STEM Journey Presentation

ISS to Gateway

Forging the Path to Space Exploration

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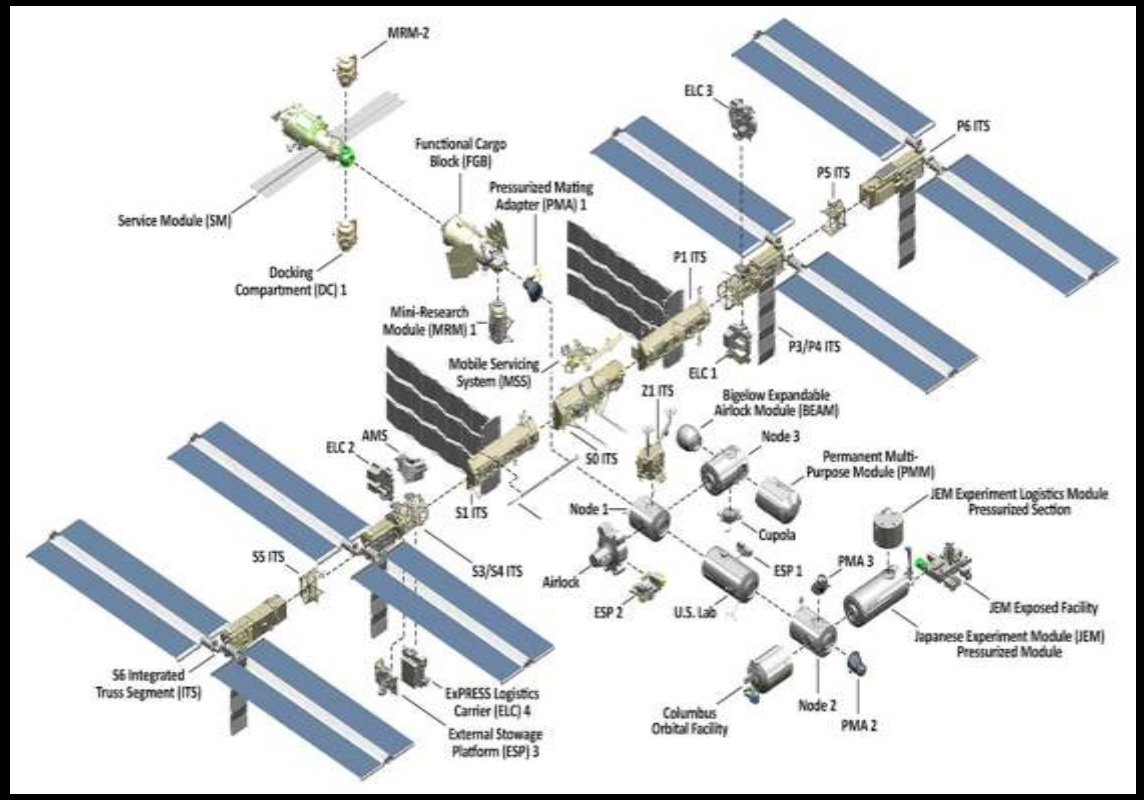
March 2, 2019

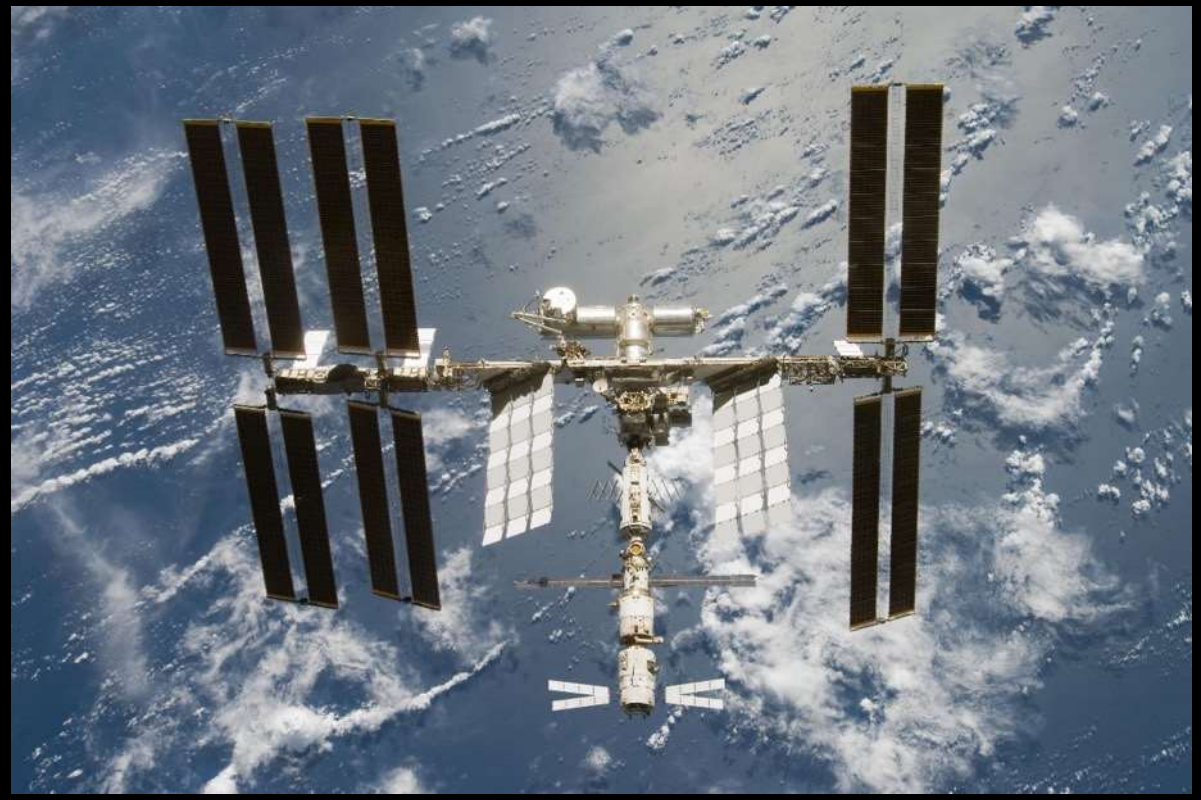
Space Policy Directive-1

"Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities.

Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations."

The International Space Station





Animation of ISS Assembly

ISS Fun Facts

Continuously Occupied Since	November 2000
Travel Speed	5 miles per second
Orbits Earth	Every 90 minutes
One Earth Day	16 ISS Sunrises/Sunsets
Length	357’ (American football field)
Travel Time to ISS	6 hours
Solar Panels Size	1 acre
Size	Larger than a 6 bedroom house
Space Walks	More than 200
Assembly	42 assembly flights: 37 NASA shuttle, 5 Russian Proton/Soyuz
Research	>2,500 research investigations

Views from ISS

Posted to Twitter by @Astro_Alex, European Space Agency astronaut Alexander Gerst, this image shows our planet's Moon as seen from the International Space Station.

The Aurora Borealis seen from the ISS

https://www.nasa.gov/mission_pages/station/images/index.html

ISS Research

What Happens in Microgravity, doesn’t stay in Microgravity

ISS as a US National Lab

"In 2005, Congress designated the U.S. portion of the ISS as the nation's newest national laboratory to maximize its use for improving quality of life on Earth, promoting collaboration among diverse users, and **advancing science, technology, engineering, and mathematics (STEM) education**. This unique laboratory environment is now available for use by non-NASA U.S. government agencies, academic institutions, and the private sector, providing these customers access to a permanent microgravity setting, a powerful vantage point in low Earth orbit, and the extreme and varied environments of space."

https://www.nasa.gov/mission_pages/station/research/nlab/index.html

ISS Research for you!

https://www.nasa.gov/mission_pages/station/research/nlab/research_opportunities

https://www.issnationallab.org/

https://nspires.nasaprs.com/

National Lab Research Opportunities

The ISS National Laboratory welcomes proposals for research and product development that might be suitable for the space station.

For more information, please see:

ISS National Lab Solicitations

ISS National Lab Research Proposal Submission and Evaluation Processes

NASA is seeking innovative partnerships for new capabilities. For more information, please see:
NASA Research Announcement: Research Opportunities for International Space Station Utilization, Solicitation: NNJ13ZBG001N (UPDATED: November 14, 2014)

ISS Research Client Service and IT Customer Service Helplines

ISS Research (Client Service) Helpline
The ISS Research Integration Office has both a phone and an email client service helpline that Payload Developers and others interested in doing research on ISS can contact to get assistance. The phone is staffed during regular business hours. After hours, please leave a message and a representative will return the call on the next business day. Or send us an email with your contact info, affiliation, detailed question(s), and how you are planning to use the info.
Phone: 281-244-6187
Email: jsc-iss-research-helpline@mail.nasa.gov

ISS IT PD Liaison/Customer Service
If you have questions regarding NASA/JSC badging, security or remote computer access (e.g., to NASA internal websites, ISS Payload documentation, etc.), please email the ISS IT PD Liaison or call Customer Service. The phone is staffed live during regular business hours. After hours, please leave a message and a representative will return the call on the next business day.
Phone: 281-244-8999
Email: jsc-iss-it-pd-liaison@mail.nasa.gov

ISS Ongoing Operations

CREW OPERATIONS

Health monitoring aboard the ISS

STATION OPERATIONS

NASA astronaut Serena Auñón-Chancellor performs plumbing duties inside the ISS toilet, also known as the Waste and Hygiene Compartment, located in the U.S. Tranquility module.

https://www.nasa.gov/mission_pages/station/images/index.html

ISS Research This Week – Astrobee

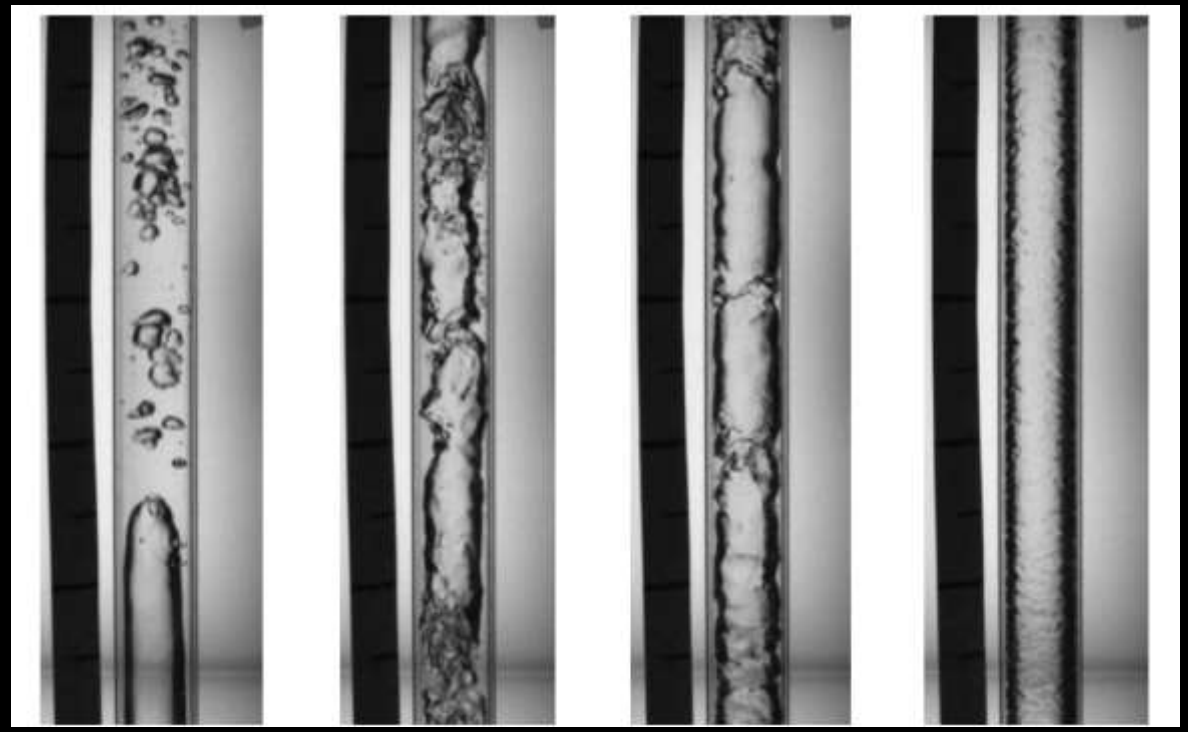
Terry Fong, Ph.D. NASA Ames Research Center, Moffett Field, CA

https://youtu.be/XqyA0trJUqI?t=10s

https://www.nasa.gov/mission_pages/station/research/experiments/explorer/Facility.html?#id=1891

ISS Research This Week – Flow Dynamics

Japan Aerospace Exploration Agency (JAXA)



SLUG FLOW CHURN FLOW SEMI-ANNULAR ANULAR

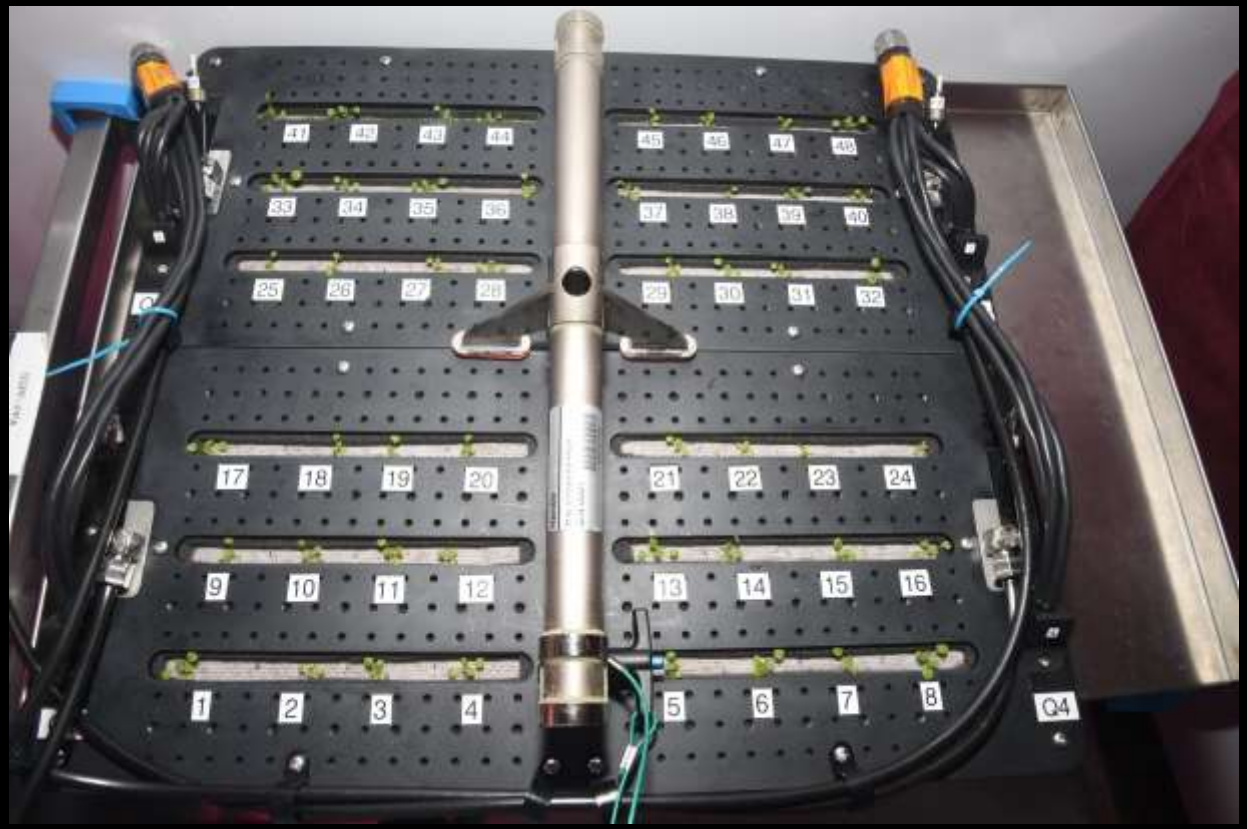
S Baba, et. Al. 2011. J.Phys: Conf. Ser. **327** 012055
https://iopscience.iop.org/article/10.1088/1742-6596/327/1/012055/pdf

ISS Research This May – VEG04A

https://www.youtube.com/watch?v=c1Gxn_nfgWA

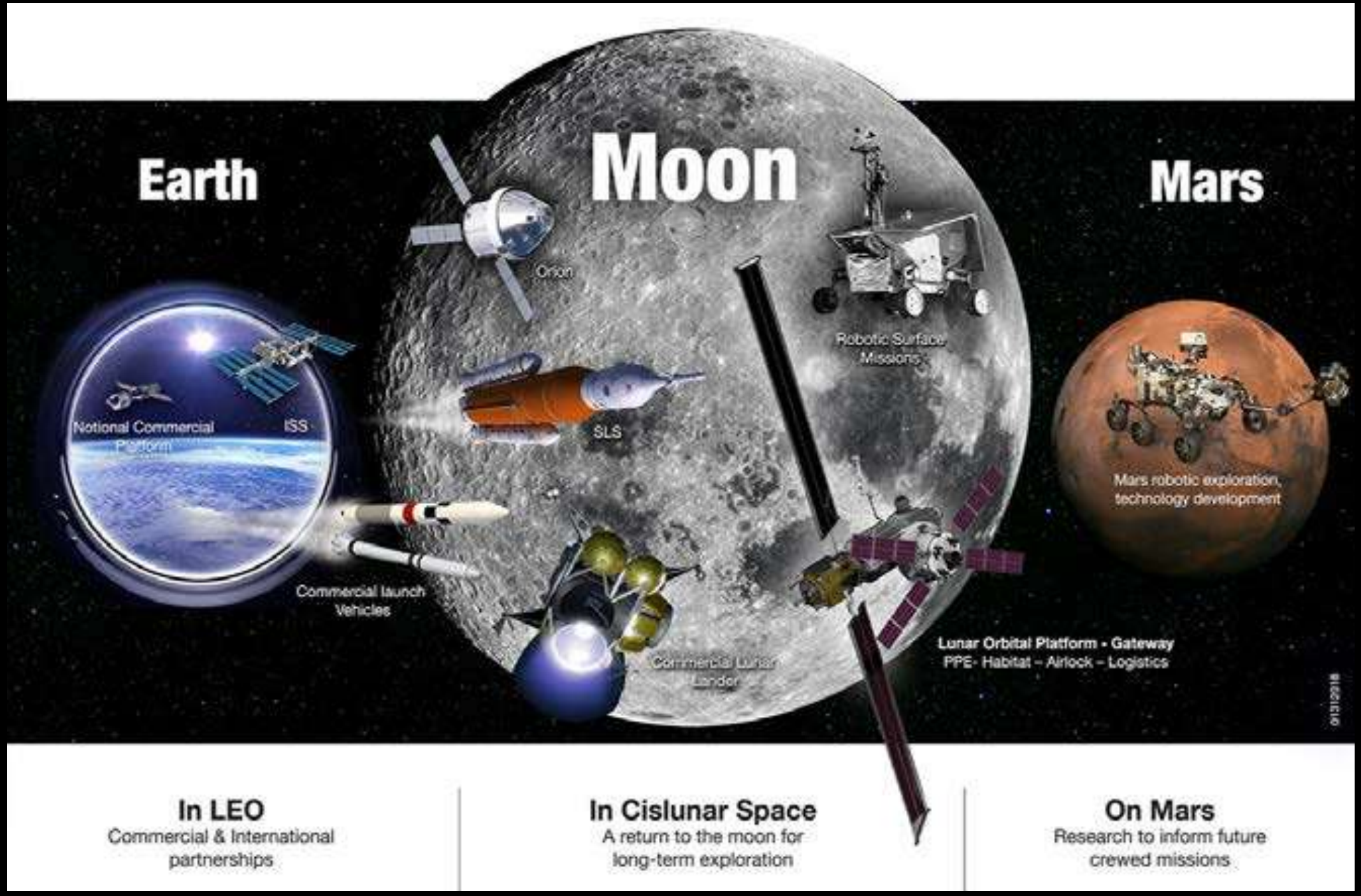
https://www.nasa.gov/mission_pages/station/images/index.html

ISS Research October – PH02

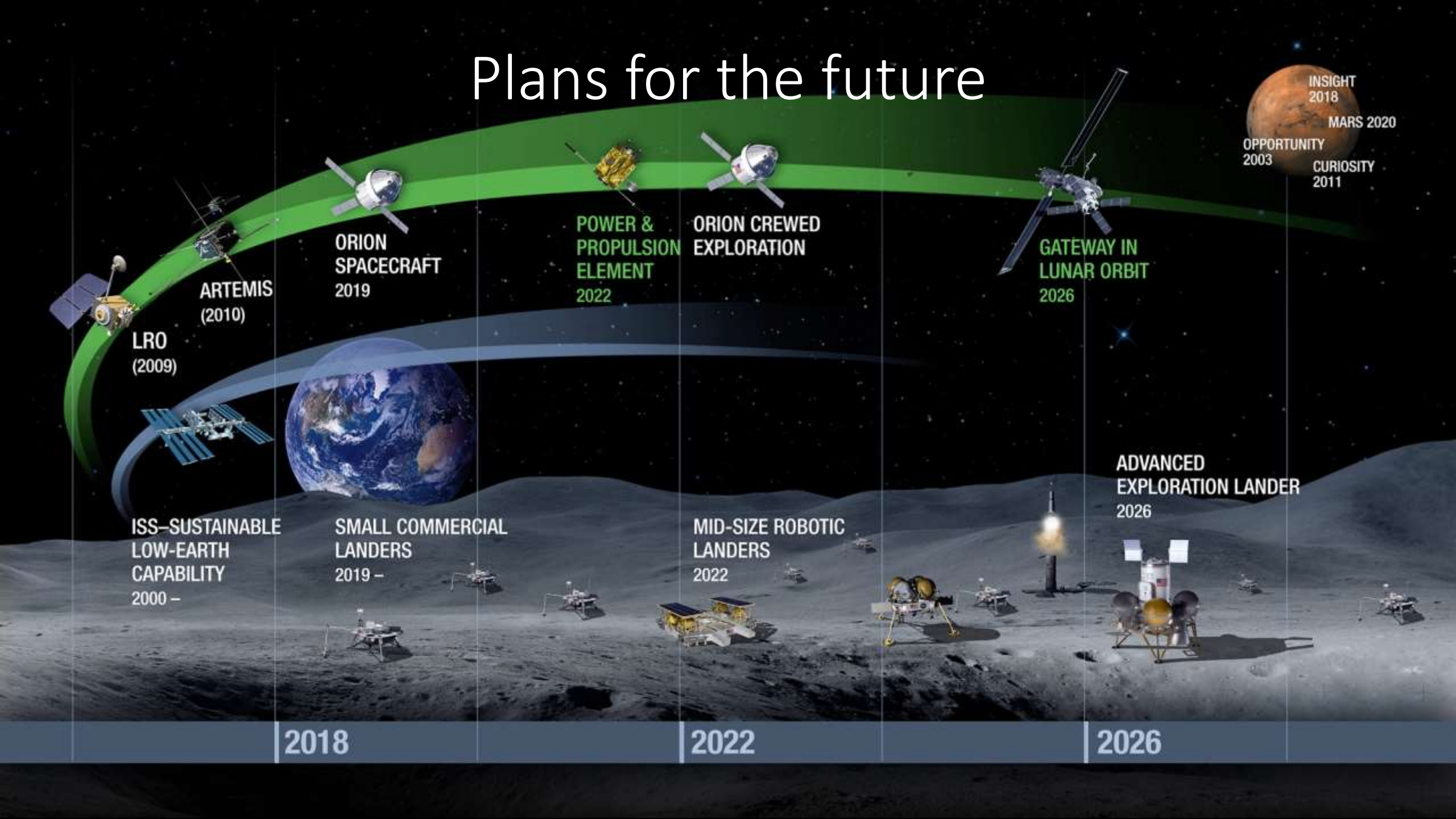


Radish

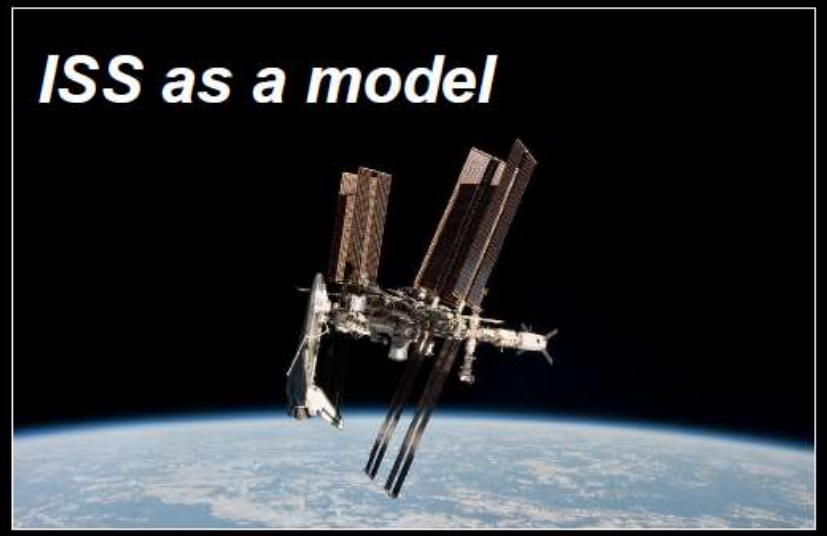
https://www.nasa.gov/mission_pages/station/images/index.html


Earth
Moon
Mars
Orion
Notional Commercial Platform
ISS
SLS
Robotic Surface Missions
Commercial launch Vehicles
Commercial Lunar Lander
Mars robotic exploration, technology development
Lunar Orbital Platform - Gateway
PPE- Habitat – Airlock – Logistics
In LEO
Commercial & International partnerships
In Cislunar Space
A return to the moon for long-term exploration
On Mars
Research to inform future crewed missions

Plans for the future



NASA'S Open Architecture Develops Space



Cygnus (Orbital ATK)

Dragon (SpaceX)

Dream Chaser (SNC)

Dragon Crew (SpaceX)

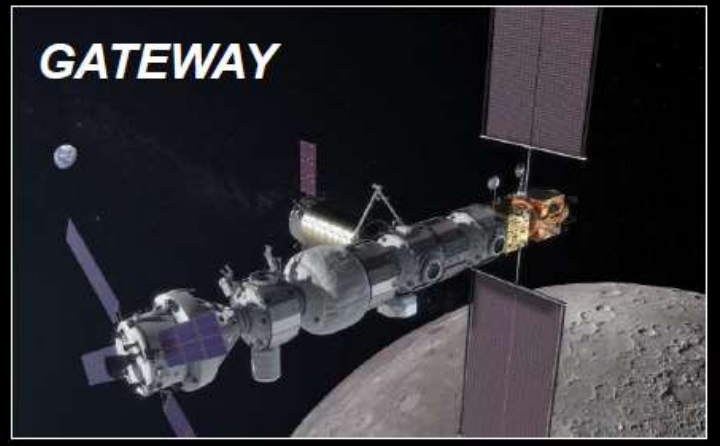
Starliner (Boeing)

INTERNATIONAL

Soyuz & Progress (Roscosmos)

H-II Transfer Vehicle (JAXA)

Orion/European Service Module (ESA)

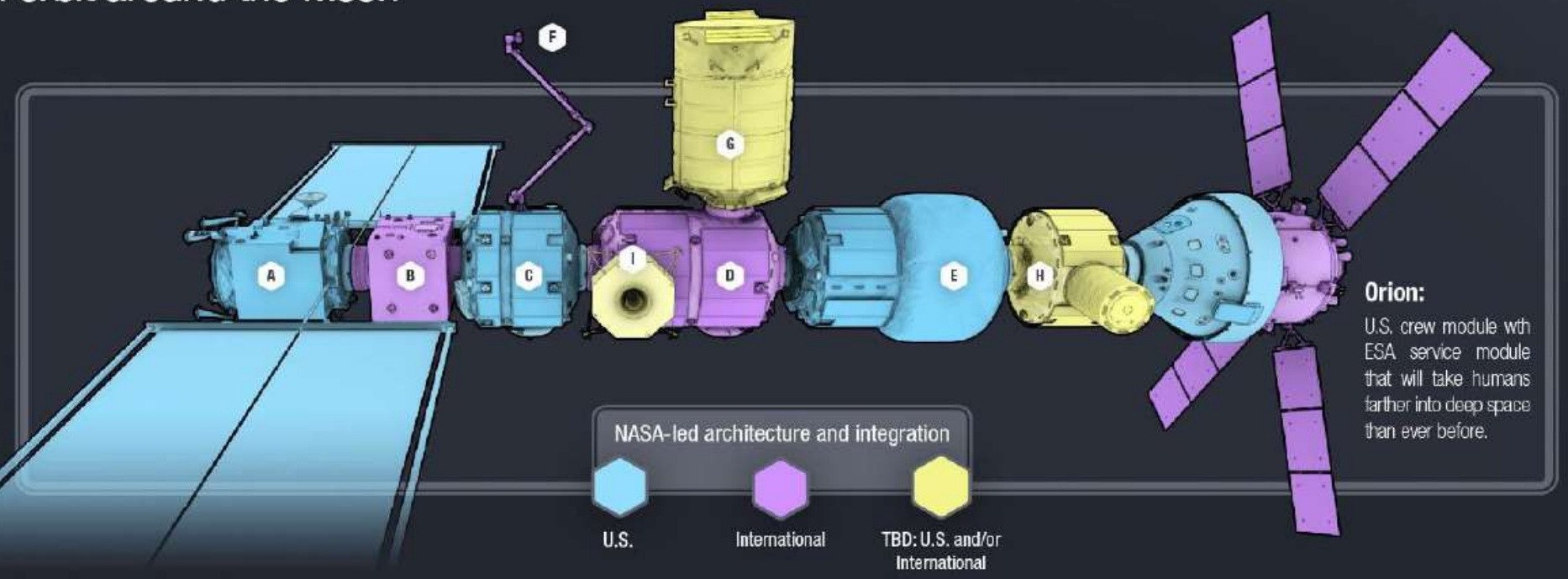


Multiple providers expected in lunar orbit and on the surface

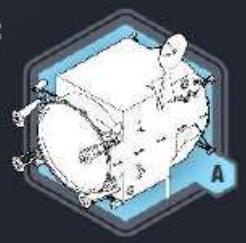
https://www.nasa.gov/topics/moon-to-mars/lunar-outpost

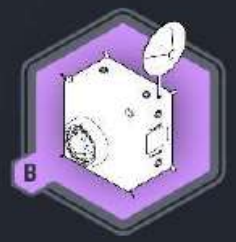
GATEWAY

An exploration and science outpost in orbit around the Moon



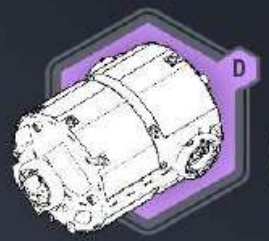
Power and Propulsion Element:
Power, communications, attitude control, and orbit control and transfer capabilities for the Gateway.

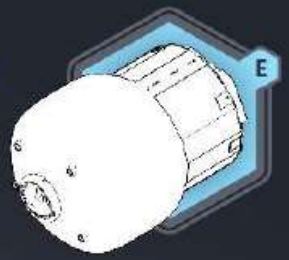




ESPRIT:
Science airlock, additional propellant storage with refueling, and advanced lunar telecommunications capabilities.

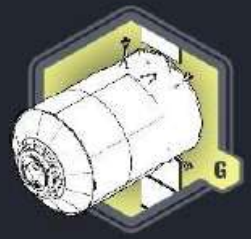
Utilization Element:
Small pressurized volume for additional habitation capability.





Habitation Modules: Pressurized volumes with environmental control and life support, fire detection and suppression, water storage and distribution.

Robotic Arm:
Mechanical arm to berth and inspect vehicles, install science payloads.



Logistics and Utilization:
Cargo deliveries of consumables and equipment. Modules may double as additional utilization volume.

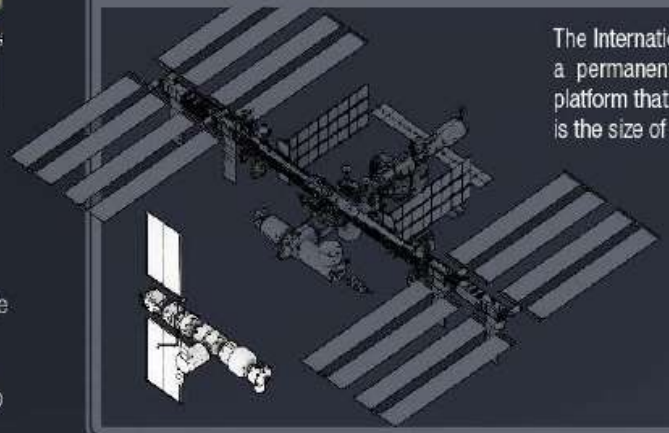
Airlock:
Enables spacewalks, potential to accommodate docking elements.

Sample Return Vehicle:
A robotic vehicle capable of delivering small samples or payloads from the lunar surface to the Gateway.

Orion:

U.S. crew module wth ESA service module that will take humans farther into deep space than ever before.

Gateway Compared to the International Space Station



The International Space Station is a permanently crewed research platform that has 11 modules and is the size of a football field.

The Gateway is a much smaller, more focused platform for extending initial human activities into the area around the Moon.

INTERNATIONAL INTEROPERABILITY STANDARDS

Draft Deep Space Interoperability System Standards Posted for feedback on March 1, 2018

- Avionics
- Communications
- Environmental Control and Life Support Systems
- Power
- Rendezvous
- Robotics
- Thermal

www.InternationalDeepSpaceStandards.com

NextSTEP Habitation

NextSTEP Phase 1: 2015-2016

Cislunar habitation concepts that leverage commercialization plans for LEO


LOCKHEED MARTIN


BIGELOW AEROSPACE


ORBITAL ATK


BOEING

FOUR SIGNIFICANTLY DIFFERENT CONCEPTS RECEIVED

Partners develop required deliverables, including concept descriptions with concept of operations, NextSTEP Phase 2 proposals, and statements of work.

NextSTEP Phase 2: 2016-2019

- Partners refine concepts and develop ground prototypes.
- NASA leads standards and common interfaces development.


BIGELOW AEROSPACE


BOEING


LOCKHEED MARTIN


SIERRA NEVADA CORPORATION


NORTHROP GRUMMAN


NANORACKS

NASA defines reference habitat architecture in preparation for Phase 3.

Phase 3: 2019+

- Partnership and Acquisition approach, leveraging domestic and international capabilities
- Development of deep space habitation capabilities
- Deliverables: flight unit(s)

https://www.nasa.gov/nextstep/habitation

Habitation Development Partnerships

Five full-sized ground prototypes will be delivered for testing in 2019. In final negotiations with NanoRacks for sixth habitat prototype demonstrator.

Lockheed Martin
Denver, CO

Refurbishes heritage hardware

Government Evaluation Location:
KSC

Northrop Grumman
Dulles, VA

Builds on proven cargo spacecraft development

JSC

Bigelow Aerospace
Las Vegas, NV

Expandable

Las Vegas

Boeing
Pasadena, TX

Leverages existing technologies

MSFC

Sierra Nevada
Louisville, CO

Modular buildup

JSC

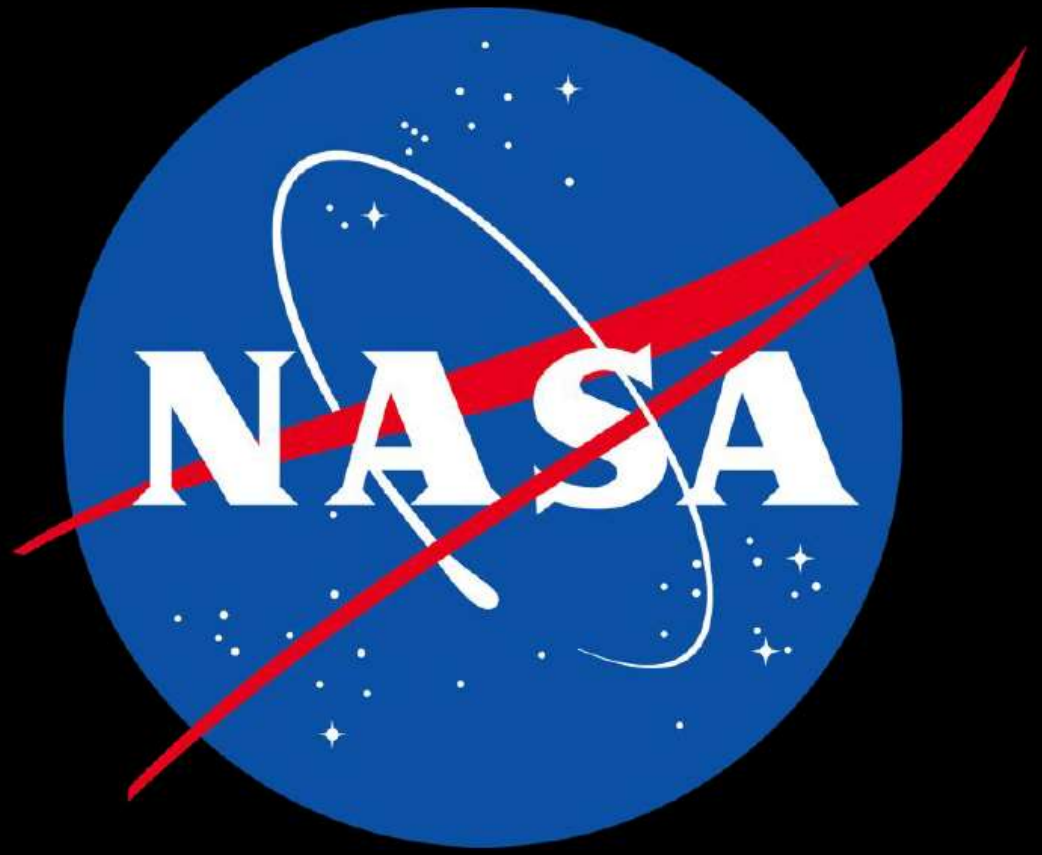
NanoRacks
Louisville, CO

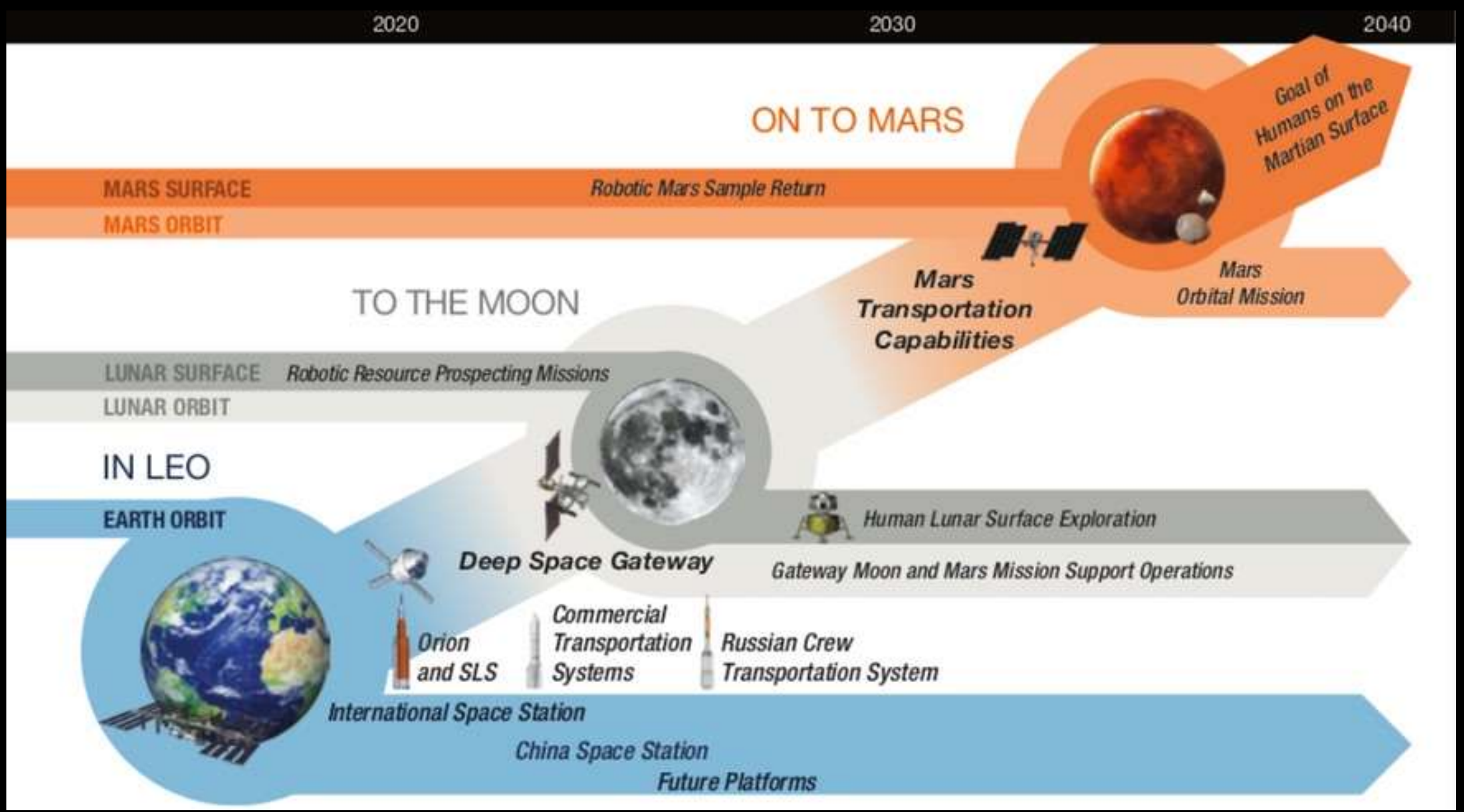
Converted Centaur upper stages

MSFC

What's Next? And What Can You Do?

- ISS National Lab Research is ramping up.
  - Check NSPIRES for Proposal Opportunities! (www.nspires.nasa.gov)
- Gateway is real. Congress approved FY19 NASA Appropriations.
- NextSTEP Phase 2 testing and closeout in 2019; Phase 3 build.
- Stay tuned for updates on your favorite NASA channel.


NASA


2020
2030
2040
ON TO MARS
Goal of Humans on the Martian Surface
MARS SURFACE
Robotic Mars Sample Return
MARS ORBIT
Mars Transportation Capabilities
Mars Orbital Mission
TO THE MOON
LUNAR SURFACE
Robotic Resource Prospecting Missions
LUNAR ORBIT
IN LEO
EARTH ORBIT
Human Lunar Surface Exploration
Deep Space Gateway
Gateway Moon and Mars Mission Support Operations
Orion and SLS
Commercial Transportation Systems
Russian Crew Transportation System
International Space Station
China Space Station
Future Platforms

Plans for the future