Welcome to JSC

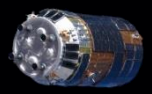
National Aeronautics and Space Administration

What's Going On Now At NASA?

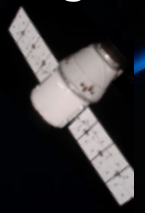
www.nasa.gov/exploration

Human Spaceflight….

JAXA HTV



SpaceX Dragon

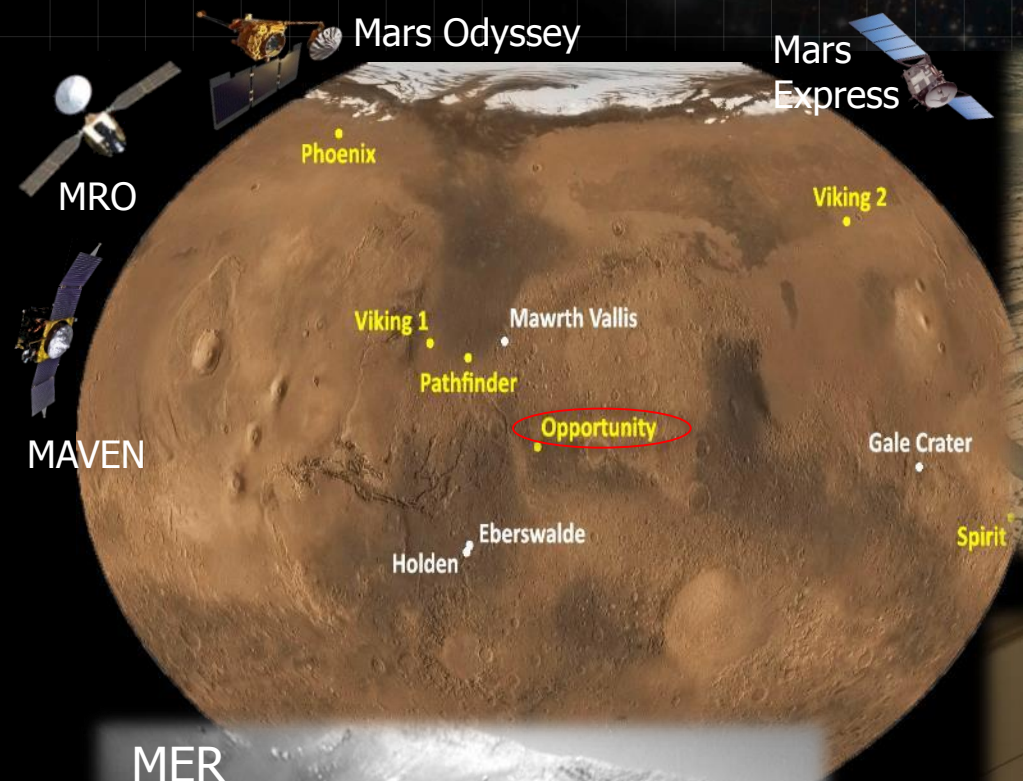


Orbital Sciences ATK Cygnus

Expedition 47

Expedition 48

Planetary Missions, Mars is busy!…



http://www.space.com/16874-where-did-nasa-spacecraft-land-on-mars-video.html

Many, many other cool missions…

Just a few to mention…

Cassini

Saturn orbit, last year of operation

Juno

Arriving at Jupiter July 2016

Hubble

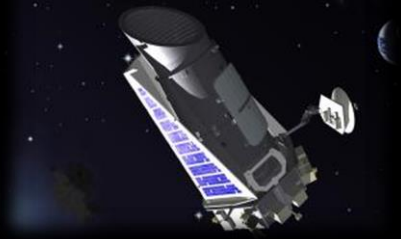
Still researching origins of the universe

Kepler

Planet Count

Confirmed Planets: 977

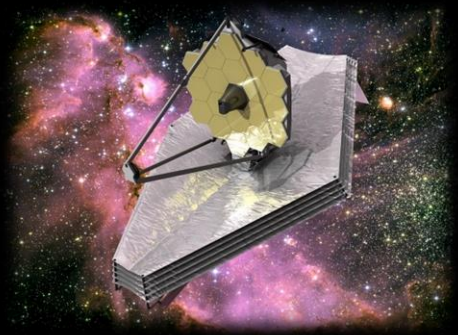
Planet Candidates: 4,234



Voyager 1

Has left the building…

Traveling interstellar space



James Webb Telescope

Launch in 2018

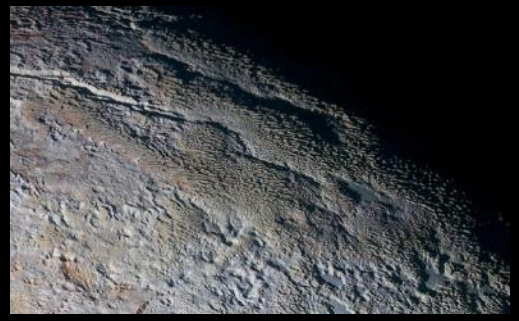
Eyes on the Solar System

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**

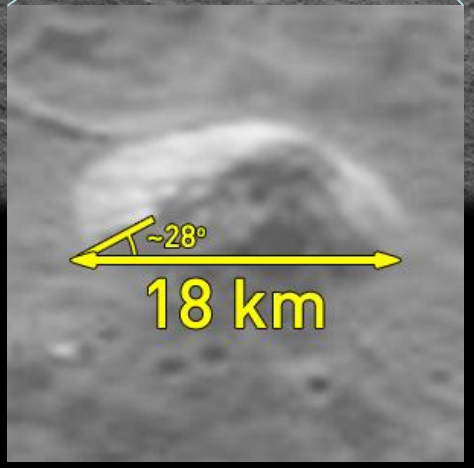
NASA’s New Horizons spacecraft passed Pluto in July 2015



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 Creres



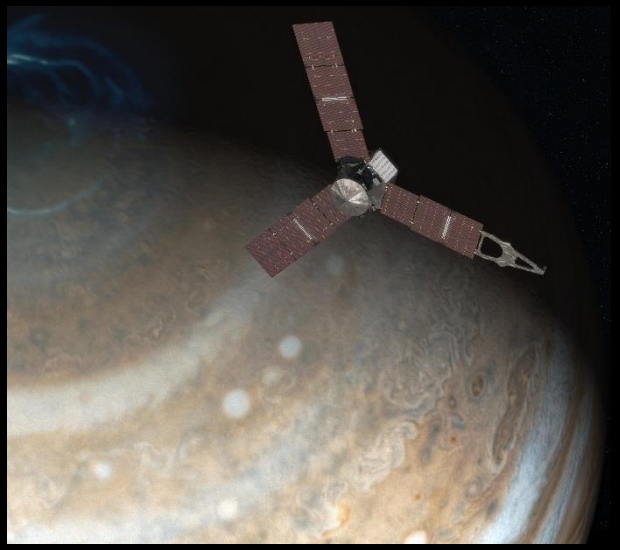
A pyramid-like peak jutting out of the frigid world's surface was discovered in 2015

Juno – Jupiter rendezvous

- Juno is a NASA New Frontiers mission currently en route to the planet Jupiter
  - Planned arrival July 4th 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)



National Aeronautics and Space Administration

Human Exploration

www.nasa.gov/exploration

EFT-1 = Exploration Flight Test -1 Complete!

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

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

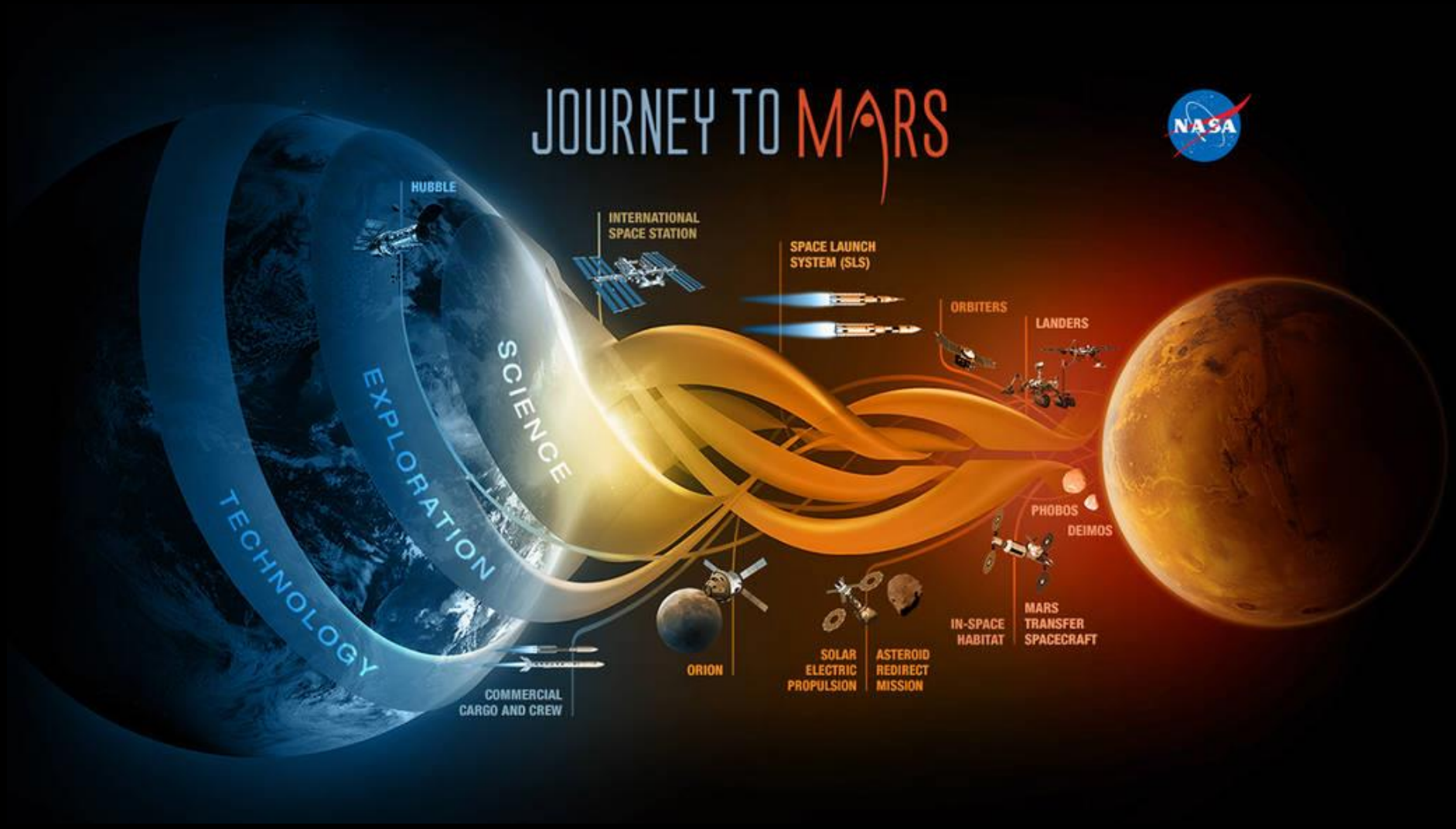
Atlas V

SpaceX Dragon Capsule

Dragon Interior

Falcon 9 Rocket

NASA Journey to Mars



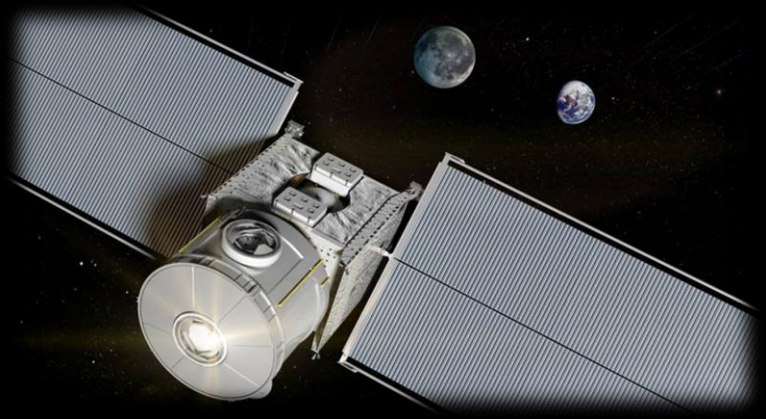
So, What is the Exploration plan?

- 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

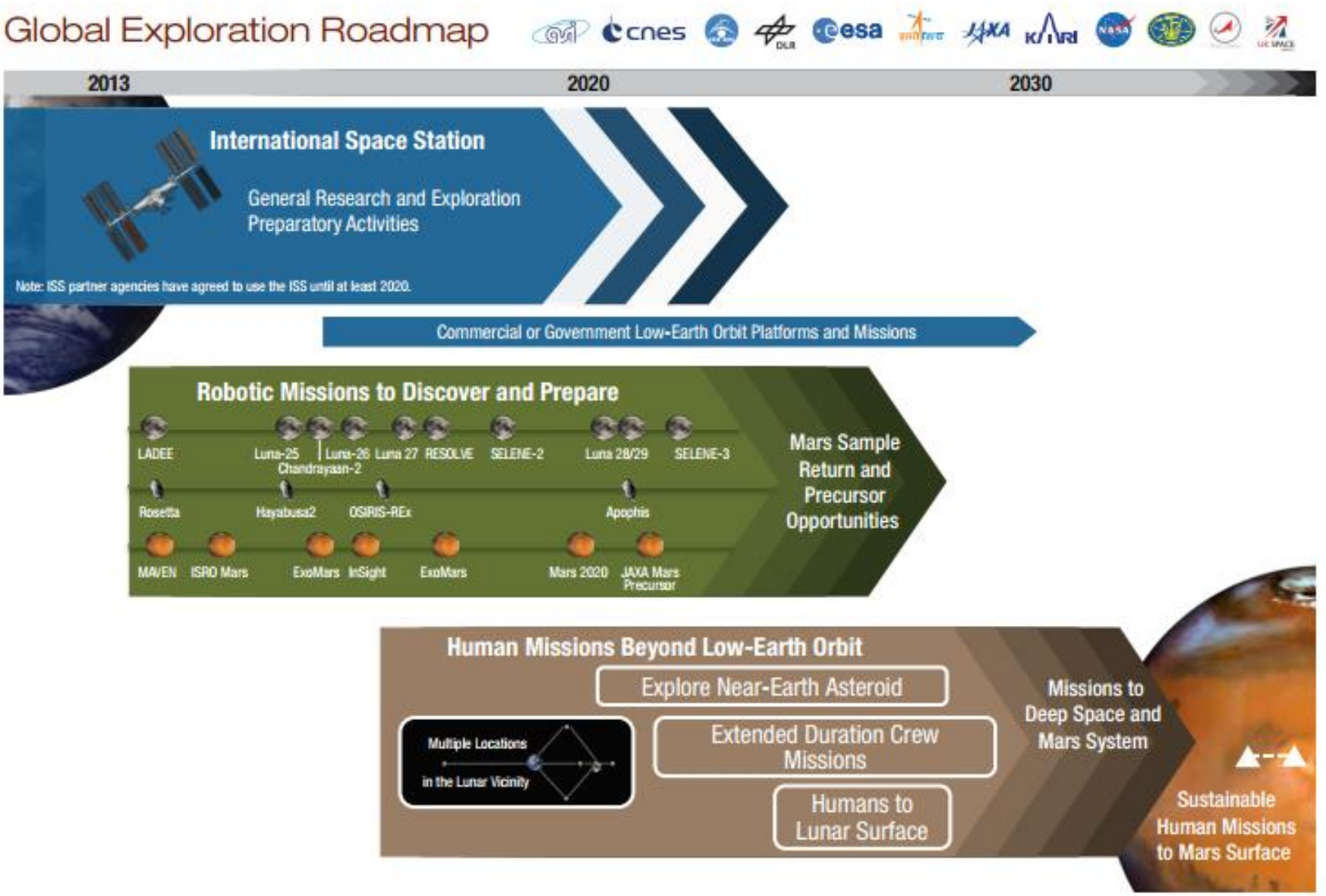
Orion

SLS

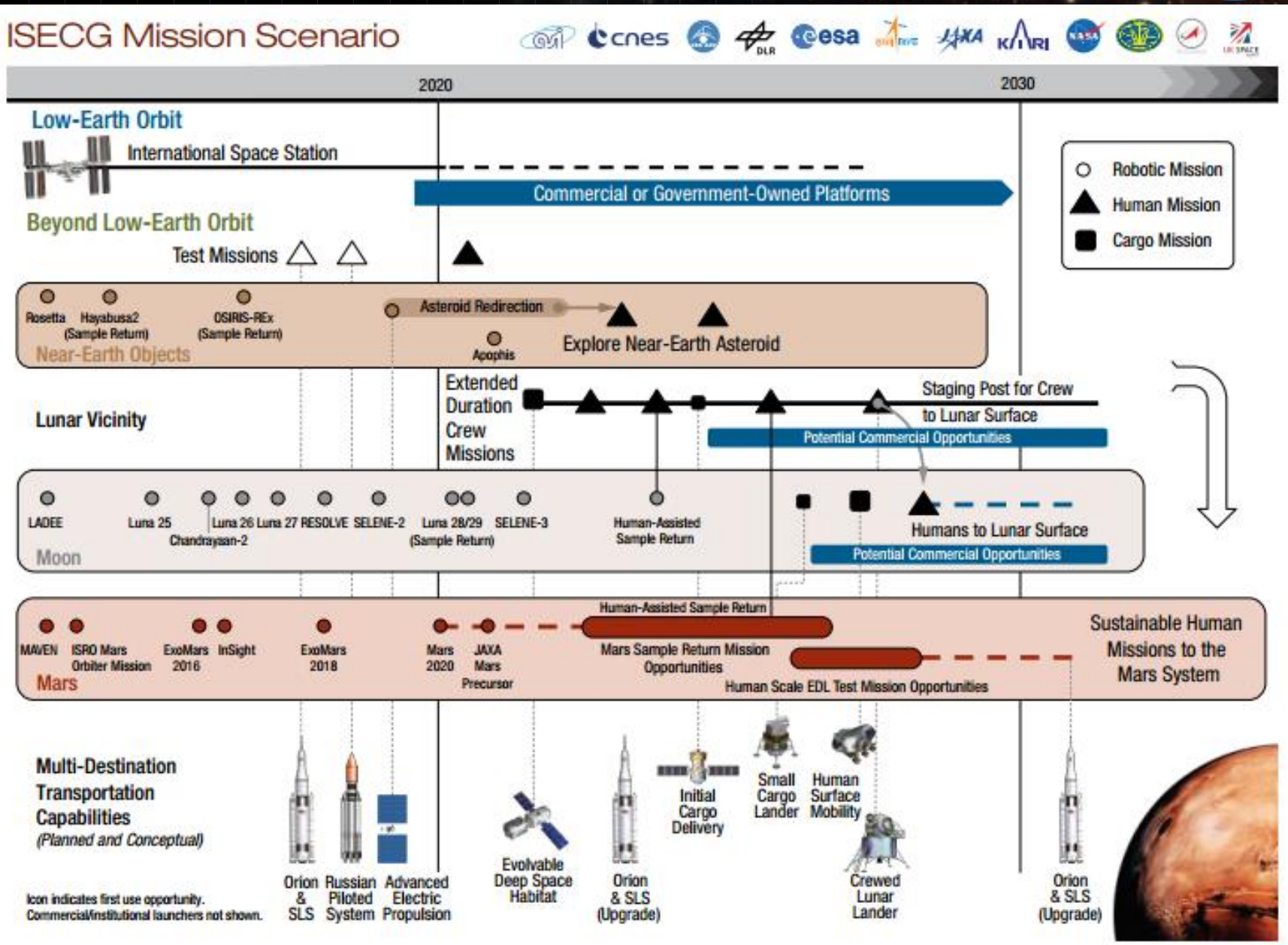
Deep Space Habitat

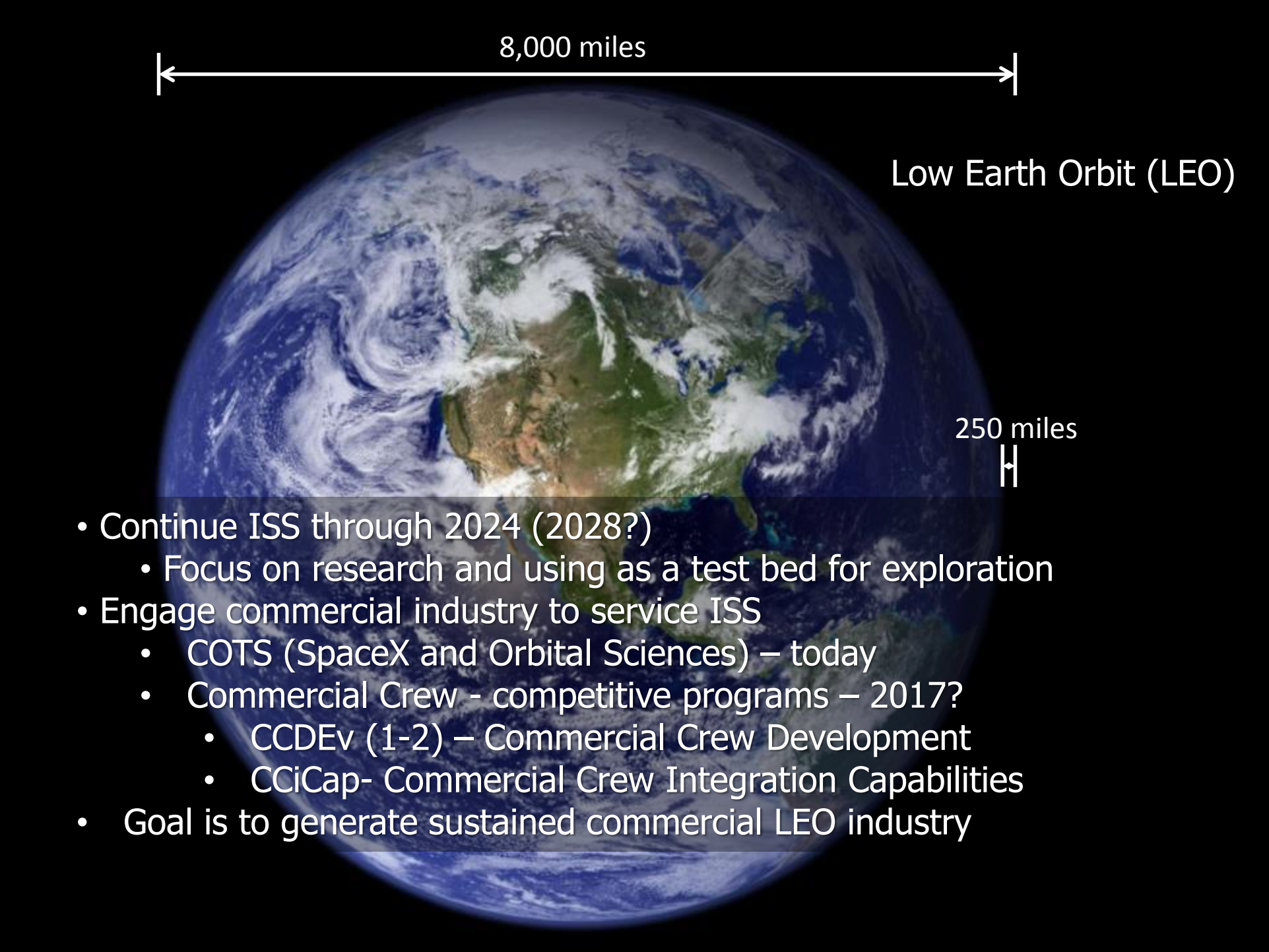


Timing for all of these…



Timing for all of these…

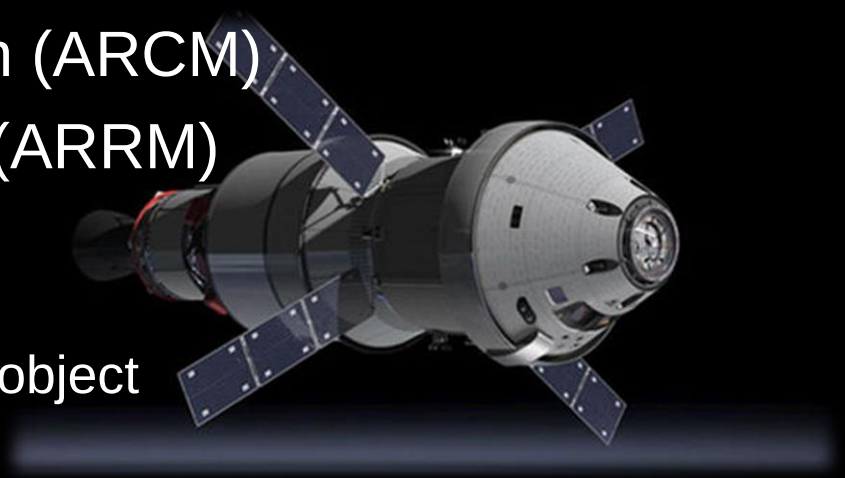




- Continue ISS through 2024 (2028?)
  - Focus on research and using as a test bed for exploration
- Engage commercial industry to service ISS
  - COTS (SpaceX and Orbital Sciences) – today
  - Commercial Crew - competitive programs – 2017?
    - CCDEv (1-2) – Commercial Crew Development
    - CCiCap-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

Asteroid Redirect Mission

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

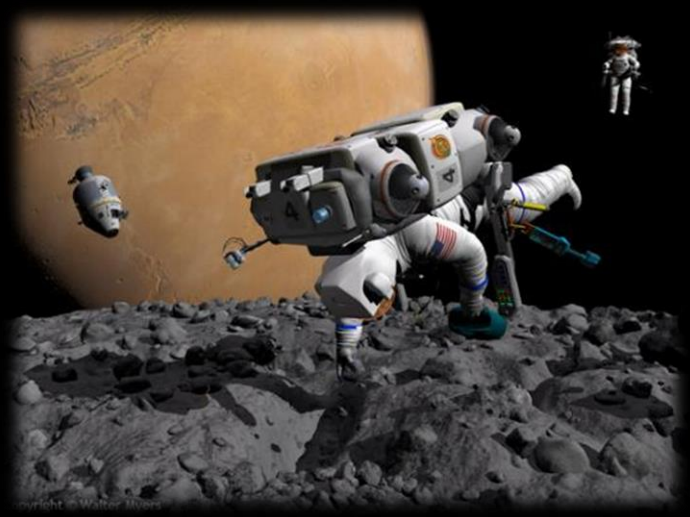


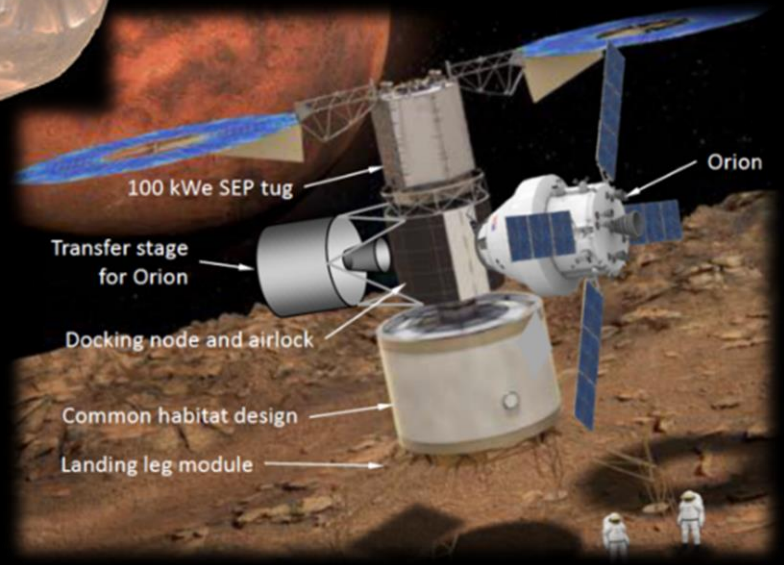
Cise Lunar Missions?

- 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)

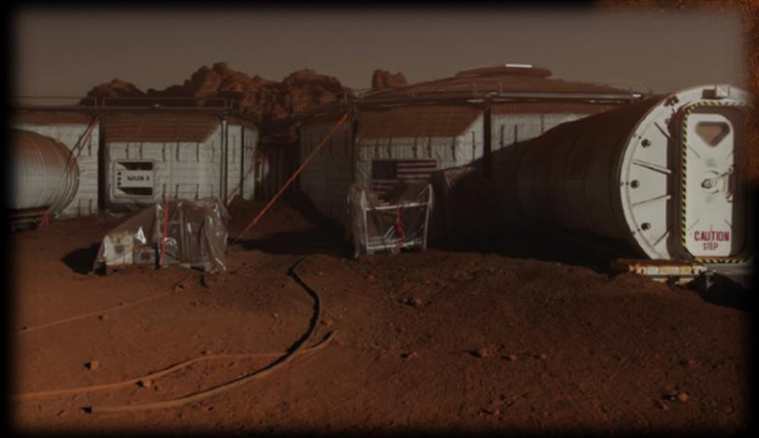
- Possible first trip to Mars
- Technology gap not as big
- Proof of concept for long range mission
- More cost affective
- *Worth the trip??*





Human Mars Mission

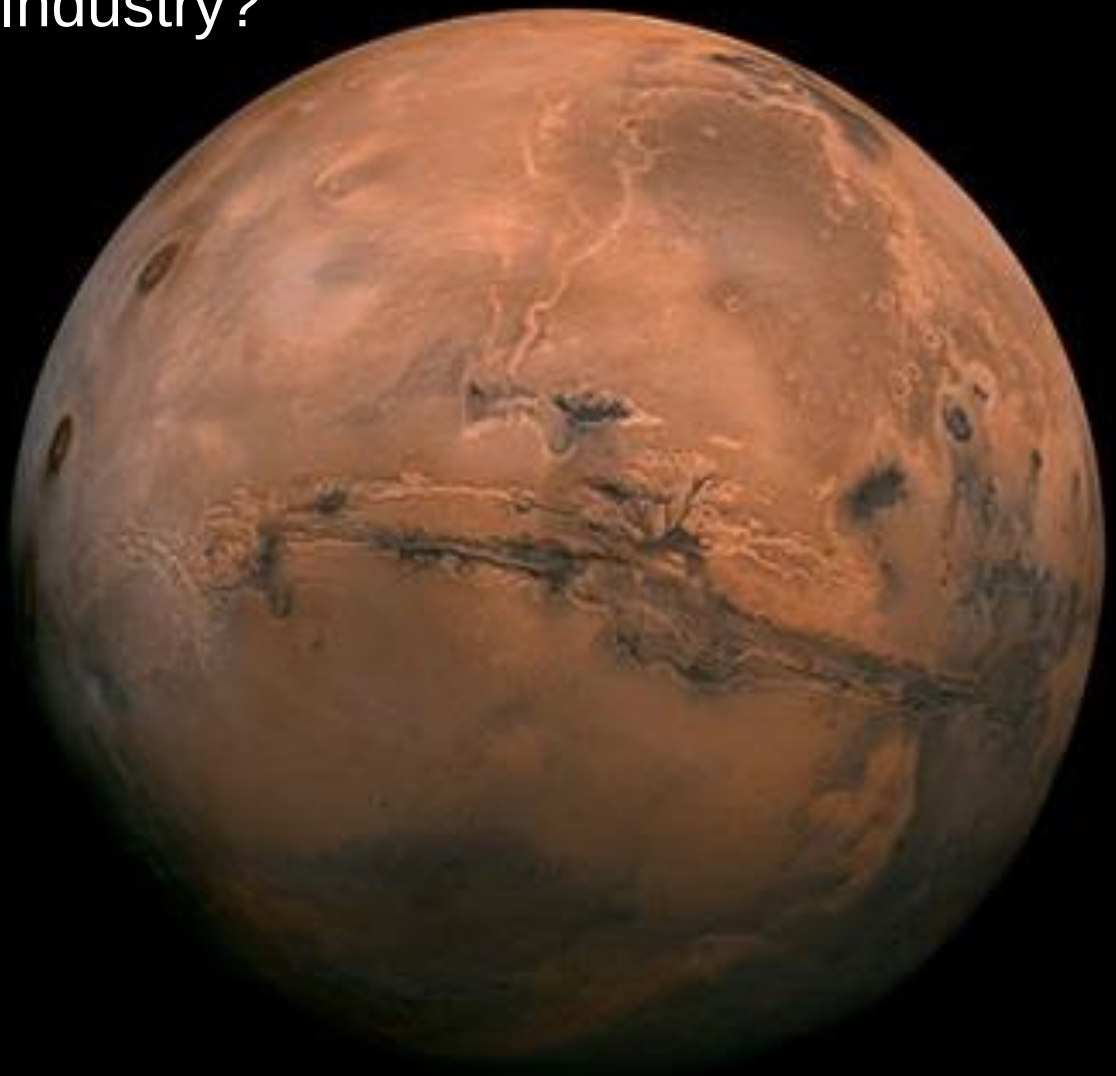
- 2-3 Year Mission
- Large technology gap exists
  - Both for Humans and Systems
- Large infrastructure required
- Will be International involvement
- Would be biggest risk, also biggest reward



Images Credit: The Martian/20th Century Fox

Other Proposed Exploration Missions

Private Industry?



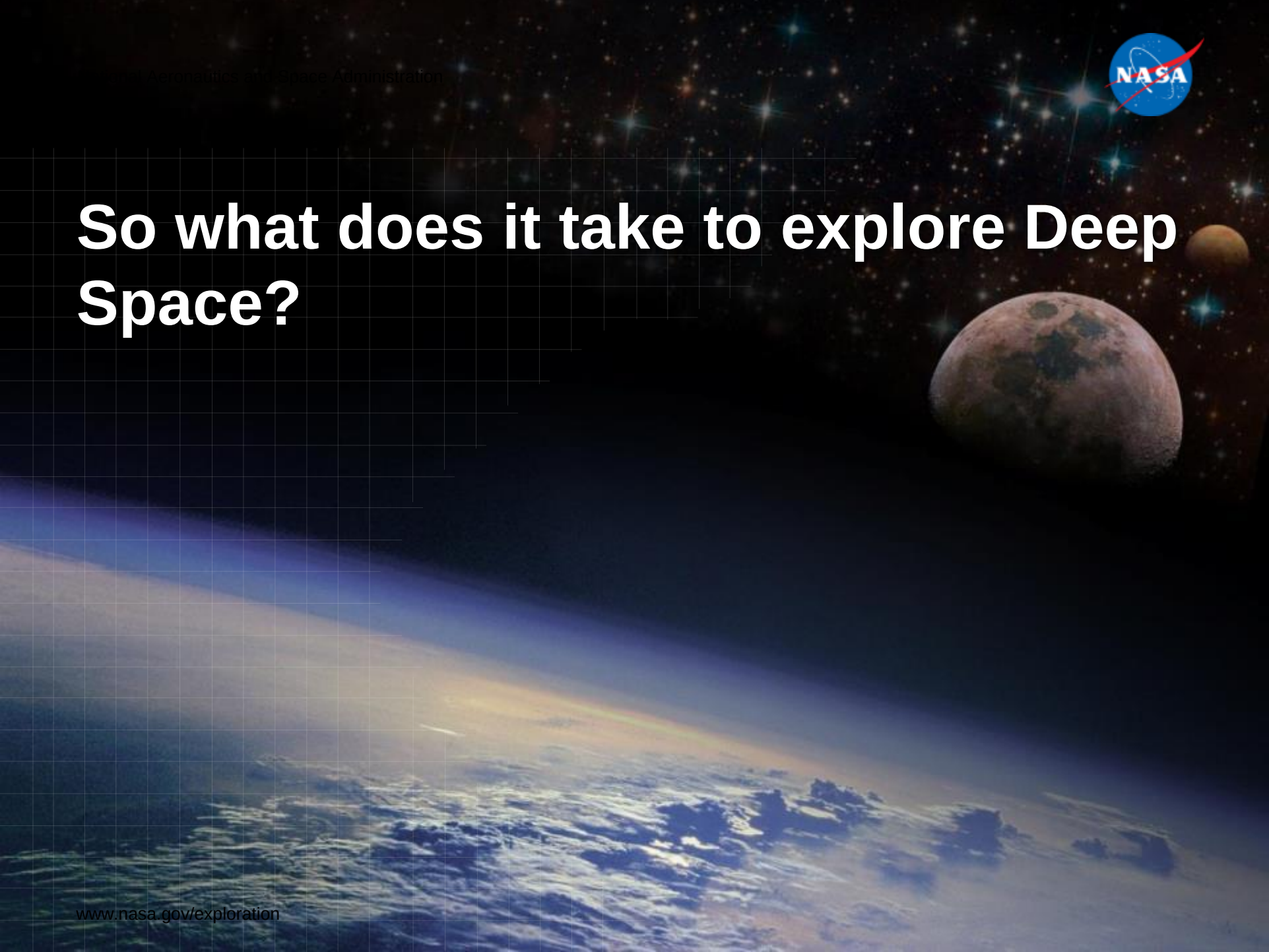
Red Dragon

- 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?

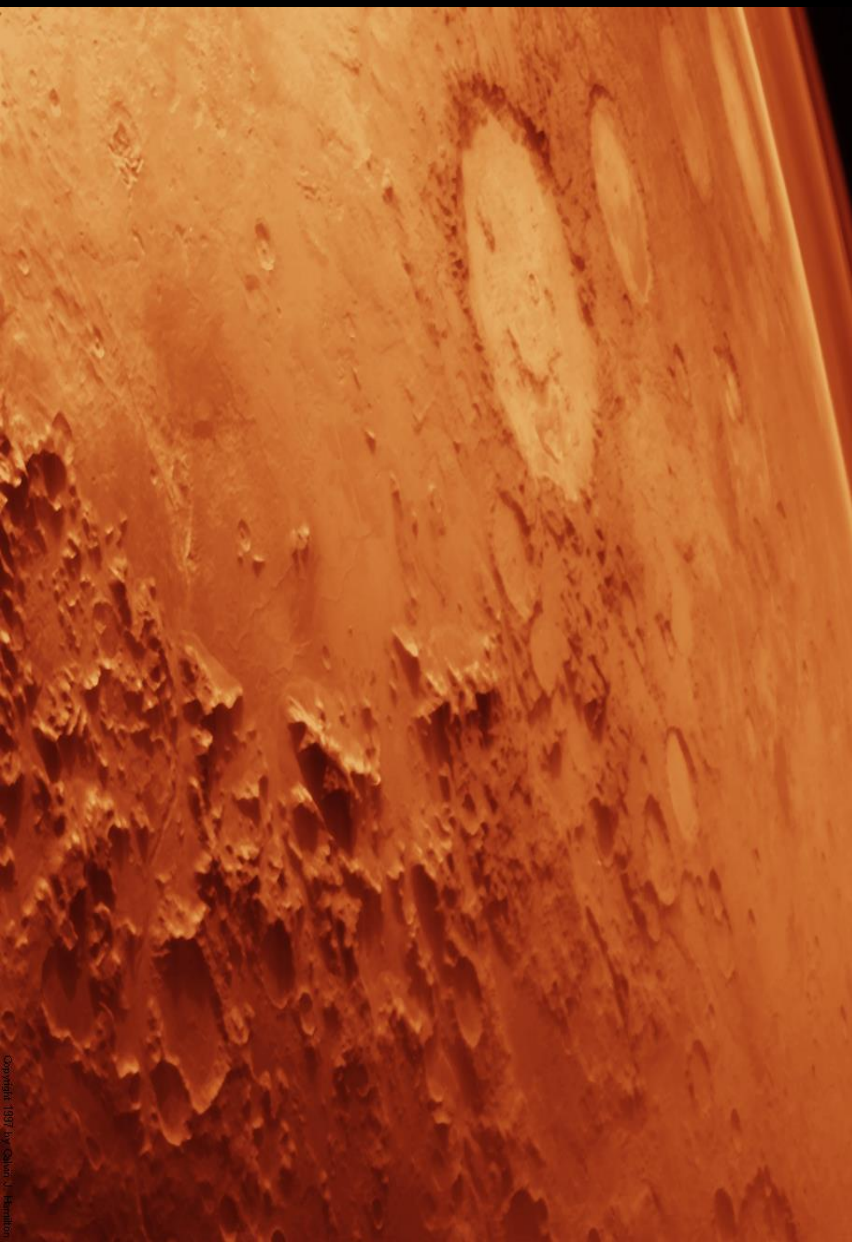
Standard for LEO today
- Pilot
- Scientist
- Engineer

- Other crew, required?
  - Doctor
  - Dentist
  - Psychologist
  - Geologist
  - IT/Computer
  - Machinist
  - Handyman
  - Sheriff
  - Judge/Lawyer

20+ People???

Required Systems Experts for Exploration Missions
- Propulsion
- Navigation
- Communication
- Environmental (Plumber, AC, Heat)
- Power
- Stowage/Inventory

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/NASAtelevision
  - Youtube Earth Video
  - http://www.youtube.com/watch?v=Ip2ZGND1I9Q
  - 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

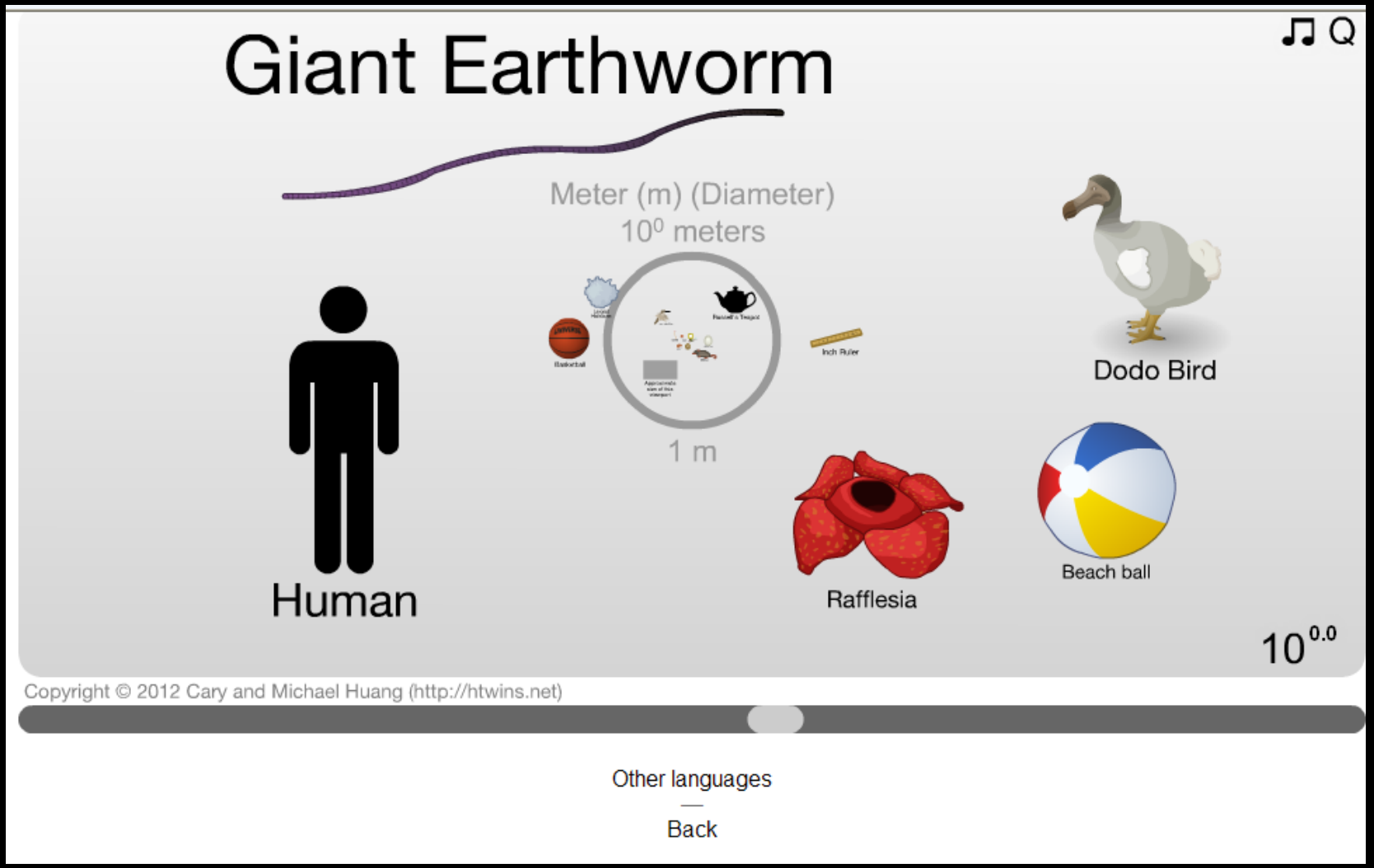
  http://htwins.net/scale2/?bordercolor=white
- ISSLive
  - http://spacestationlive.jsc.nasa.gov/
- Distance Learning Network
  - NASA DLN Website: http://www.nasa.gov/offices/education/programs/national/dln/index.html
  - Toolkit with Material and Templates: http://communications.nasa.gov/OCP/Communications%20Tool%20Kit/Presentation%20Templa

JPL – Eyes on the Solar System

Eyes on the Solar System
http://eyes.nasa.gov/

Perspective -

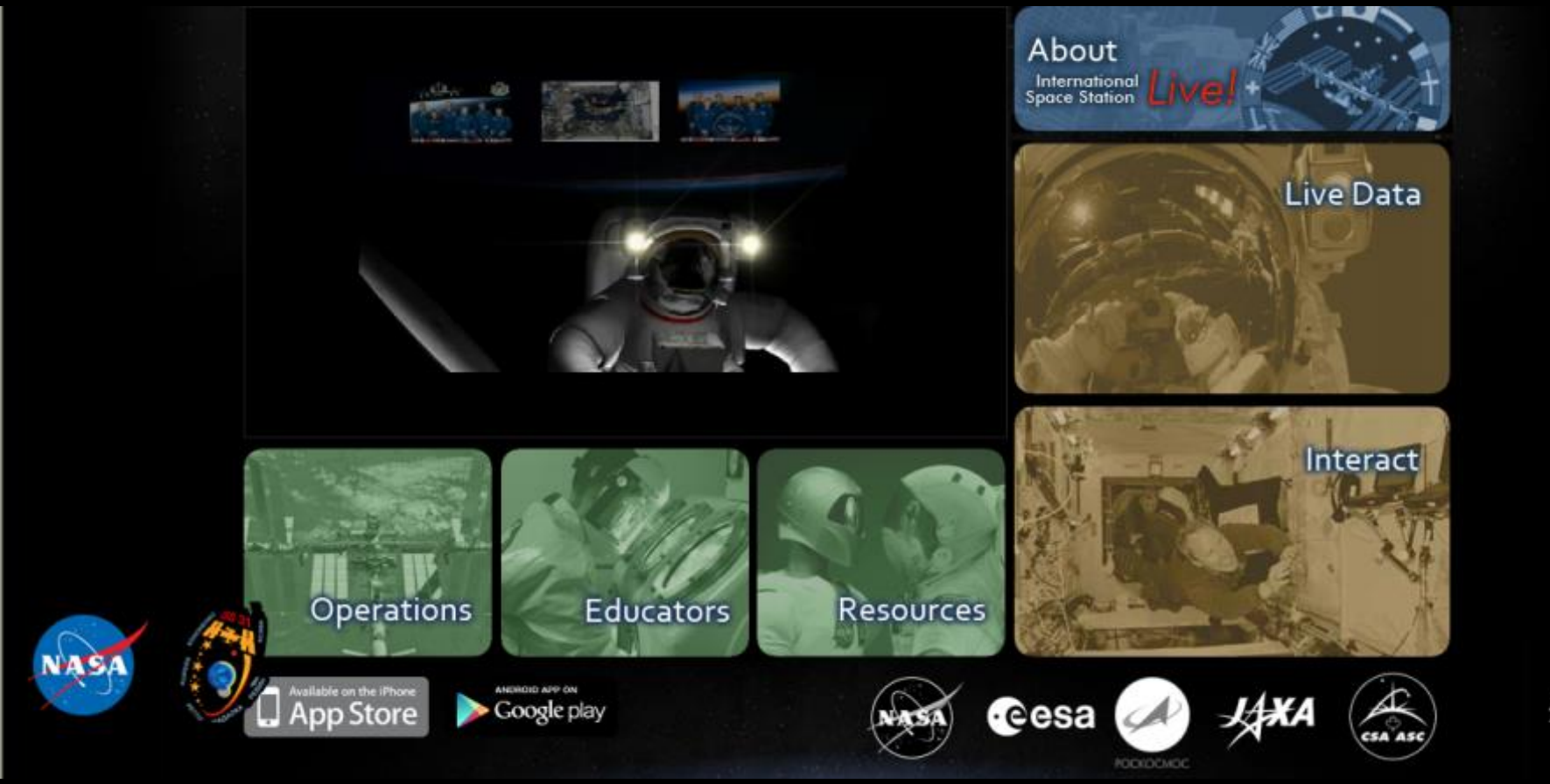
http://htwins.net/scale2/?bordercolor=white



ISS*Live*

ISSLive

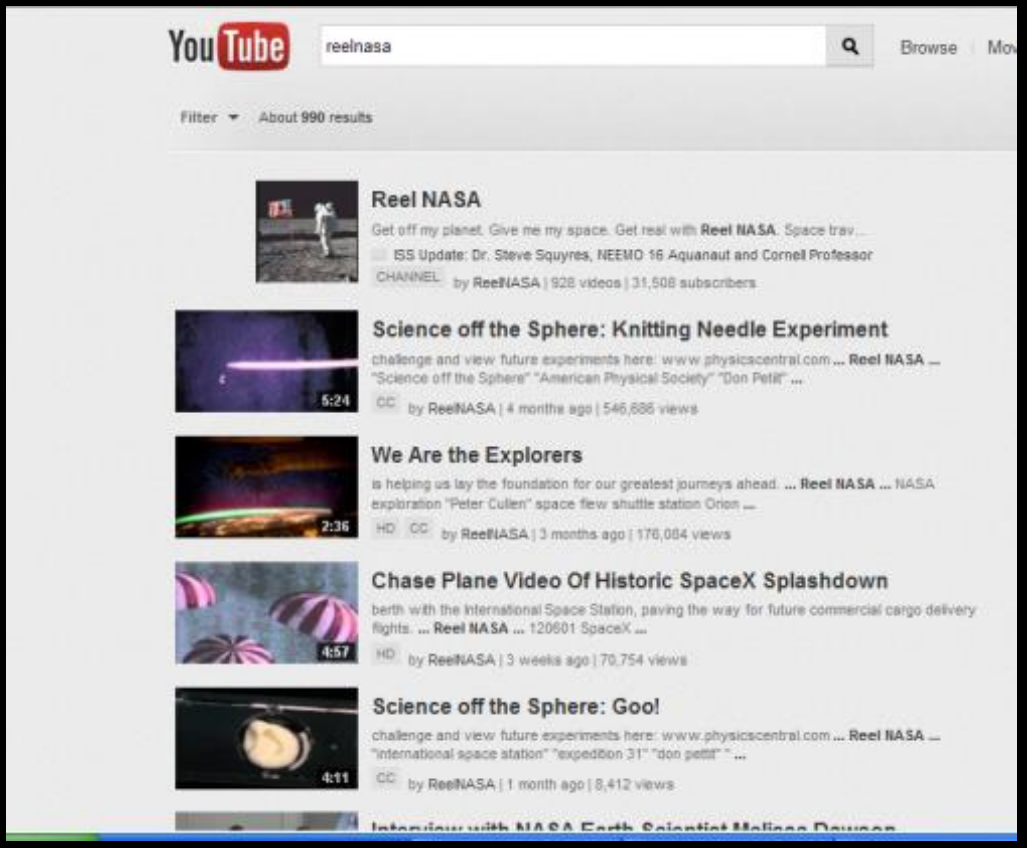
http://isslive.com/



Youtube – REELNASA

ReelNASA

http://www.youtube.com/results?search_query=reelnasa&sa=X&spell=1&search=Search&oi=spell



NASA Spinoffs

http://spinoff.nasa.gov/

Heavens Above

http://heavens-above.com/

NASA Distance Learning

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

See the Space Station fly over YOUR home!

Use “Skywatch” program or go to “sightings by city”

- **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