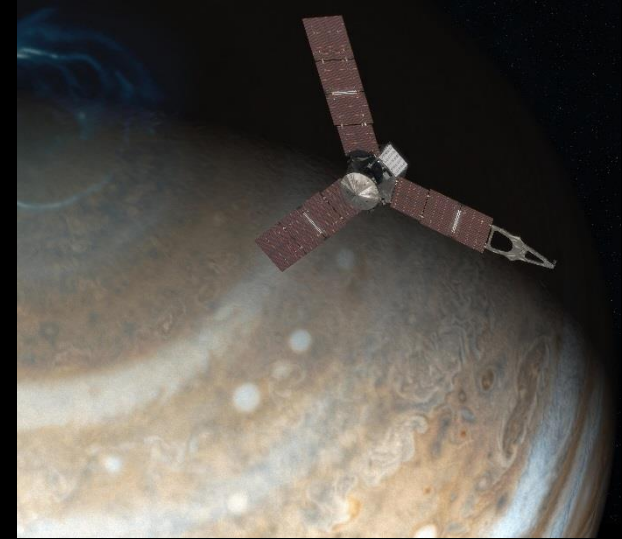


A pyramid-like peak jutting out of the frigid world's surface was discovered in 2015

# Juno – Jupiter rendezvous



- Juno is a NASA New Frontiers mission currently en route to the planet Jupiter
  - Planned arrival July 4<sup>th</sup> 2016
- The spacecraft is to be placed in a polar orbit to study Jupiter's composition, gravity field, magnetic field, and polar magnetosphere
- Juno will also search for clues about how the planet formed, including whether it has a rocky core, the amount of water present within the deep atmosphere, how its mass is distributed, and its deep winds (~400 mph)







# Human Exploration

# EFT-1 = Exploration Flight Test -1 Complete!



- 1<sup>st</sup> mission (unmanned) for Orion (MPCV)
- Tested heat shield at high entry velocity
- Used Delta IV Heavy rocket



# 2014

## EXPLORATION FLIGHT TEST 1

### 20,000 MPH Re-entry



## EXPLORATION FLIGHT TEST ONE

TWO ORBITS + 20,000 MPH ENTRY + 3,671 MILE APOGEE + 28.6 DEGREE INCLINATION





# MPCV – Multi-Purpose Crew Vehicle “Orion”



- Second test flight in 2018 (SLS)
- First Manned Mission 2021 (SLS)





# NASA Heavy Lift Vehicle - SLS

- SLS – Space Launch System
  - Estimated 80-120 metric tons capacity
  - First launch planned for 2017
- 5 Segment Solid rocket test this week



Cargo and Crew Vehicle





# Commercial Crew for LEO (Low Earth Orbit)



## 2 Companies

1. SpaceX Dragon 2
2. Boeing Starliner



Boeing CST-100 Starliner

SpaceX Dragon Capsule

Atlas V



Dragon Interior

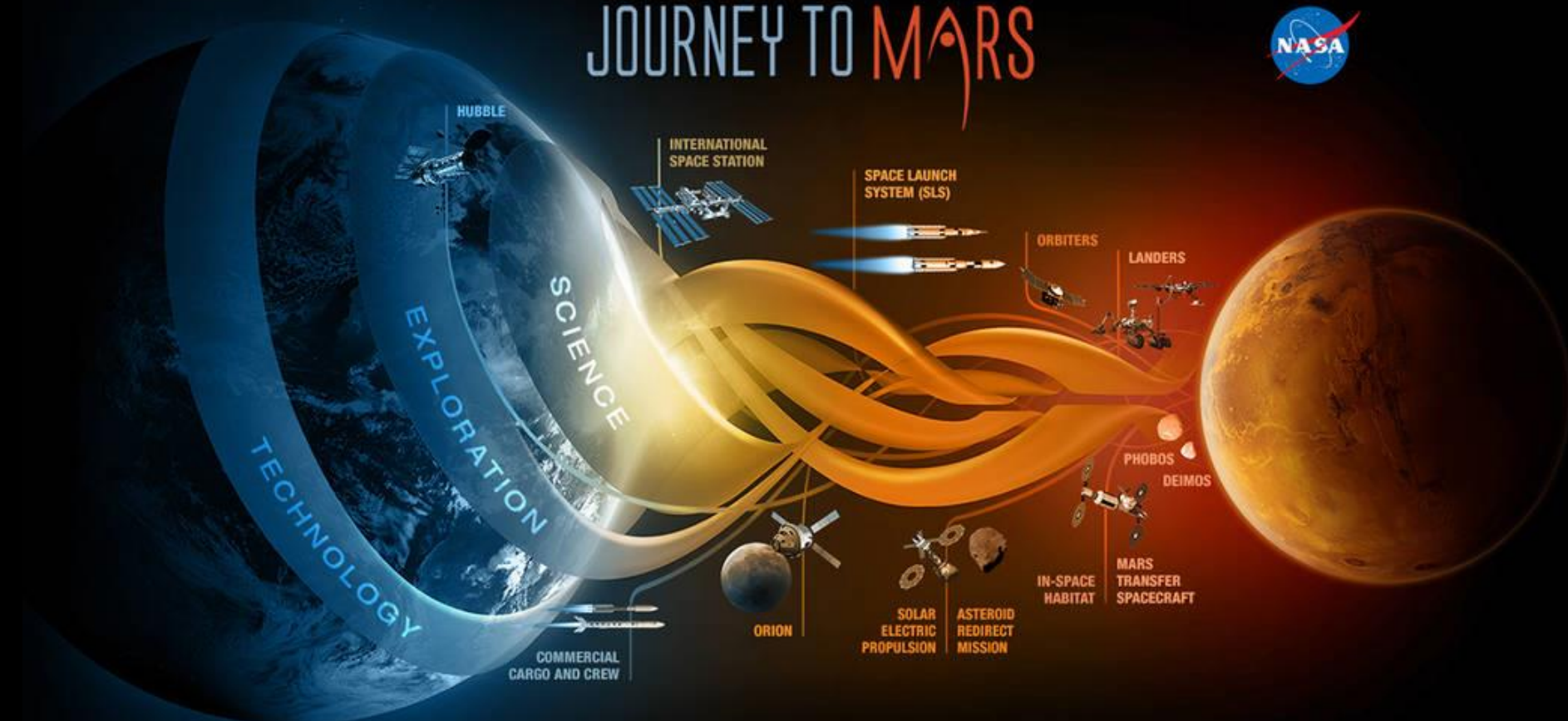


Falcon 9 Rocket

# NASA Journey to Mars



## JOURNEY TO MARS





# So, What is the Exploration plan?



- Develop strong commercial LEO presence
- Build the exploration vehicles for deep space missions
- Develop the technologies to support these deep space exploration
- Define the path to Mars

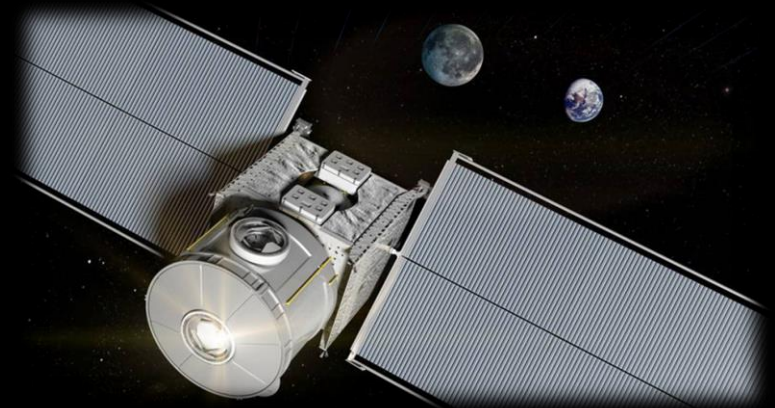


Orion



SLS

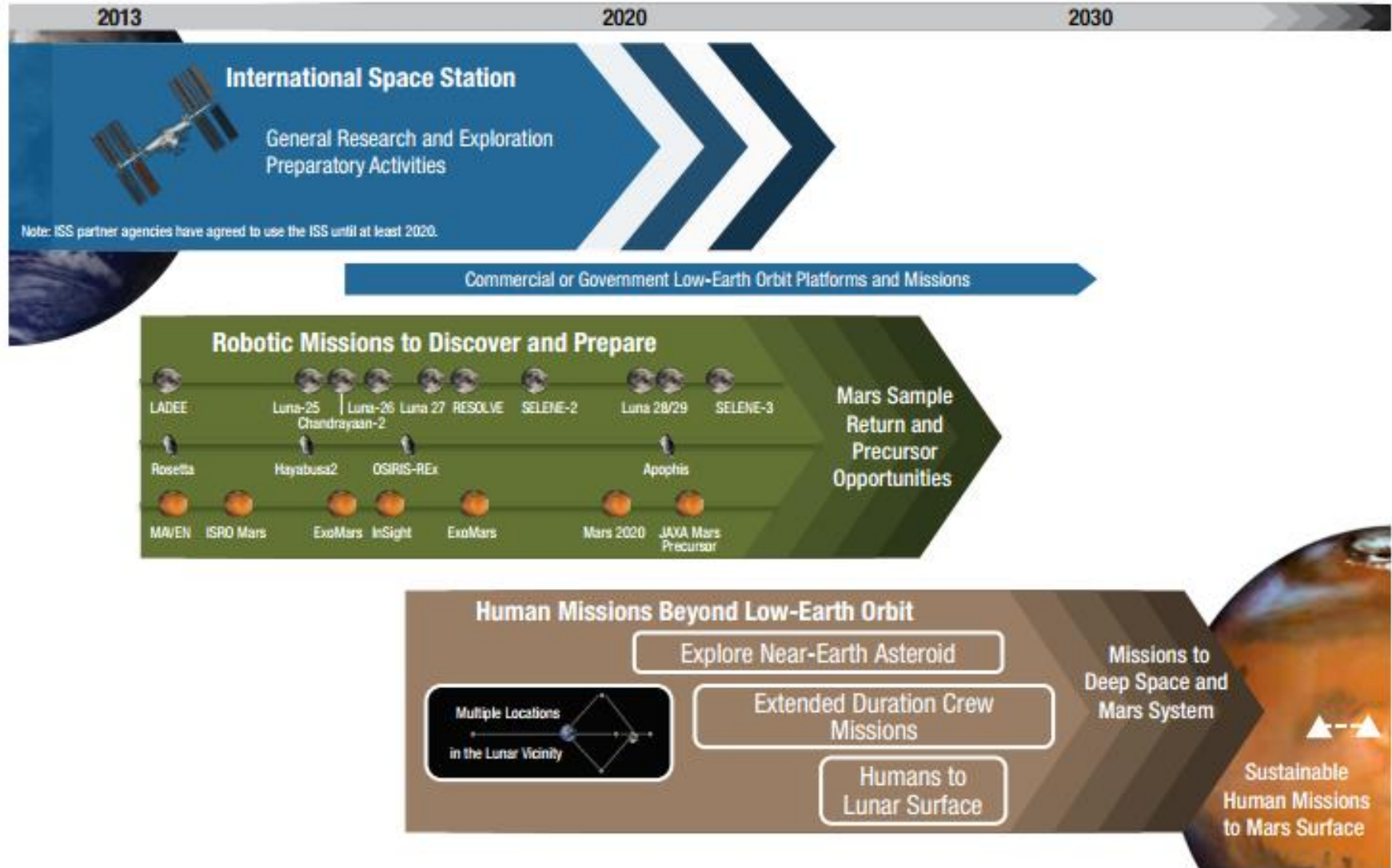
Deep Space Habitat



# Timing for all of these...



## Global Exploration Roadmap

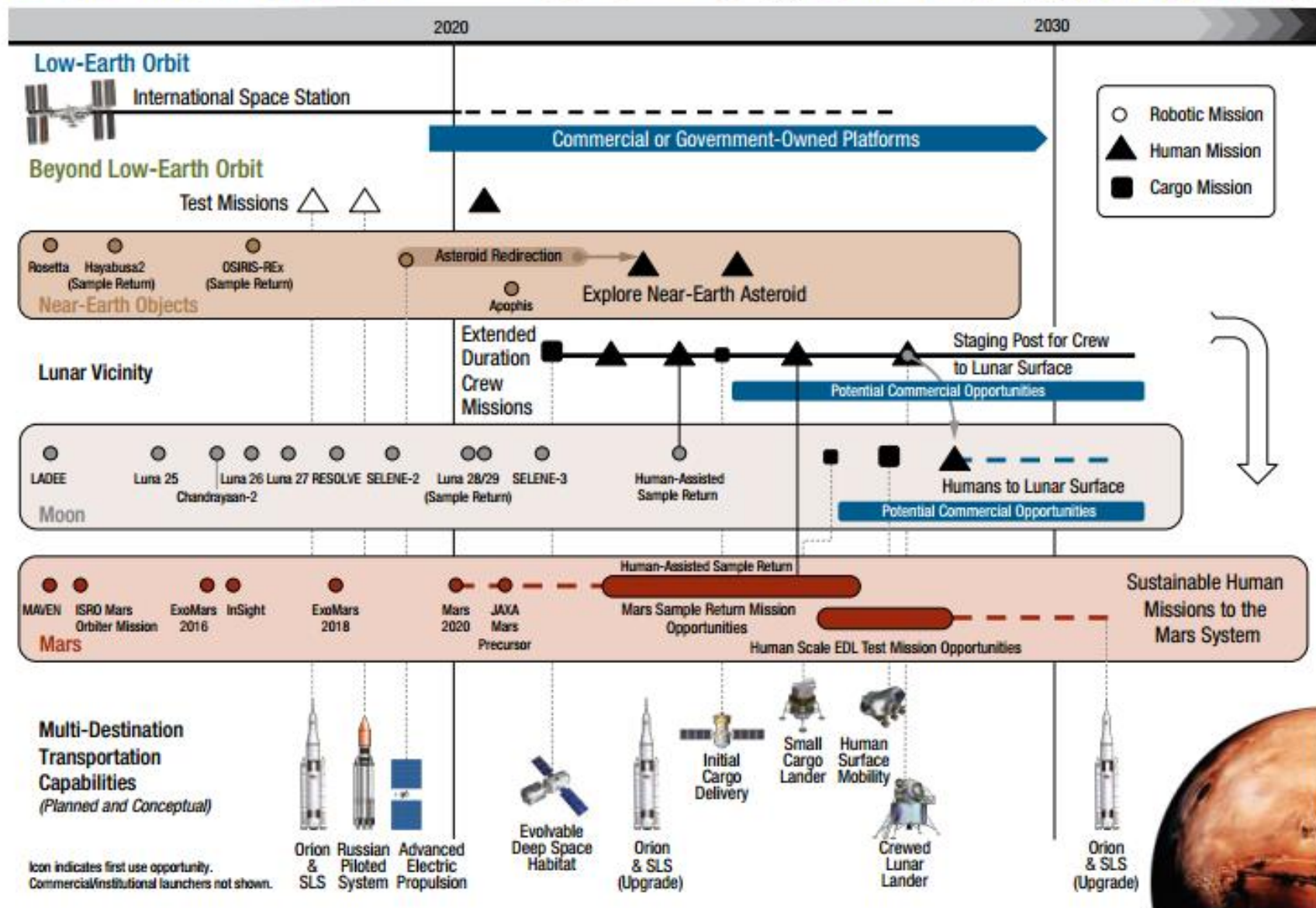




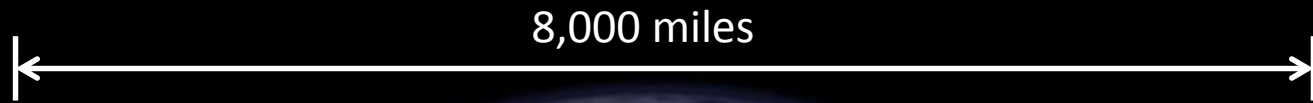
# Timing for all of these...



## ISECG Mission Scenario



8,000 miles



Low Earth Orbit (LEO)

250 miles



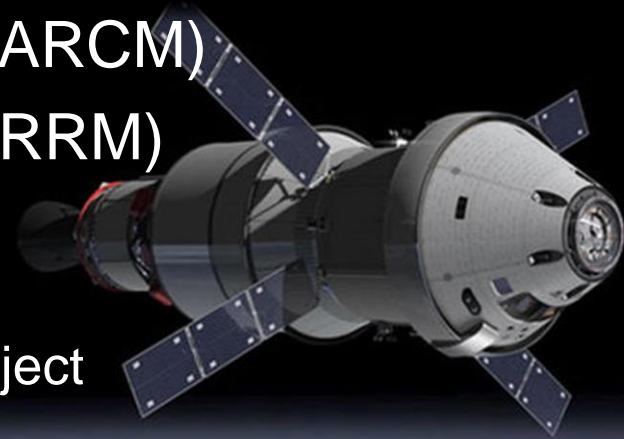
- Continue ISS through 2024 (2028?)
  - Focus on research and using as a test bed for exploration
- Engage commercial industry to service ISS
  - COTS (SpaceX and Orbital Sciences) – today
  - Commercial Crew - competitive programs – 2017?
    - CCDEv (1-2) – Commercial Crew Development
    - CCiCap- Commercial Crew Integration Capabilities
- Goal is to generate sustained commercial LEO industry



# Asteroid Redirect Mission



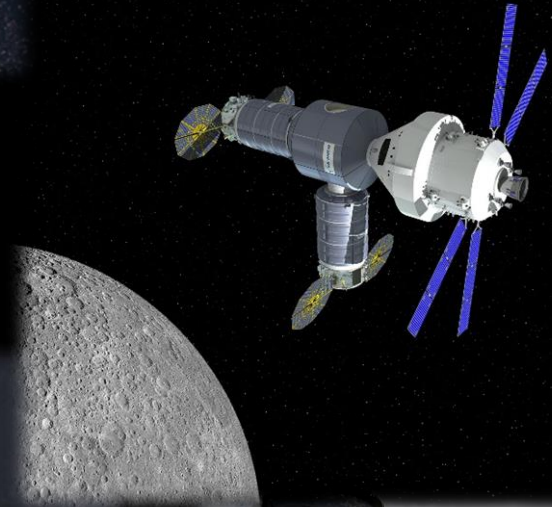
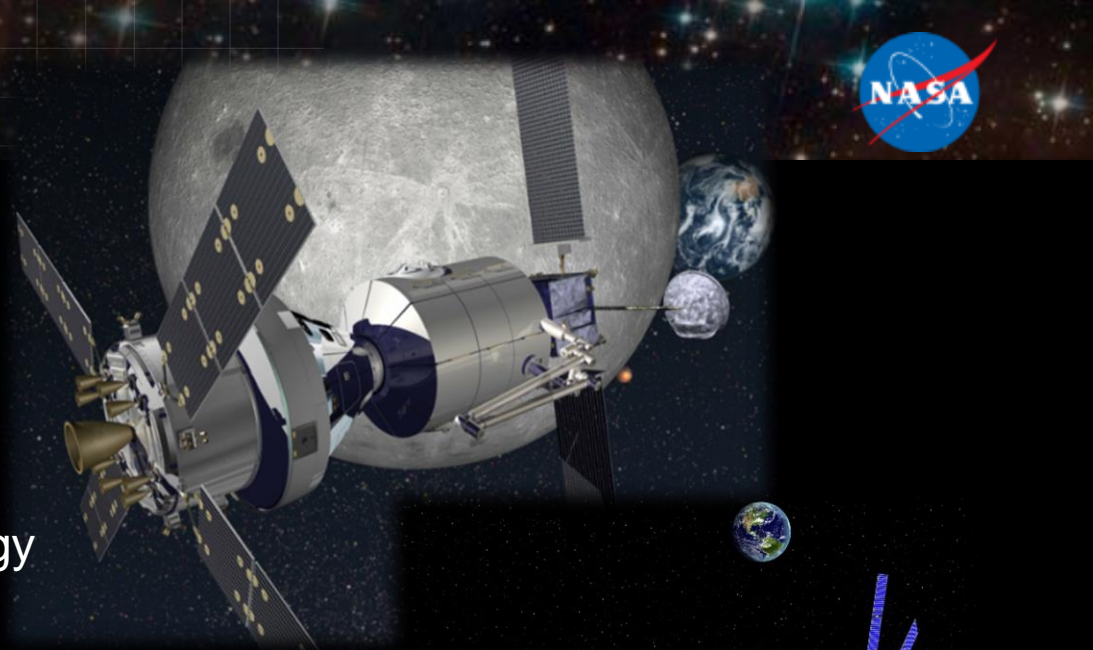
- Asteroid Redirect Return Mission (ARRM)
- Asteroid Redirect Crew Mission (ARCM)
  - Possible Lunar orbit or use of L2 (Lagrange point)
  - Science collection from deep space object
  - Exploration System Technology Demonstration



# Cise Lunar Missions?



- Lunar orbiting outpost
  - Possible use of L2 (Lagrange point)
  - Science collection from deep space
  - Exploration System Technology Demonstration
- Lunar Base
  - Science collection
  - Exploration Systems Technology Demonstration
  - Surface Habitat, Lander and Walking suit test bed for Mars

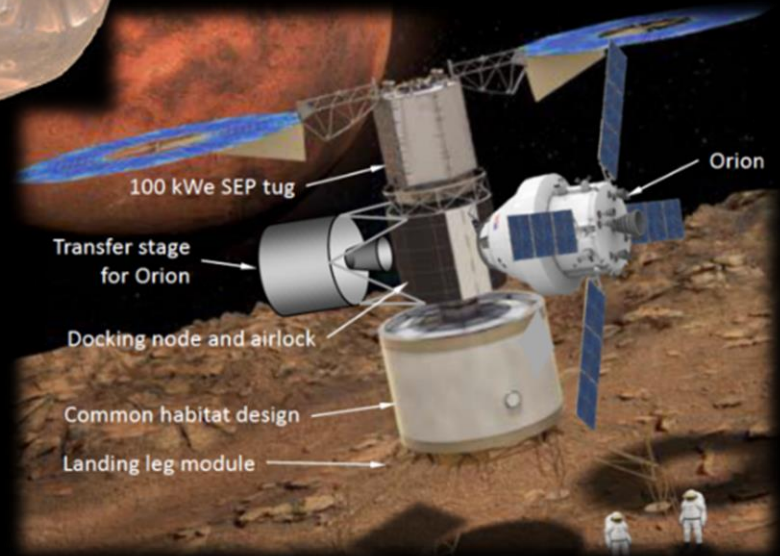
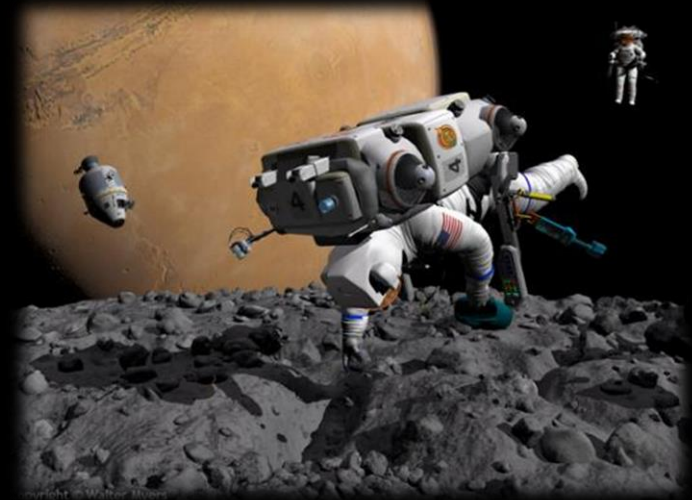




# Mars Orbital Mission- Phobos (Mars Moon)



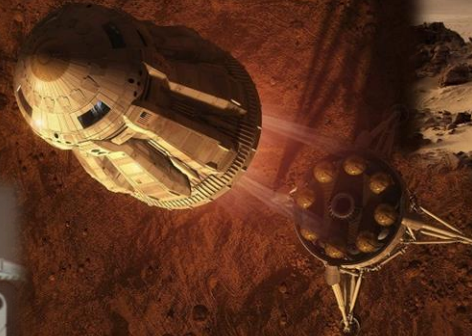
- Possible first trip to Mars
- Technology gap not as big
- Proof of concept for long range mission
- More cost affective
- *Worth the trip??*



# Human Mars Mission



- 2-3 Year Mission
- Large technology gap exists
  - Both for Humans and Systems
- Large infrastructure required
- Will be International involvement
- Would be biggest risk, also biggest reward



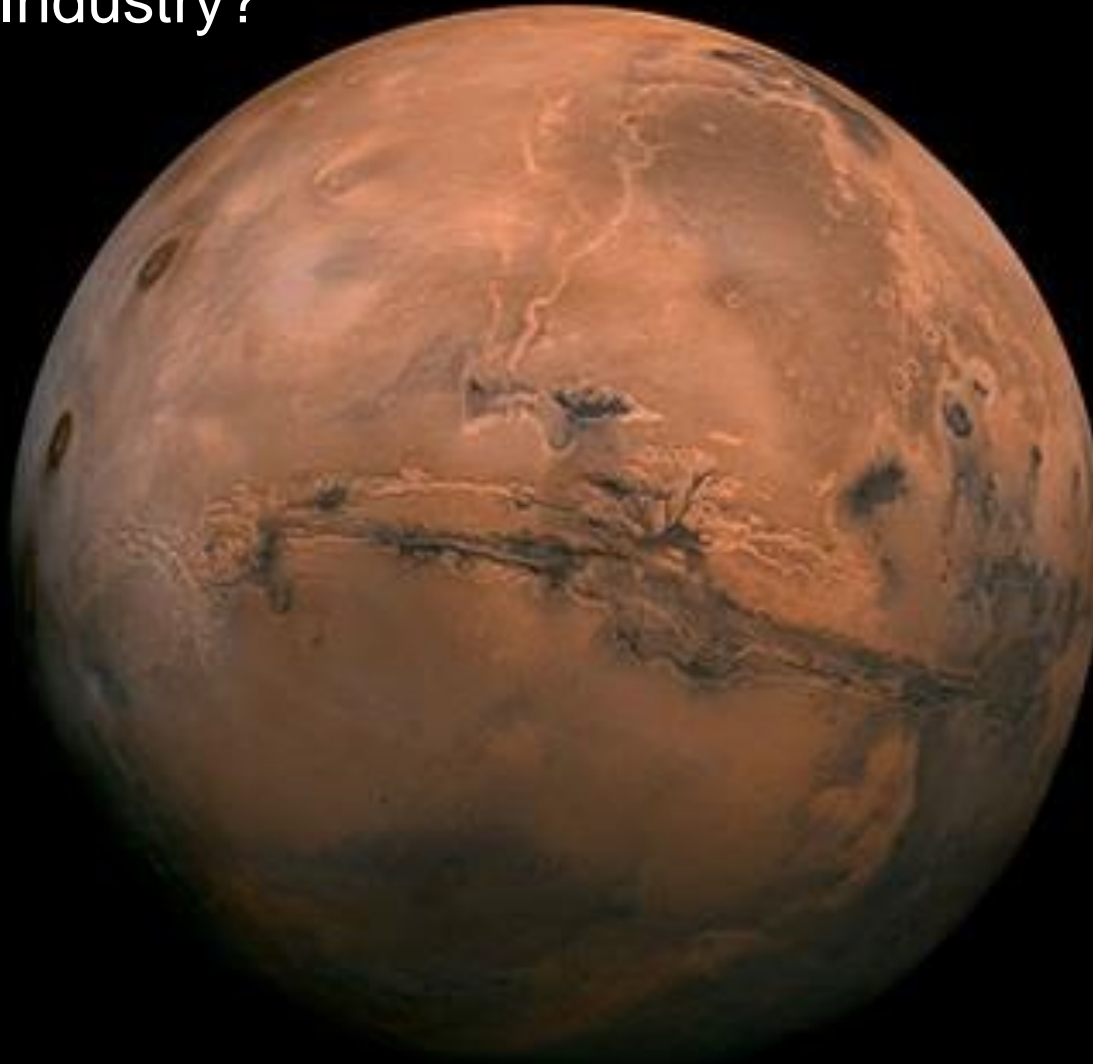
Images Credit: The Martian/20<sup>th</sup> Century Fox



# Other Proposed Exploration Missions



Private Industry?



# Red Dragon



- Red Dragon is a proposed unmanned SpaceX Dragon capsule for low-cost Mars lander
- Missions to be launched using Falcon Heavy rocket(s)
- These Mars missions will also be pathfinders for the much larger SpaceX Mars colonization architecture that will be announced in September 2016
- Certain level of engagement with NASA via Space Act Agreement



SpaceX's Red Dragon Mars Mission in Images





# Mars One - One way trip to mars



- Mars One is an organization based in the Netherlands
- Proposed to land the first humans on Mars and establish a permanent human colony there by 2027
- Candidate pool reduced to 40 astronauts in 2016
- NASA is not involved in this project





# So what does it take to explore Deep Space?



# Space Exploration Challenges...



## • Who would you need on a deep space mission?

### Standard for LEO today

- Pilot
- Scientist
- Engineer

### Required Systems Experts for Exploration Missions

- Propulsion
- Navigation
- Communication
- Environmental (Plumber, AC, Heat)
- Power
- Stowage/Inventory

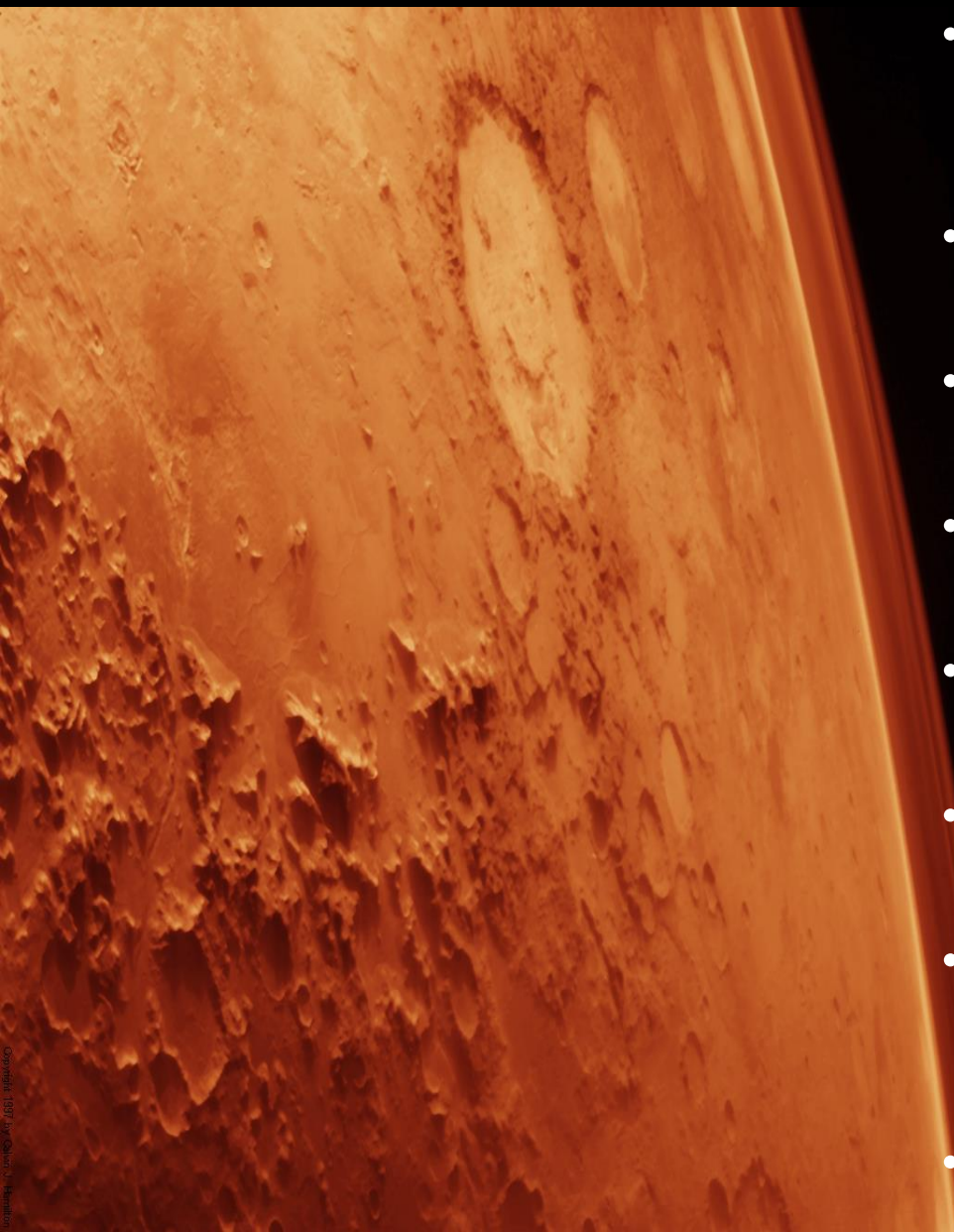
### • Other crew, required?

- Doctor
- Dentist
- Psychologist
- Geologist
- IT/Computer
- Machinist
- Handyman
- Sheriff
- Judge/Lawyer

**20+  
People???**



# Space Exploration Challenges...



- Up mass
  - Exploration Vehicle – est. 100 tons of material and supplies (ISS 420 tons)
- Propulsion
  - Chemical, Ion, Solar Electric
- Environmental Systems
  - Closed loop, Reliability, Redundancy
- Automation
  - Self maintaining systems
- Radiation Shielding
  - Crew and systems health
- Communication
  - Comm delays increase
- Long Range Human Health Affects
  - Bone health, eye damage, long term radiation exposure
- Stowage/Logistics



# NASA Exploration Technologies



**Advanced In-Space Propulsion:** This project develops concepts, technologies, and test methods for high-power electric propulsion and nuclear thermal propulsion systems to enable low-cost and rapid transport of cargo and crew beyond low Earth orbit.



**Autonomous Systems and Avionics:** This project develops and demonstrates integrated autonomous systems capable of managing complex operations in space to reduce crew workload and dependence on support from Earth. Technologies will address operations in extreme environments, efficient ground-based and on-board avionics systems and operations, and cost-effective human-rated software development.



**Cryogenic Propellant Storage and Transfer:** This project develops technologies to enable long-duration storage and in-space transfer of cryogenic propellants. Technology development includes active cooling of propellant tanks, advanced thermal insulation, measurement of propellant mass, liquid acquisition devices, and automated fluid couplings for propellant transfer between vehicles.



**Entry, Descent, and Landing (EDL) Technology:** This project develops advanced thermal protection system materials, aerothermodynamics modeling and analysis tools, and concepts for aerocapture and atmospheric entry systems for landing large payloads safely and precisely on extra-terrestrial surfaces and returning to Earth.

› [Read about the Mars Science Laboratory Entry, Descent, and Landing Instrument \(MEDLI\) Suite](#)



**Extravehicular Activity Technology:** This project develops component technologies for advanced space suits to enable humans to conduct "hands-on" surface exploration and in-space operations outside habitats and vehicles. Technology development includes portable life support systems, thermal control, power systems, communications, avionics, and information systems, and space suit materials.

<http://www.nasa.gov/exploration/technology/>

# NASA Exploration Technologies



**High-Efficiency Space Power Systems:** This project develops technologies to provide low-cost, abundant power for deep-space missions, including advanced batteries and regenerative fuel cells for energy storage, power management and distribution, solar power generation, and nuclear power systems. A major focus will be on the demonstration of dual-use technologies for clean and renewable energy for terrestrial applications.



**Human Robotic Systems:** This project develops advanced robotics technology to amplify human productivity and reduce mission risk by improving the effectiveness of human-robot teams. Key technologies include teleoperation, human-robot interaction, robotic assistance, and surface mobility systems for low-gravity environments. Early demonstrations will focus on human teams interacting with multiple robotic systems. Longer-term demonstrations will focus on enabling operations in remote, hostile environments with limited support from Earth.

> [About Robonaut, NASA's dexterous humanoid robot](#)



**In-Situ Resource Utilization:** This project will enable sustainable human exploration by using local resources. Research activities are aimed at using lunar, asteroid, and Martian materials to produce oxygen and extract water from ice reservoirs. A flight experiment to demonstrate lunar resource prospecting, characterization, and extraction will be considered for testing on a future robotic precursor exploration mission. Concepts to produce fuel, oxygen, and water from the Martian atmosphere and from subsurface ice will also be explored.

> [About in-situ resource utilization \(ISRU\) field testing in Mauna Kea, Hawaii](#)



**Life Support and Habitation Systems:** This project develops technologies for highly reliable, closed-loop life support systems, radiation protection technology, environmental monitoring and control technologies, and technologies for fire safety to enable humans to live for long periods in deep-space environments.



**Lightweight Spacecraft Materials and Structures:** This project develops advanced materials and structures technology to enable lightweight systems to reduce mission cost. Technology development activities focus on structural concepts and manufacturing processes for large composite structures and cryogenic propellant tanks for heavy lift launch vehicles, and on fabric materials and structural concepts for inflatable habitats.

<http://www.nasa.gov/exploration/technology/>





**Questions?**

**Thank You!**



# My favorites...



# My favorite sites and links...



- Heavens Above
  - <http://heavens-above.com/>
- NASA Spinoffs
  - <http://spinoff.nasa.gov/>
- Eyes on the Solar System
  - <http://eyes.nasa.gov/>
  - Youtube NASA Television
    - <http://www.youtube.com/user/NASAtlevision>
    - Youtube Earth Video
      - <http://www.youtube.com/watch?v=lp2ZGND1I9Q>
      - ISS Tour by CDR/Suni Williams
        - <http://www.youtube.com/watch?v=doN4t5NKW-k>
        - Why Mars is Hard Stan Love
          - <http://www.youtube.com/watch?v=fturU0u5KJo>
- Perspectives
  - <http://htwins.net/scale2/?bordercolor=white>
- ISSLive
  - <http://spacestationlive.jsc.nasa.gov/>
- Distance Learning Network
  - NASA DLN Website: <http://www.nasa.gov/offices/education/programs/national/dln/index.html>
  - Toolkit with Material and Templates:  
<http://communications.nasa.gov/OCP/Communications%20Tool%20Kit/Presentation%20Template%20Web%20Site/CTK.html>



# JPL – Eyes on the Solar System



**NASA EYES ON THE SOLAR SYSTEM** beta  
Jet Propulsion Laboratory | California Institute of Technology

Tours & Features

STEREO Ahead  
STEREO Behind  
Venus  
WINDS 6  
TDRS 5  
Pioneer 10  
Sun  
Jason-1  
OSTM  
ACRIMSAT  
Chandra  
HST  
SORCE  
TRMM  
RAX-2  
GRACE-1  
QuikSCAT  
ACE  
SOHO

DESTINATION	DATE + TIME	SPEED + RATE	MULTIMEDIA	VISUAL CONTROLS
 CURRENT TARGET: EARTH	JUN 22, 2012 10:50:51.2 AM NOW	62,890 MPH 1.00 SEC/SYSEC REAL RATE	 29 May 2012 - Partial Eclipse of the Strawberry 05.28.2012	 FREE FLY 60.0°

Eyes on the Solar System

<http://eyes.nasa.gov/>





# ISSLive



ISSLive

<http://isslive.com/>



About  
International Space Station *Live!*

Live Data

Interact

Operations

Educators

Resources



Available on the iPhone  
App Store

ANDROID APP ON  
Google play





# Youtube – REELNASA



## ReelNASA

[http://www.youtube.com/results?search\\_query=reelnasa&sa=X&spell=1&search=Search&oi=spell](http://www.youtube.com/results?search_query=reelnasa&sa=X&spell=1&search=Search&oi=spell)

A screenshot of a YouTube search results page for the query "reelnasa". The page shows the YouTube logo, a search bar with "reelnasa" entered, and a "Filter" dropdown menu. Below the search bar, it says "About 990 results". The search results are listed as follows:

- Reel NASA**: Get off my planet. Give me my space. Get real with Reel NASA. Space trav...  
ISS Update: Dr. Steve Squyres, NEEMO 16 Aquanaut and Cornell Professor  
CHANNEL by ReelNASA | 928 videos | 31,508 subscribers
- Science off the Sphere: Knitting Needle Experiment**: challenge and view future experiments here: www.physicscentral.com ... Reel NASA ...  
"Science off the Sphere" "American Physical Society" "Don Pettit" ...  
CC by ReelNASA | 4 months ago | 546,686 views
- We Are the Explorers**: is helping us lay the foundation for our greatest journeys ahead. ... Reel NASA ... NASA  
exploration "Peter Cullen" space flew shuttle station Orion ...  
HD CC by ReelNASA | 3 months ago | 176,084 views
- Chase Plane Video Of Historic SpaceX Splashdown**: berth with the International Space Station, paving the way for future commercial cargo delivery  
flights. ... Reel NASA ... 120601 SpaceX ...  
HD by ReelNASA | 3 weeks ago | 70,754 views
- Science off the Sphere: Gool**: challenge and view future experiments here: www.physicscentral.com ... Reel NASA ...  
"international space station" "expedition 31" "don pettit" ...  
CC by ReelNASA | 1 month ago | 8,412 views
- Interview with NASA Earth Scientist Melissa Davaos**

# NASA Spinoffs



<http://spinoff.nasa.gov/>



## Office of the Chief Technologist

Value for NASA, Benefits for the Nation

## NASA Spinoff



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Request a Spinoff

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Spinoff Database

Spinoff FAQ

Contact Us

Connect with NASA Spinoff



Partnership with NASA



[NASA Online Partnering Tool](#)



### What is NASA's Investment in America's Future?

Jeopardy! host Alex Trebek shares how NASA spinoffs provide tangible benefits for the Nation.

NASA @ Home and City



Find a trace of outer space in your home and city.

[View Feature](#)

Spinoff Tweets



NASA Spinoff

**NASASpinoff**



# Heavens Above



<http://heavens-above.com/>

Heavens-Above Home Page - Windows Internet Explorer

Address bar: <http://heavens-above.com/>

File Edit View Favorites Tools Help

HomeDO4 Flight Planning Br... wWU engineering - Bing HomeDO4 Flight Planning Br...

Find: biconic Previous Next Options

---

 [Aerospace](#)  
Earn an Aerospace degree online at American Public University System.  
[www.APUS.edu/Aerospace](http://www.APUS.edu/Aerospace) AdChoices

---

**Configuration**  
Current observing site: **Clear Lake, 33.0781°N, 96.4950°W**  
[select from map](#) or [from database](#) or [edit manually](#)  
[Registered user login](#) | [Why register?](#)  
[Create new user account](#)

**Satellites**  
10 day predictions for: [ISS](#) | [Tiangong 1](#)  
[Genesis-1 / 2](#) | [Envisat](#) | [HST](#)  
[Select another satellite](#) from the database  
Daily predictions for all satellites brighter than magnitude:  
(brightest) 3.5 | 4.0 | 4.5 (dimmiest)  
All passes of [ISS](#) - including daylight and invisible passes.  
Iridium Flares  
[next 24 hrs](#) | [next 7 days](#) | [previous 48 hrs](#)  
Daytime flares for 7 days - see satellites in broad daylight!  
[Spacecraft escaping the Solar System](#) - where are they now?  
[Radio amateur satellites](#) - 24 hour predictions (all passes)  
[Height of the ISS](#) | [Phobos Grunt](#) - how does it vary with time

**Astronomy**  
Comets currently brighter than mag. 12  
[189P NEAT](#) | [96P Machholz](#) | [C/2009 P1 Garradd](#)  
Minor planets currently brighter than mag. 10  
[4 Vesta](#) | [1 Ceres](#) | [18 Melpomene](#)  
[Whole sky chart](#)  
[Sun and Moon data for today](#)  
[Planet summary data](#)  
[Planet details \(under construction\)](#)  
[Mercury](#) | [Venus](#) | [Earth](#) | [Mars](#) | [Jupiter](#) | [Saturn](#) | [Uranus](#) | [Neptune](#) | [Pluto](#)  
[Solar system chart](#)

  
© Heavens-Above.com  
Current position of ISS

 523

**GPS Fleet Tracking**  
GPS Tracking Lowers Costs Free, Live Demonstration  
[www.Saoc-Quest.com](http://www.Saoc-Quest.com)

Windows taskbar: start, 7 Microsoft..., 2 Windows..., 3 Microsoft..., 4 Internet..., Intel® PROS..., 2 Microsoft..., Desktop, 12:24 PM

# NASA Distance Learning



NASA DLN Website: <http://www.nasa.gov/offices/education/programs/national/dln/index.html>

The screenshot shows the NASA Digital Learning Network (DLN) website. At the top, there is a navigation bar with the NASA logo and menu items: HOME, NEWS, MISSIONS, MULTIMEDIA, CONNECT, and ABOUT NASA. Below the navigation bar is a search bar with a "Search" button. The breadcrumb trail reads: NASA Home > Education > Programs > DLN. On the right side of the breadcrumb trail are "Send" and "Share" icons.

The main content area features a large banner for the "NASA Digital Learning Network™" with the tagline "A Universe of Possibilities". Below the banner, it lists "DLN sites: Ames, Dryden, Glenn, Goddard, JPL, Johnson, Kennedy, Langley, Marshall, Stennis".

The left sidebar contains a "Digital Learning Network (DLN)" section with the following links: DLN Home, About DLN, Event Catalog, PD & Special Events, Event Guidelines, DLInfo Channel, Technical FAQ, 5E Teaching Model, Tools & Plugins, Contact Us, Feedback Forms, and Search Event. Below this is a "DLN User" section with links: > Sign In, > New User Registration, > New School/Org Registration, and > Forgot Password.

The main content area has a "Welcome to NASA's DLN" section. It states: "NASA's Digital Learning Network™ provides science, technology, engineering, and mathematics or STEM content featuring NASA missions and research. Register for free, interactive events listed in our catalog or watch our webcasts listed below." Below this text are two social media links: "Like us on Facebook!" and "Follow us on Twitter!". A photograph shows a classroom setting with students and a teacher. Below the social media links, it says: "To assist both new and existing users, we STRONGLY encourage you to view our DLN Overview Video and the DLNIntro presentation located in About DLN. DLNIntro will guide you through our website, show how to register for modules, and explain other services."

At the bottom of the page, there is a "DLN Announcements" section. A partial announcement is visible, mentioning "USDLA Awards NASA's Digital Learning".



See the Space Station fly over YOUR home!

Use "Skywatch" program or go to "sightings by city"

- [spaceflight.nasa.gov/realdata/sightings](https://spaceflight.nasa.gov/realdata/sightings)

SATELLITE	LOCAL DATE/TIME	DURATION (MIN)	MAX ELEV (DEG)	APPROACH (DEG-DIR)	DEPARTURE (DEG-DIR)
ISS	Tue Nov 14/06:22 AM	4	66	10 above WSW	31 above NE

