National Aeronautics and Space Administration

NASA Advisory Council

HEO Committee Public Meeting

Kathryn Lueders
Associate Administrator
Space Operations Mission Directorate

Jim Free
Associate Administrator
Exploration Systems Development
Mission Directorate

January 18, 2021

Agenda

1. 2021 Accomplishments
2. 2022 Look Ahead
3. Mission Directorate Reorganization
4. Exploration Systems Development Mission Directorate (ESDMD) Update
5. Space Operations Mission Directorate (SOMD) Update

2021 Accomplishments

CMUS AT SEA TESTS

NASA's 2021 Human Spaceflight Accomplishments

Splashdown of SpaceX Cargo Resupply 21 (CRS-21)

Orion handover to Exploration Ground Systems for processing

NASA SpaceX Crew-2 launch

Northrop Grumman Commercial Resupply Services (CRS-15)

Artemis I Core Stage shipment to Kennedy Space Center

Artemis I Core Stage Green Run

Gateway PPE/HALO launch vehicle contract awarded to SpaceX

Artemis III Human Landing System selected

Announcement of first Private Astronaut Mission to the International Space Station (ISS)

Artemis II European Service Module (ESM) delivered to Kennedy Space Center

Launch of Mark Vande Hei and cosmonauts to ISS on Soyuz 64S

Return of Soyuz 63S and crew from the International Space Station

SpaceX Cargo Resupply (CRS-22)

NASA SpaceX Crew-1 return from the space station

Nauka Multipurpose Laboratory installed on the space station

Gateway HALO contract awarded to Northrop Grumman

Launch of Double Asteroid Redirection Test (DART)

Launch of Landsat-9 Earth observation mission

Northrop Grumman Commercial Resupply Services (CRS-16)

Return of Kate Rubins and cosmonauts from ISS on Soyuz 63S

Return of NASA SpaceX Crew-2

Launch of NASA SpaceX Crew-3

Stacking completed for Artemis I transportation system

NASA's announcement of new class of astronaut candidates

Launch of Lucy mission to explore Jupiter's Trojan asteroids

Launch IXPE X-ray imaging mission

Five companies selected to develop concepts for recurring human lunar landing services

Laser Communications Relay Demonstration (LCRD) launch

Announcement for new class of Flight Director applicants

More than 1,500,000 participating students in ISS STEM activities

Launch of the James Webb Space Telescope

NASA astronauts and Russian cosmonauts completed 13 spacewalks

10 NASA astronauts lived and worked aboard the station

Five commercial cargo missions to ISS

Three partners selected by NASA to develop Commercial LEO Free-flyer Concepts

NASA selects Axiom Space for the second Private Astronaut Mission to the ISS

2022 Look Ahead


THIS IS
NASA 2022
0:11 / 2:30
HD

Upcoming Events

Webb Telescope – January 2022
The James Webb Space Telescope completes mission deployments/arrives in its L2 (second Lagrange Point) orbit about 29 days after launch (mission support from SCaN and LSP)

Northrop Grumman (NG-17) – Targeting Feb. 19, 2022
Northrop Grumman's 17th commercial resupply services mission to the International Space Station; launching from Virginia

Geostationary Operational Environmental Satellite-T (GOES-T) – March 1, 2022
NASA and NOAA's latest weather satellite, GOES-T, launching from Florida

Mark Vande Hei to set new record for NASA human spaceflight – March 15, 2022
Vande Hei will hold the record for the longest single spaceflight for an American astronaut; return to Earth planned for March 30 after 355 days in space.

CAPSTONE – March 19, 2022
NASA CubeSat to validate new navigation technologies and verify dynamics in Gateway's planned orbit; launching from New Zealand

Axiom Mission 1 (Ax-1) – NET March 31, 2022
First private astronaut mission to the International Space Station; duration ~8-10 days long

Upcoming Events

Artemis I – March/April 2022
The first integrated flight test of the uncrewed Space Launch System rocket and Orion spacecraft on a multi-week mission around the Moon

Orion splashdown – Pending Artemis I launch
NASA's Orion spacecraft splashdown following a multi-week mission around the Moon

Intuitive Machines' CLPS Flight – First Quarter 2022
Suite of robotic NASA payloads sent lunar surface as part of a Commercial Lunar Payload Services (CLPS) delivery; lunar landing in the following weeks

NASA's SpaceX Crew-4 – NET April 15, 2022
Crew-4 launching from Florida to the International Space Station

Boeing Orbital Flight Test-2 (OFT-2) – May 2022
Boeing's uncrewed CST-100 Starliner OFT-2, launching from Florida to the International Space Station

Astrobotic's CLPS Flight – June 2022
Suite of robotic NASA payloads sent to the lunar surface as part of a Commercial Lunar Payload Services delivery; landing will occur in the following weeks

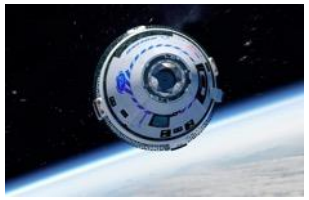
Upcoming Events

DART – Sept. 26-Oct. 1, 2022
Window when Double Asteroid Redirection Test (DART) spacecraft impacts an asteroid in world's first test of planetary defense

NASA's SpaceX Crew-5 Launch / Crew-4 Return – Fall, 2022
Boeing's CFT earliest possible launch to space station from Florida

Artemis II Crew Announcement – 2022
NASA will announce the astronauts that will fly on the first crewed flight of Orion spacecraft and Space Launch System rocket for the Artemis II mission

Boeing's Crew Flight Test (CFT) – Under review pending OFT-2
Boeing's CFT earliest possible launch to space station from Florida



Boeing Starliner-1 – Under review pending earlier flight tests
Launch of first operational Boeing commercial crew launch to space station from Florida

Mission Directorate Reorganization

Mission Directorate Reorganization

In September 2021, NASA Administrator Bill Nelson announced the agency was creating two new mission directorates that would best position the agency for the next 20 years. The move separated the Human Exploration and Operations Mission Directorate (HEOMD) into the new **Exploration Systems Development Mission Directorate (ESDMD)** and **Space Operations Mission Directorate (SOMD)**.

The changes were made because of increasing space operations in low-Earth orbit and development programs well underway for deep space exploration including Artemis missions.

The intent for creating two separate mission directorates was to ensure these critical areas have focused oversight teams in place to support and execute for mission success. This approach also allows one mission directorate to operate in space while the other builds future space systems, so there is a constant cycle of development and operations to advance NASA's goals in space exploration.

National Aeronautics and
Space Administration

ESDMD Update

Jim Free

Associate Administrator,
Exploration Systems Development Mission Directorate (ESDMD)
NASA Headquarters, Washington, D.C.

January 18, 2022

Briefing Topics

- **Exploration Systems Development Mission Directorate (ESDMD) Priorities**
- **Manifest Updates and Status**
- **Artemis Mission Status and Forward Plan**
- **Moon-Mars Architecture**
- **Gateway**
- **Future Artemis Mission Status**

ESDMD Priorities

- Successful preparations for and execution of the Artemis I mission
- Working refinements of Exploration Systems Development Mission Directorate (ESDMD) organization; communication with stakeholders for review and input; Implementation; Connectivity with Space Operations Mission Directorate (SOMD)
- Incorporation and embedding of science across Artemis
- Execution of Artemis II, III and IV final developments, build completion, launch and operations this includes program/project management process improvements
- Defined lunar and Mars architecture with on-ramps for newly developed technology based on broad objectives

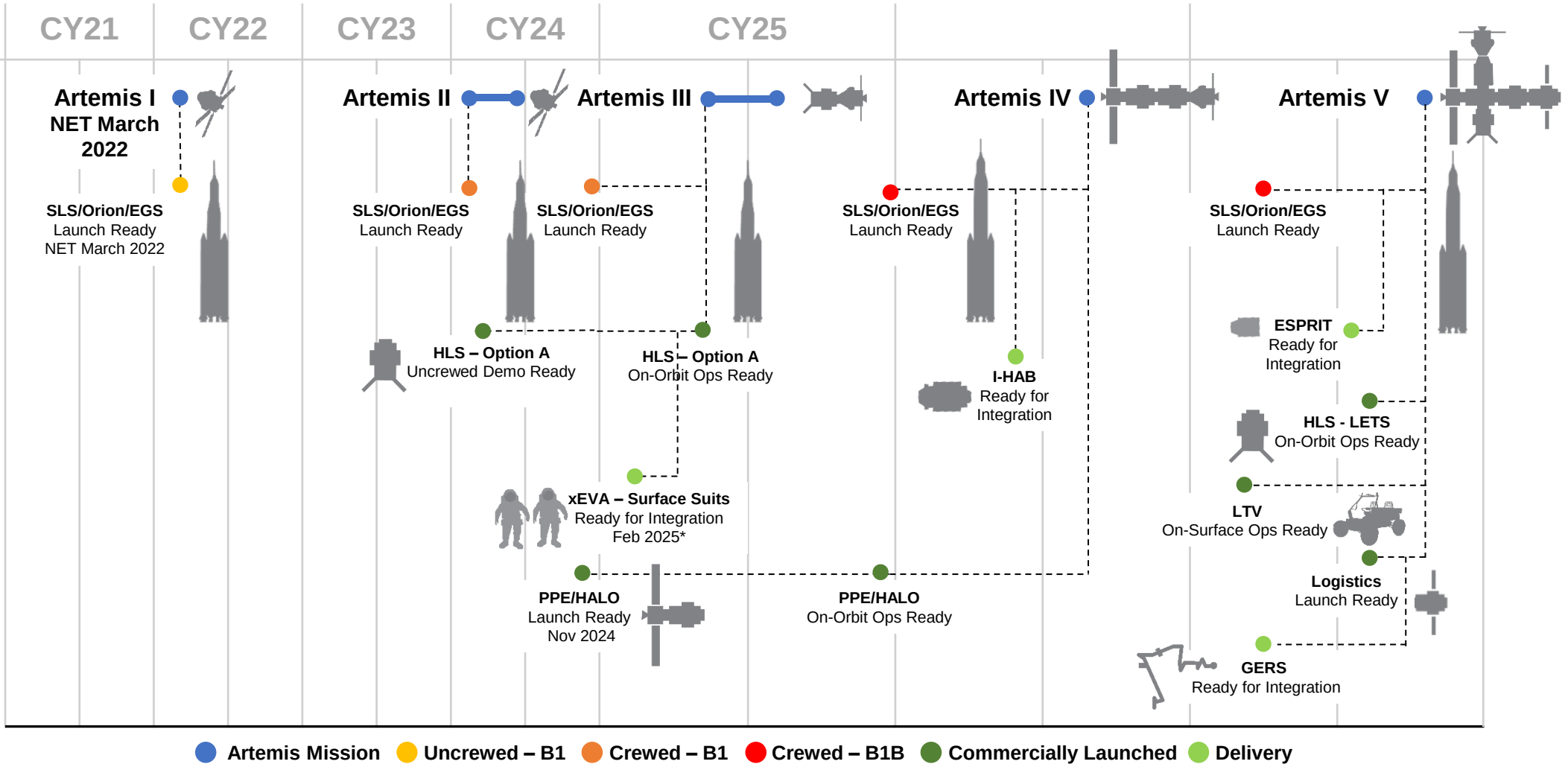
Manifest Updates and Status

Working Manifest for Technical Integration

Key Terminology:

B1: Block 1 (SLS with ICPS)
B1B: Block 1B (SLS with EUS)
EGS: Exploration Ground Systems
ESPRIT: European System Providing Refueling, Infrastructure & Communications
EUS: Exploration Upper Stage
GERS: Gateway External Robotics System
HALO: Habitation and Logistics Outpost
HLS: Human Landing System
ICPS: Interim Cryo Propulsion Stage
I-HAB: International Habitat
LETS: Lunar Exploration Transportation Services
LTV: Lunar Terrain Vehicle
PPE: Power & Propulsion Element
SLS: Space Launch System
xEVA: Exploration Extravehicular Activity

***Date based on Government planning and estimates; not contract informed**



Artemis I Mission Status and Forward Plan

REV Q
As of 1/5/2022

MAJOR MILESTONES FOR ARTEMIS KSC FLOW

Status – Jan 5 – Will Be Updated As Risk Is Realized

DATE KEY:
Forecast Date/Actual Date


Nov 15
LAS HANDOVER TO EGS (Planned 11/15/19)


Nov 20
ML READY FOR BOOSTER STACKING (Planned 11/2/20)

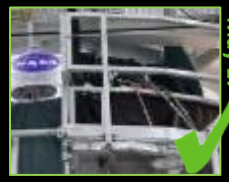

Nov 20
BOOSTER STACKING ON ML BEGINS (Planned 11/21/20)


Jan 14
ORION CSM HANDOVER TO EGS (Planned 12/4/20)


Mar 30
START OF ORION HYPERS SERVICING (Planned 3/26)


Apr 16
ORION SERVICE MODULE FUELING COMPLETED (Planned 4/17)


Apr 29
CORE STAGE ARRIVES AT VAB FROM SSC (Planned 4/26)


May 17
ORION CREW MODULE FUELING COMPLETE (Planned 5/14)


Jun 4
ICPS FUELING AT MPPF COMPLETED (Planned 6/4)


Jun 6
CS TRANSFER AISLE WORK COMPLETED (Planned 6/4)


Jun 9
START OF CORE STAGE MATE (Planned 6/7)


Jun 15
START INSTALL OF INTERNAL PLATFORMS


Jun 21
START OF LVSA MATE (Planned 6/16)


Jul 5
STACK ICPS (Planned 6/26)


Jul 10
ORION TO LASF (Planned 6/24)


Aug 6
CORE STAGE POWER UP (Planned 7/19)


Aug 10
STACK ORION STAGE ADAPTER STRUCTURAL TEST ARTICLE (Planned 6/25)


Aug 13
STACK MASS SIMULATOR FOR ORION (Planned 7/2)


Aug 13
COMPLETE SLS PREVALVE CLUTCH CHANGEOUT


Aug 17
MODAL TAP TEST (Planned 7/26)


Aug 23
FIRST INTEGRATED POWER UP


Aug 30
UMBILICAL CONNECTS COMPLETE (Planned 7/10)


Sep 19
START OF UMBILICAL RELEASE AND RETRACT TEST (URRT) (Planned 8/11)


Sep 28
INTEGRATED MODAL TEST (IMT) COMPLETED (Planned 8/20)


Oct 1
DESTACK MASS SIMULATOR FOR ORION (Planned 8/24)


Oct 4
ORION STAGE ADAPTER TO VAB HIGH BAY 4


Oct 4
DESTACK ORION STAGE ADAPTER STRUCTURAL TEST ARTICLE (Planned 8/26)


Oct 6
ESTABLISH CORE STAGE ACCESS COMPLETED (Planned 8/28)


Oct 9
STACK OSA (Planned 8/27)


Oct 19
ORION TO VAB HIGH BAY 4 (Planned 8/30)


Oct 22
STACK ORION TO SLS (Planned 9/3)


Nov 28
UMBILICAL REMATES


Dec 7
INTEGRATED VEHICLE INTERFACE VERIFICATION TEST (IVT) PT 1 (Planned 9/9)


Dec 17
COMM END-TO-END (LIVE) COMPLETE (Planned 9/24)


Dec 20
COUNTDOWN SEQUENCE TEST (CST) PT 1 (Planned 9/25)

PROGRAM SPECIFIC ENGINEERING TESTING (PSET) COMPLETE

CORE STAGE FLIGHT BLANKET INSTALL

FLIGHT TERMINATION SYSTEM TEST PART 1

PREPS FOR ROLLOUT

ROLL TO PAD B

START OF WET DRESS REHEARSAL (WDR)

LAUNCH DATE SET AFTER SUCCESSFUL WDR

START OF FINAL CLOSEOUTS FOR LAUNCH & FLIGHT SAFETY SYSTEM

CREW MODULE STOW COMPLETE

FLIGHT TERMINATION SYSTEM 10 DAY REQUIREMENT

ROLL TO PAD B

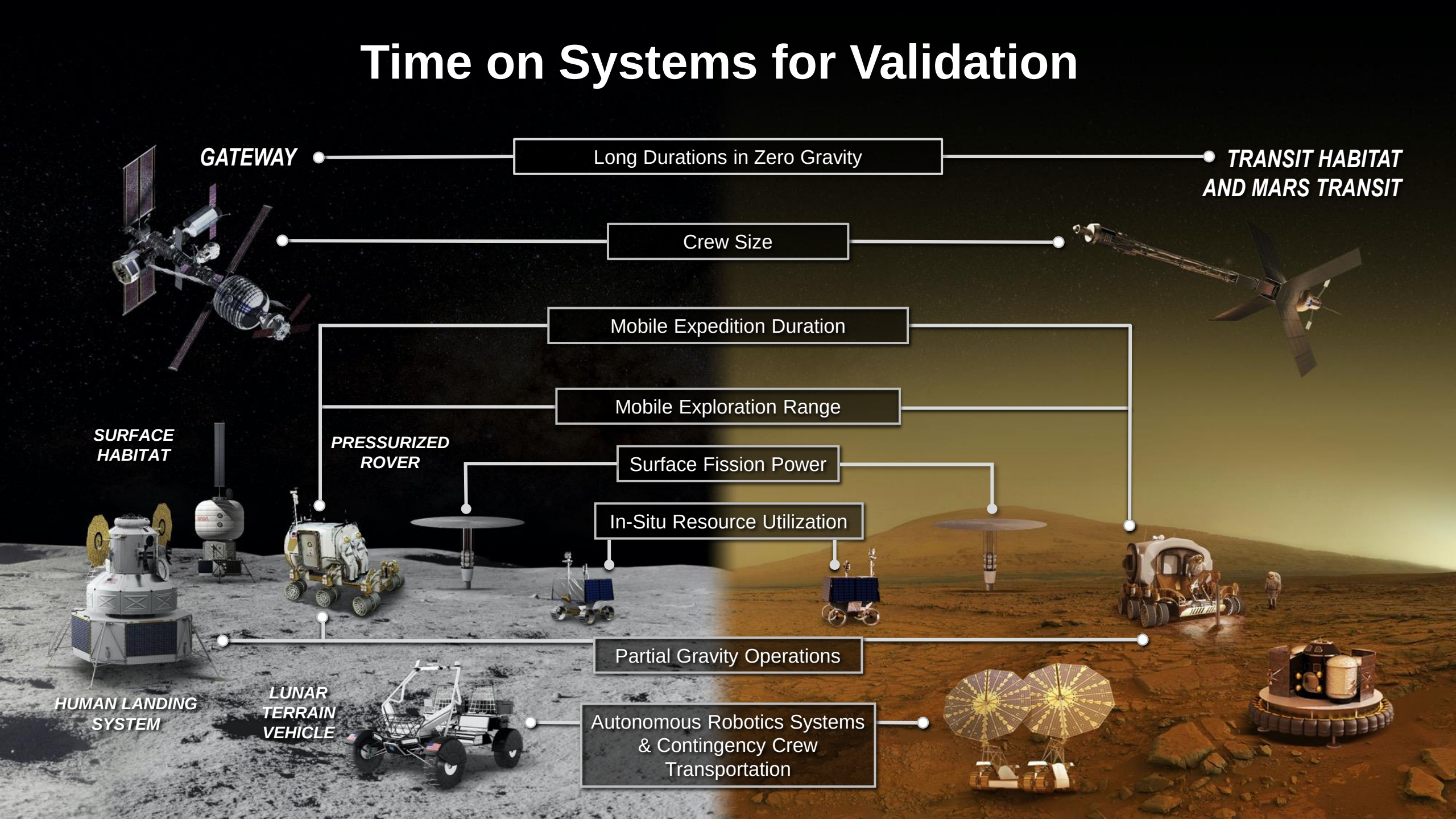
PAD OPS AND LAUNCH COUNTDOWN

ARTEMIS I LAUNCH WINDOW OPENS

RECOVERY OPS COMPLETED

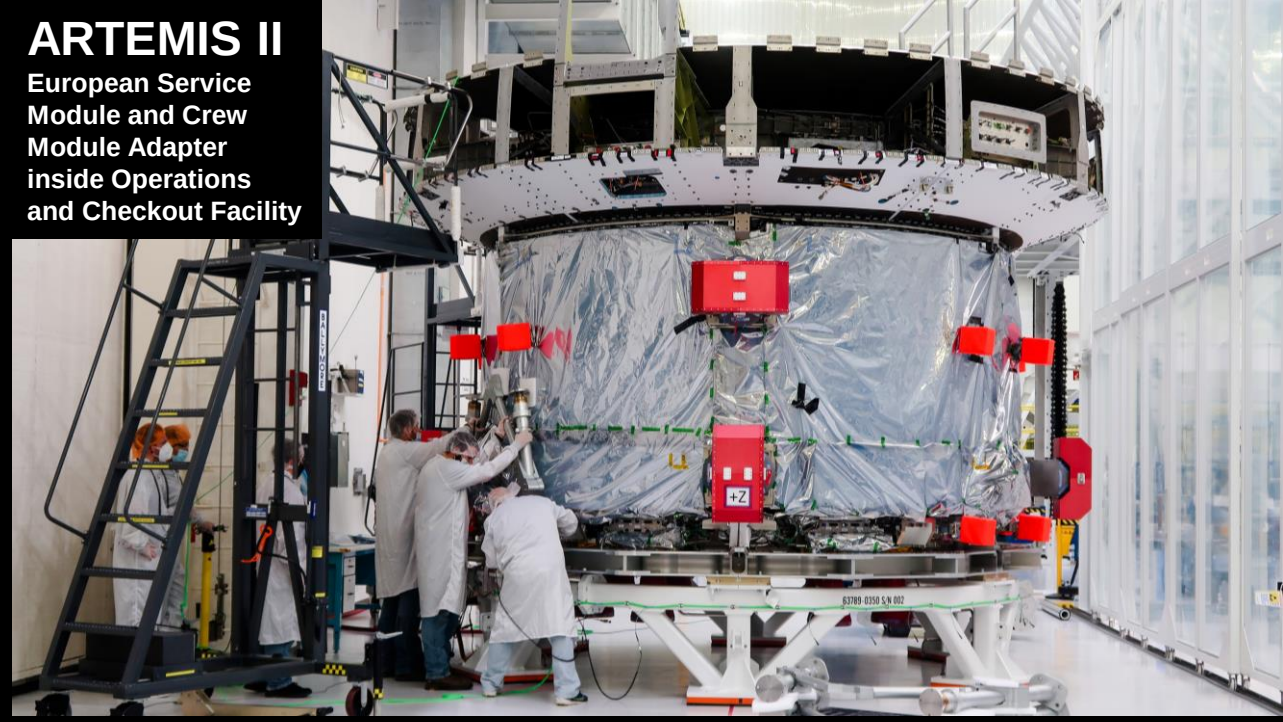
Moon-Mars Architecture

Time on Systems for Validation



Future Artemis Mission Status

ARTEMIS II
Crew Module at
Kennedy Space Center

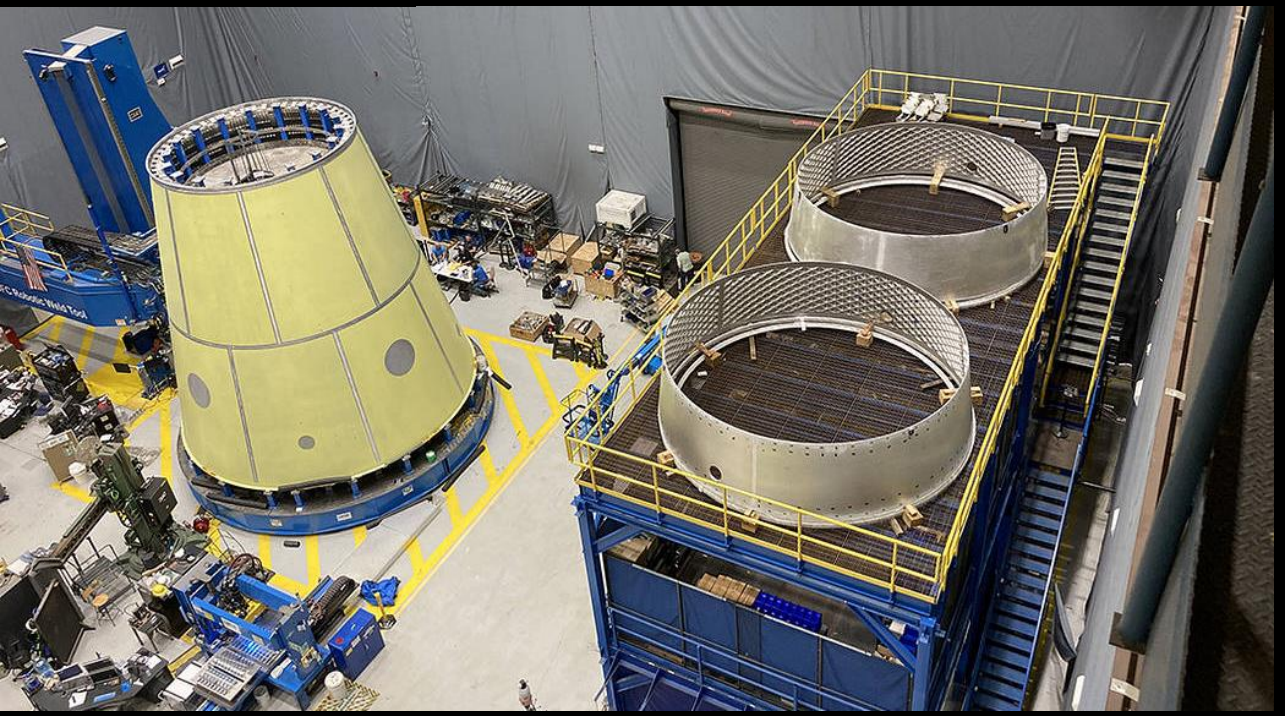


ARTEMIS II
European Service
Module and Crew
Module Adapter
inside Operations
and Checkout Facility

ARTEMIS II
Heat Shield at
Kennedy Space Center

ARTEMIS II + III

Launch Vehicle Stage Adapter (II) and Orion Stage Adapters (II + III)



ARTEMIS II

Interim Cryogenic Propulsion Stage

ARTEMIS III

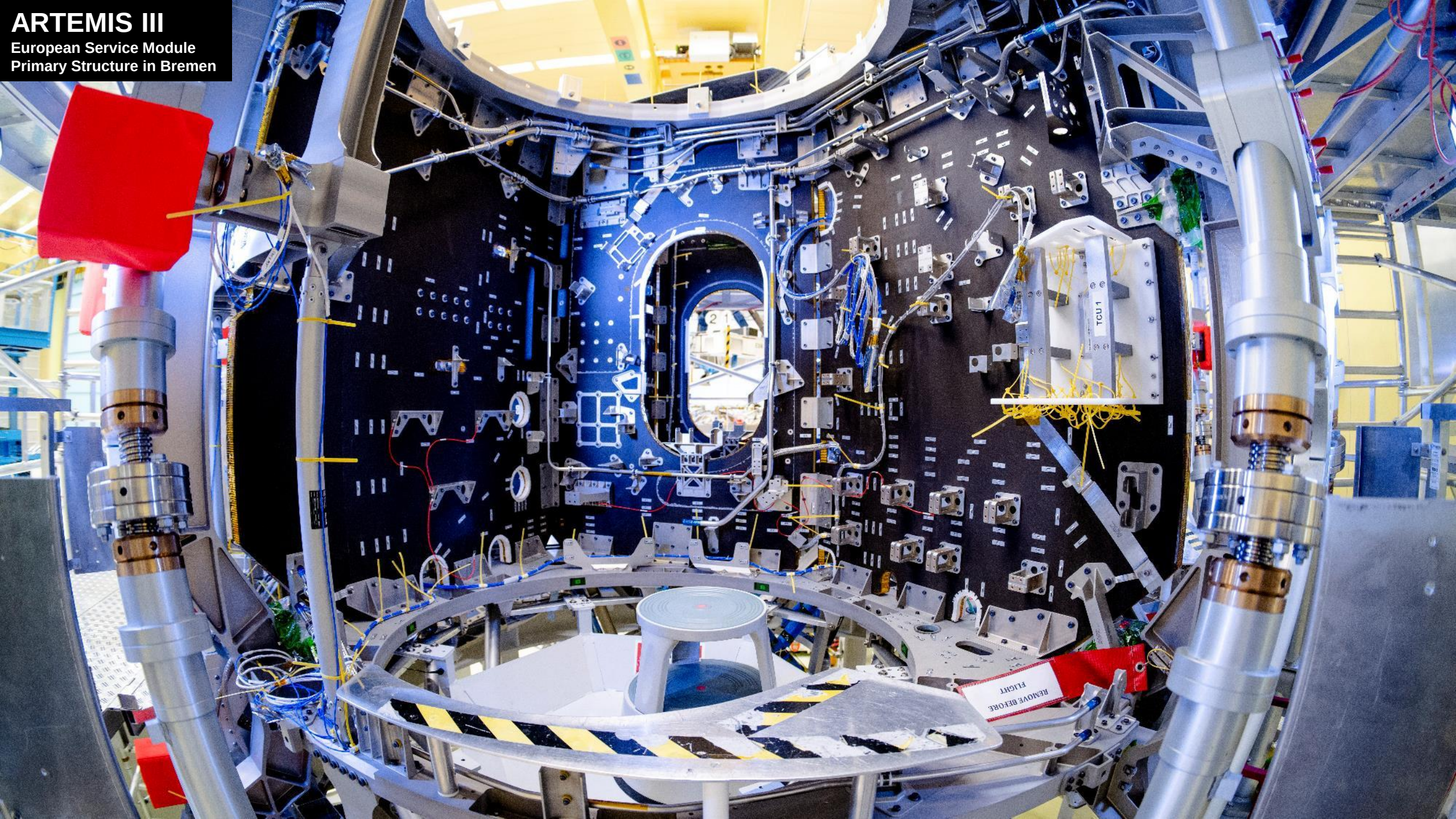
Pressure Vessel at Kennedy Space Center

ARTEMIS III

European Service Module
Primary Structure in Bremen

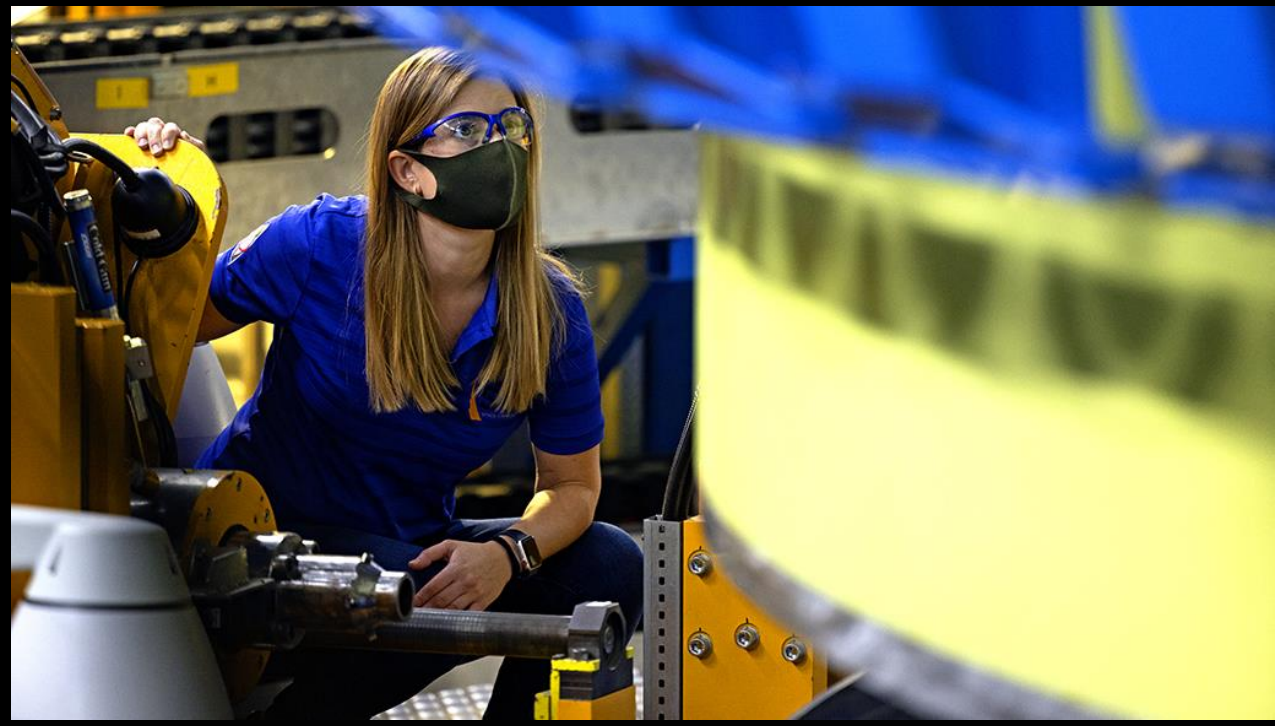
ARTEMIS III

European Service Module
Primary Structure in Bremen



ARTEMIS III

SLS Forward Skirt



ARTEMIS IV

SLS Booster Motors

ARTEMIS IV

SLS Core Stage
Engine Section

Gateway

Gateway Integrated Spacecraft

SPACEX

Co-manifested PPE/ HALO Launch Vehicle

MAXAR

Power and Propulsion Element (PPE)

CSA ASC

Gateway External Robotic System (GERS)

SPACEX

Logistics Module

JAXA

HTV-XG Resupply (proposed)

Airlock (provider TBD)

ESPRIT-Refueler

esa

International Habitat (I-HAB)

esa JAXA

Habitation and Logistics Outpost (HALO)

NORTHROP GRUMMAN

Orion Spacecraft

European Service Module

esa

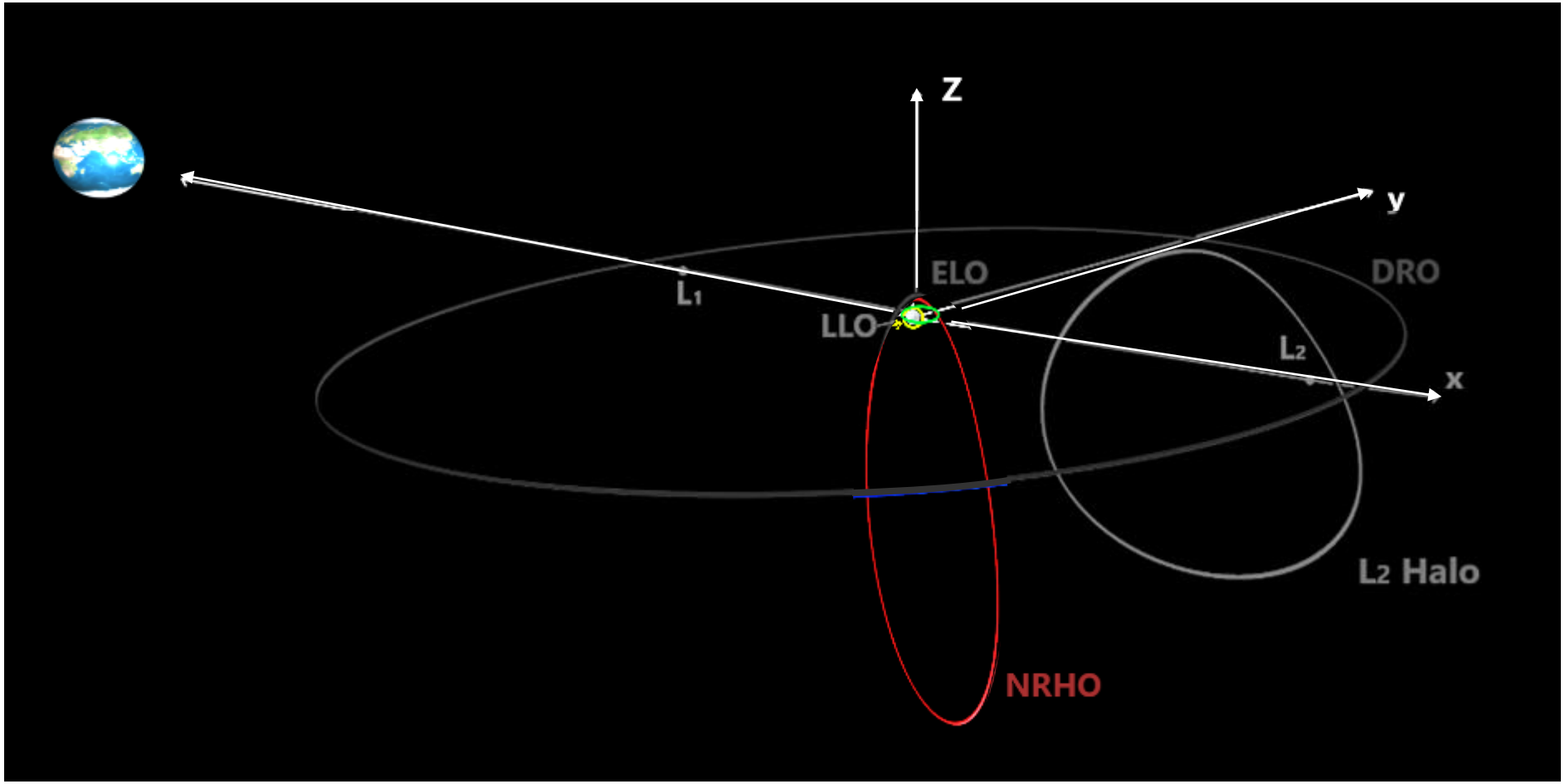
NASA

Human Landing System (HLS) (govt. reference concept shown)

Gateway Near Rectilinear Halo Orbit (NRHO)

Staging Orbit Drivers:

- ✓ Crew Vehicle Access
- ✓ Lunar Surface Access
- ✓ Orbit Maintenance
- ✓ Power/Lighting
- ✓ Thermal Balance
- ✓ Communication
- ✓ Extended Lunar Mission Duration
- ✓ Mars Mission Buildup
- ✓ Mars Mission Analog
- ✓ Mars Mission Departure Point
- ✓ Mars Mission Return Point
- ✓ International Collaboration



Near Rectilinear Halo Orbit Supports Sustainable Lunar Exploration and Mars Preparation/Transit/Return Point

Conclusion

Conclusion

- Reorganization process moving and working to wrap up soon
- Artemis I
  - Push to Artemis I is critical with some key upcoming milestones
    - E.g – Countdown Systems Test #2, Engine Blanket Closeout, Wet Dress Rehearsal
- Artemis II
  - Artemis I lessons learned expected to have impact on Artemis II
  - First crew launch will be significant
- Artemis III
  - Credible plans for Human Landing System development and execution are in process
  - Extravehicular Activities Suit development details to be refined with contract award
- Artemis IV
  - Mission elements (Mobile Launcher-2 and Block 1B) in focus
  - Challenges expected with Block 1B development
  - Working International Partner and Logistics Element

National Aeronautics and
Space Administration

SOMD Update

Kathryn Lueders

Associate Administrator,
Space Operations Mission Directorate (SOMD)
NASA Headquarters, Washington, D.C.

January 18, 2022

Briefing Topics

- SOMD Priorities
- ISS Extension
- Commercial LEO
- Evolution of Space Communications
- Launch Vehicle Strategy
- Conclusion

SOMD Priorities

- Lay the groundwork for the Exploration Operations function
- Execute on the strategies to maintain and expand usage of the International Space Station (ISS) through 2030
- Mature the stepping stones to have a Commercial LEO Destination and evolution of our research and technology partnerships by 2030
- Continue the transformation of the Near Earth Network support strategy and further evolution of the Deep Space Network to accommodate the future communication, and related service demands
- Continue the evolution of launch vehicle strategies for a range of risk strategies for the agency

International Space Station (ISS) Extension

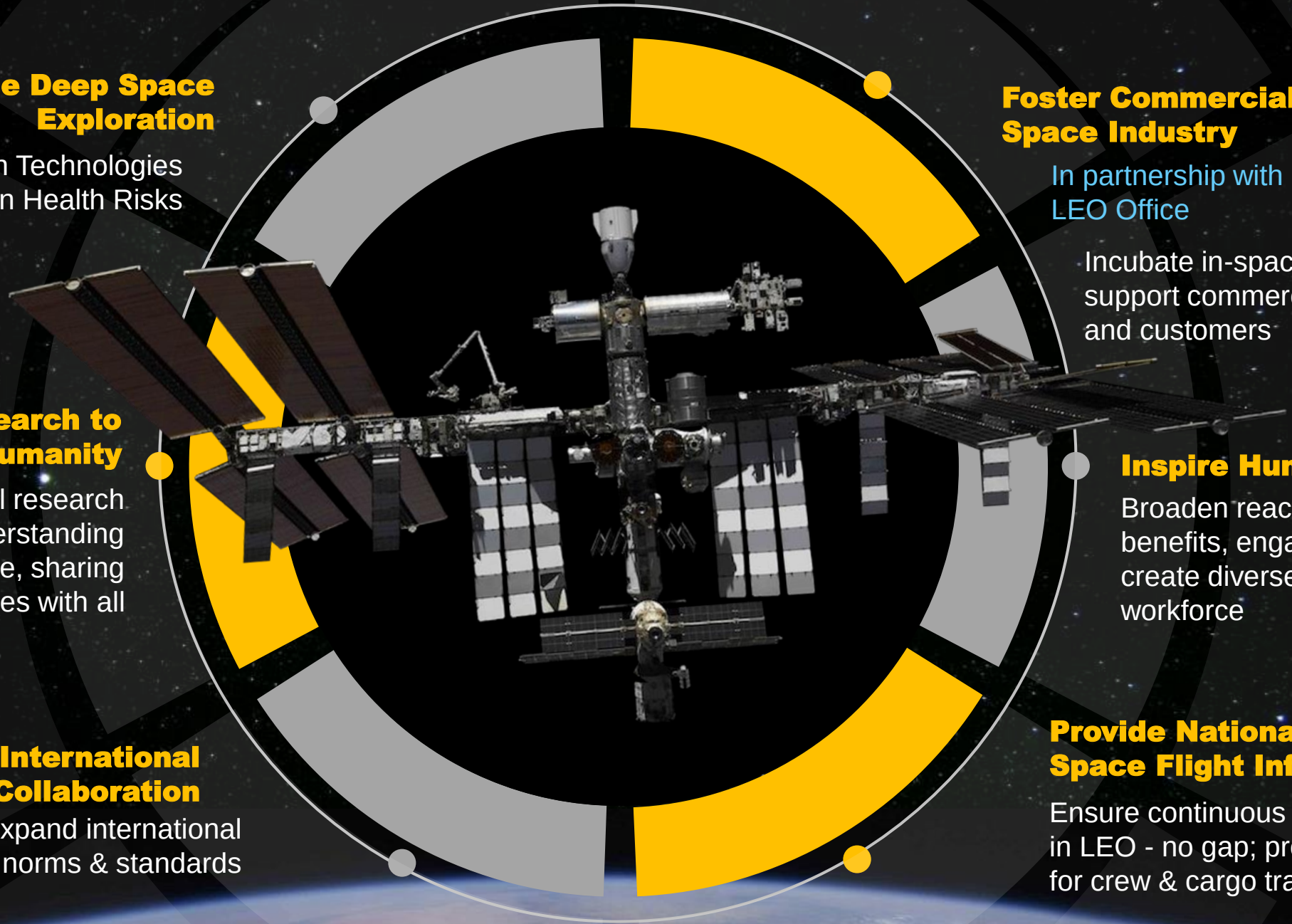
ISS Extension Through 2030

- On December 31, 2021, the White House announced a decision to extend operations of the ISS through 2030*
- Extension through 2030 will allow time to complete critical exploration development activities while bringing new commercial LEO capabilities online

- The ISS International Partners are working with their respective governments to extend through 2030
- There are no technical constraints to operating through 2030

* https://blogs.nasa.gov/spacestation/2021/12/31/biden-harris-administration-extends-space-station-operations-through-2030

ISS Mission Goals



Enable Deep Space Exploration

Validate Exploration Technologies and Reduce Human Health Risks

Foster Commercial Space Industry

In partnership with Commercial LEO Office

Incubate in-space manufacturing, support commercial LEO facilities and customers

Conduct Research to Benefit Humanity

Life-saving medical research & applications, understanding climate change, sharing discoveries with all

Inspire Humankind

Broaden reach of space benefits, engage public, create diverse future STEM workforce

Lead International Collaboration

Maintain & expand international partnerships, set norms & standards

Provide National Human Space Flight Infrastructure

Ensure continuous human presence in LEO - no gap; provide destination for crew & cargo transportation

Commercial Low-Earth Orbit (LEO)

Commercial Crew Success

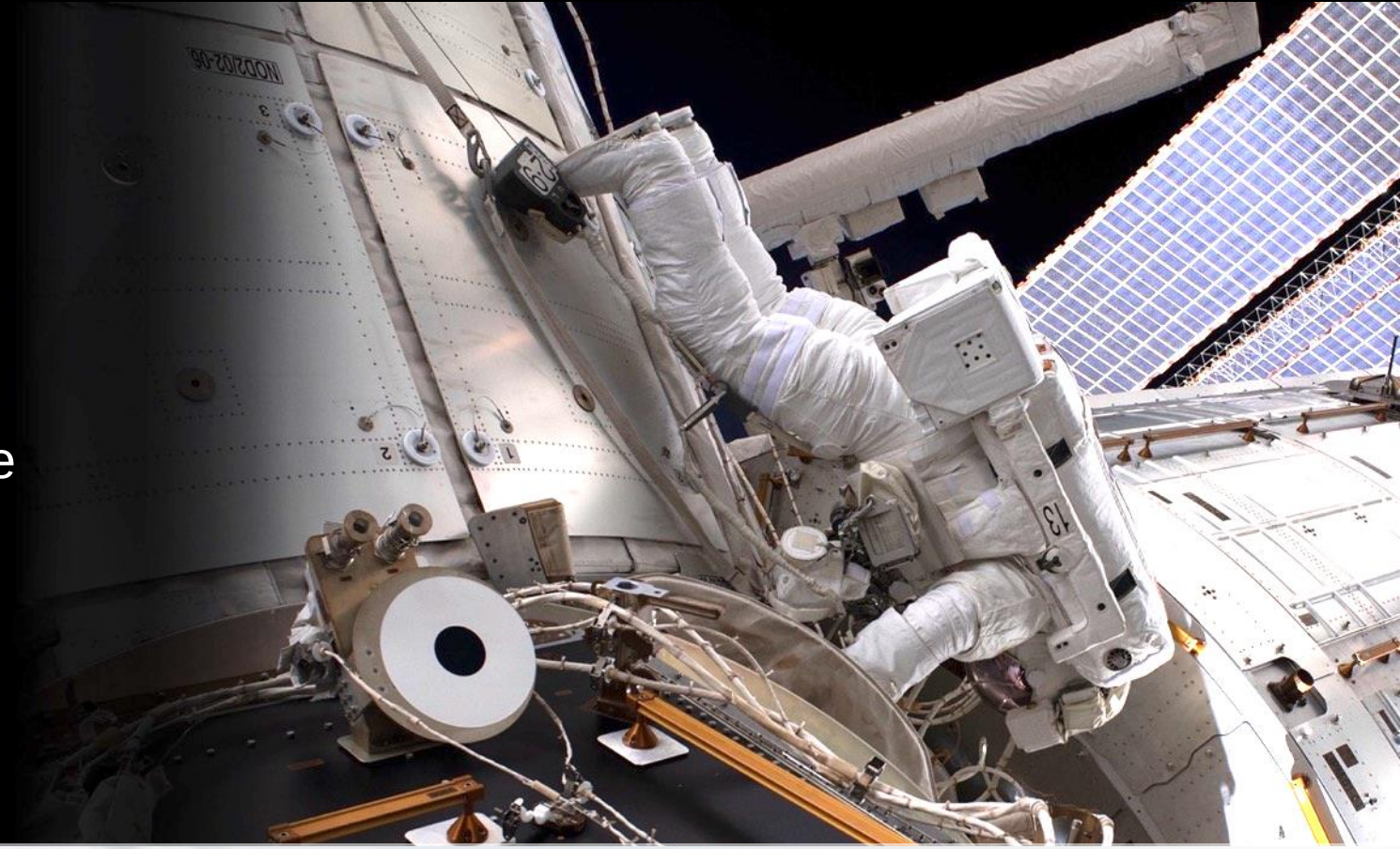
NASA SpaceX Crew-1
Completion of first operational commercial crew flight to the International Space Station

NASA SpaceX Crew-2
First commercial mission to fly two international crewmembers; a record 199 days in space

NASA SpaceX Crew-3
Arrived at the space station for a planned 6-month scientific research mission

The International Space Station is the centerpiece of exploration and a model for a new future in space.

By building continuous and ongoing cargo and crew operations aboard the space station, along with commercial and international partnerships, human exploration can advance at a sustainable pace.



Operational

Northrop Grumman

SpaceX

Final Dev

Sierra Space

Operational

SpaceX

Final Dev

Boeing

Concept Maturation

Sierra Space

Blue Origin

Vision for LEO Economy:
A World of New Possibilities

- NASA is one of many customers in a robust low-Earth orbit (LEO) economy
- Commercially-owned and operated transportation for cargo and crew
- Commercially-owned and operated LEO destinations that are safe, reliable, and cost-effective
- Regular production, distribution, and trade of goods and services
- Ongoing research and science activities including a LEO National Lab
- Continuation of human spaceflight exploration objectives
- Sustained presence and U.S. leadership in LEO

COMMERCIAL CARGO & CREW TRANSPORTATION

Operational

Northrop Grumman

SpaceX

Final Dev

Sierra Space

Operational

SpaceX

Final Dev

Boeing

Concept Maturation

Sierra Space

Blue Origin

COMMERCIAL LEO DESTINATIONS

Notional

Axiom

More Elements of a Strong LEO Economy

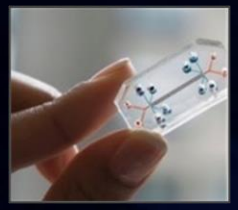
Private Astronaut Missions & Space Tourism

Commercial Marketing, Advertisement & Entertainment Activities

Inspiration for Student STEM Activities

In-Space Manufacturing & Production

LEO National Lab



Technology Demonstrations

Human Research

Evolution of Space Communications

Space Communications & Navigation (SCaN)

Supporting capabilities that are critical to every NASA mission, providing astronauts, scientists, engineers, and mission controllers reliable exchange of data between satellites in space and facilities on the ground

Communications Networks

Deep Space Network (DSN)

Near Space Network (NSN)

ACCESS

12 Ground Complexes

Areas of Focus

Communication Network Operations and Management

Commercialization of Near Earth communications

Optical and quantum communication

Technological Advancements

Positioning, Navigation and Timing

LunaNet

Human Spaceflight Network Integration

Spectrum Management

Search and Rescue

Networks Development

Recent Accomplishments

10 Science Mission Directorate (SMD) primary operations

60 SMD extended operations

6 human spaceflight missions including Crew-2 launch and Crew-1 return, + 4 launch vehicles

New Initiatives and Long-Term Plans

Transition to commercial providers, targeting 2023 for 100% commercial service (existing and new missions)

Provide architecture supporting exploration and science programs through 2040+

Initiate technical demonstrations on ISS to enable deep space exploration

Engage academia and the public with STEM activities, grants, and internships

Launch Vehicle Strategies

Heritage Fleet

Electron

Pegasus XL

Antares

Atlas V

Falcon 9

Falcon Heavy

Emerging Fleet

Vulcan

New Glenn

Rocket 3.0

Alpha

Terran

Areas of Focus

Launch Operations

Engineering

Integration

Analysis

Program Management

~22 years launching
99 full missions + advisory services
98% mission success rate

Launch Services Program

Providing the United States with a dependable and secure Earth-to-space bridge dedicated to launching all types of spacecraft for all types of missions

Recent Accomplishments

Successful launch of Landsat 9, Lucy, DART, and IXPE between September – December 2021

Successful “advisory” launch of JWST in December 2021

Award of GOES-U and Europa Clipper

Venture-Class Acquisition of dedicated and rideshare launch services (VADR) RFP released

HALO + PPE award and management of launch services

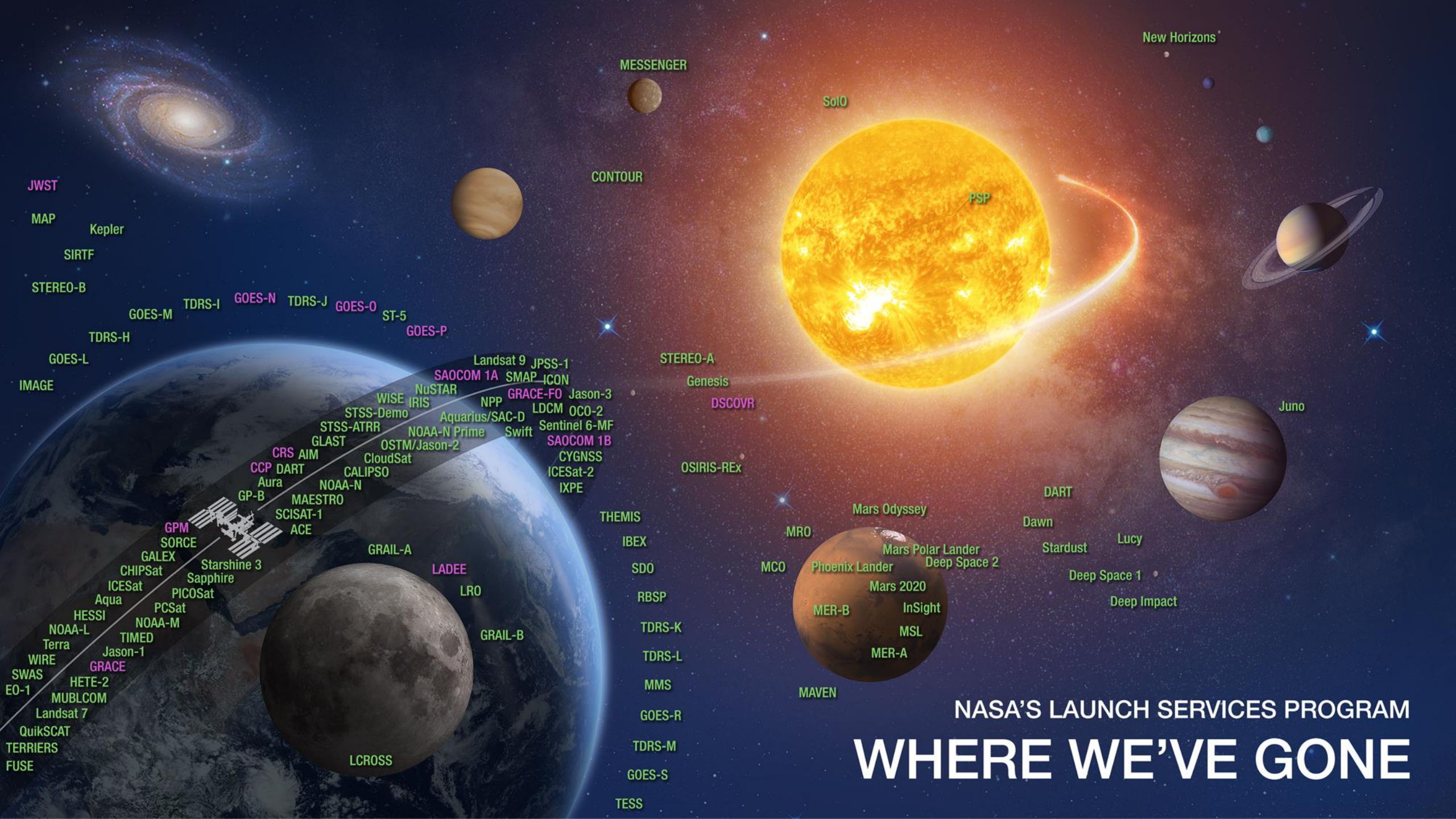
New Initiatives and Long-Term Plans

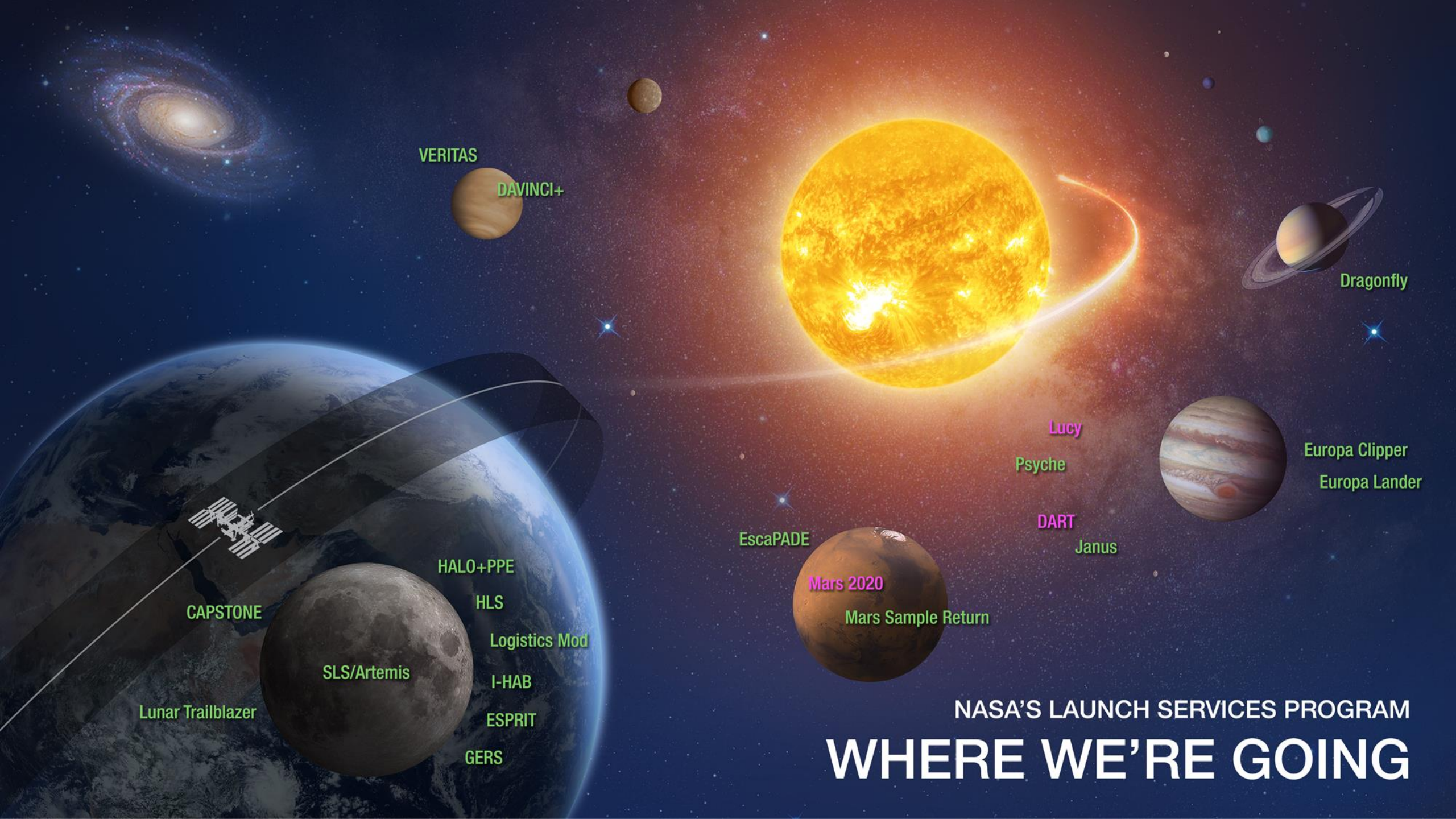
Provides management of NASA Launch Services contracts, launch mission assurance, mission design and launch integration support

Certify new commercial rockets to launch high-value civil-sector payloads

Provide launch “advisory services” to NASA missions as tasked

Evolve growth of NASA’s small satellite sector


New Horizons
MESSENGER
SolO
CONTOUR
PSP
JWST
MAP
Kepler
SIRTF
STEREO-B
GOES-M
TDRS-I
GOES-N
TDRS-J
GOES-O
ST-5
GOES-P
TDRS-H
GOES-L
IMAGE
Landsat 9
JPSS-1
SAOCOM 1A
SMAP
ICON
NuSTAR
GRACE-FO
Jason-3
WISE
IRIS
NPP
LDCM
OCO-2
STSS-Demo
Aquarius/SAC-D
Sentinel 6-MF
STSS-ATRR
NOAA-N Prime
Swift
SAOCOM 1B
GLAST
OSTM/Jason-2
CYGNSS
CRS
AIM
CloudSat
ICESat-2
CCP
DART
CALIPSO
IXPE
Aura
NOAA-N
GP-B
MAESTRO
SCISAT-1
GPM
ACE
SORCE
GALEX
CHIPSat
Starshine 3
Sapphire
ICESat
PICOSat
Aqua
PCSat
HESSI
NOAA-M
NOAA-L
TIMED
Terra
Jason-1
WIRE
GRACE
SWAS
HETE-2
EO-1
MUBLCOM
Landsat 7
QuikSCAT
TERRIERS
FUSE
GRAIL-A
LADEE
LRO
GRAIL-B
LCROSS
STEREO-A
Genesis
DSCOVR
OSIRIS-REx
THEMIS
IBEX
SDO
RBSP
TDRS-K
TDRS-L
MMS
GOES-R
TDRS-M
GOES-S
TESS
Juno
DART
Dawn
Lucy
Stardust
Deep Space 1
Deep Impact
Mars Odyssey
MRO
Mars Polar Lander
Deep Space 2
MCO
Phoenix Lander
Mars 2020
InSight
MER-B
MSL
MER-A
MAVEN
NASA'S LAUNCH SERVICES PROGRAM
WHERE WE'VE GONE


VERITAS
DAVINCI+
Dragonfly
Lucy
Psyche
Europa Clipper
Europa Lander
DART
Janus
EscaPADE
Mars 2020
Mars Sample Return
HALO+PPE
HLS
Logistics Mod
I-HAB
ESPRIT
GERS
CAPSTONE
SLS/Artemis
Lunar Trailblazer
NASA'S LAUNCH SERVICES PROGRAM
WHERE WE'RE GOING

SOMD Conclusion

SOMD is committed to leveraging all aspects of our organization to prepare for operational Artemis missions with an eye toward human missions to Mars and will continue to provide excellent support to missions across the agency.

These include:

Operational Experience

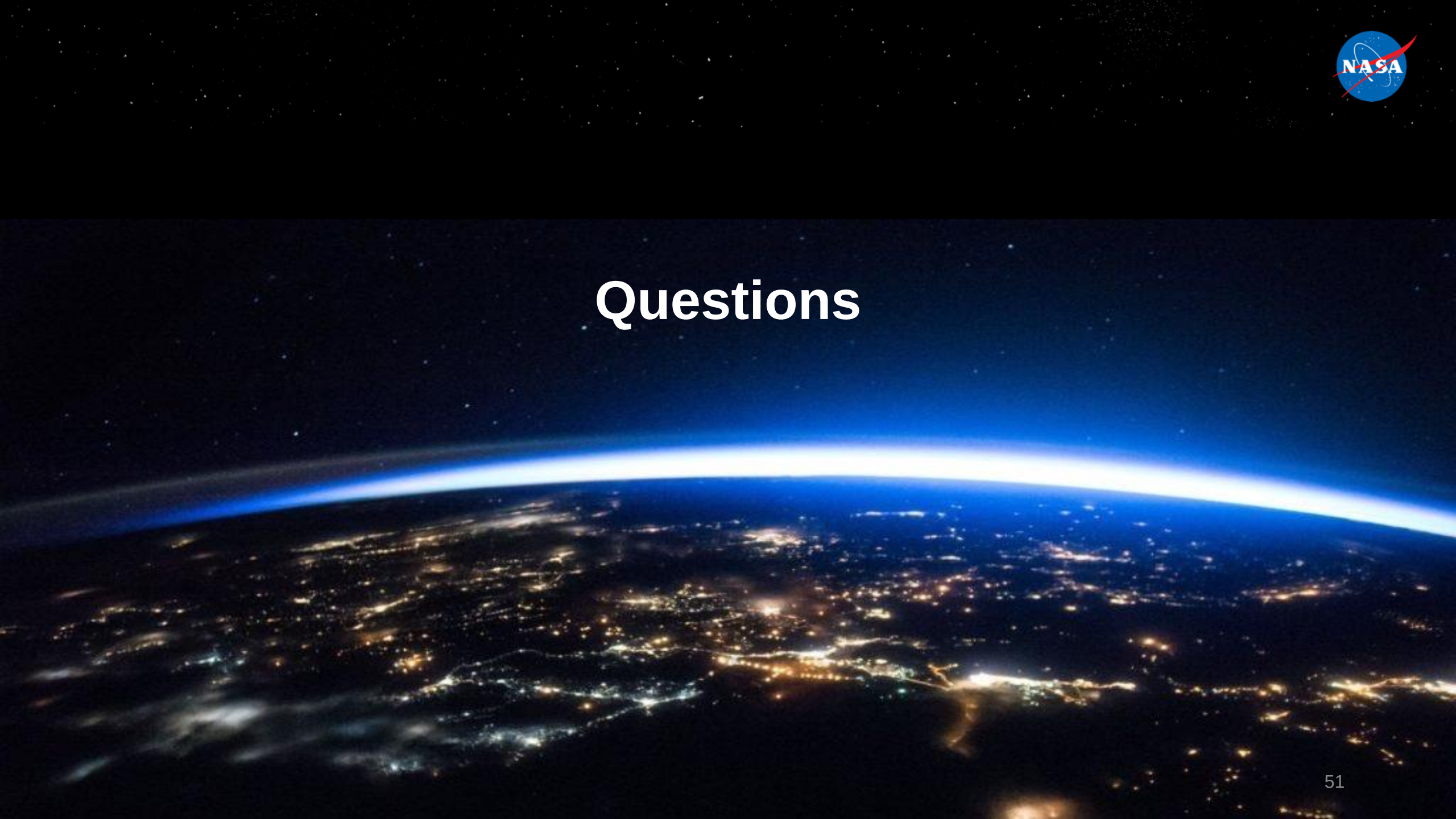
Expanding Science on ISS

International Partnerships

Proven Business Models

Launch Services

Space Communications Assets



Questions