Human Exploration & Operations Committee

Ms. Lynn Cline
Interim Chair
HEO NAC
October 2, 2024

HEO Committee Members

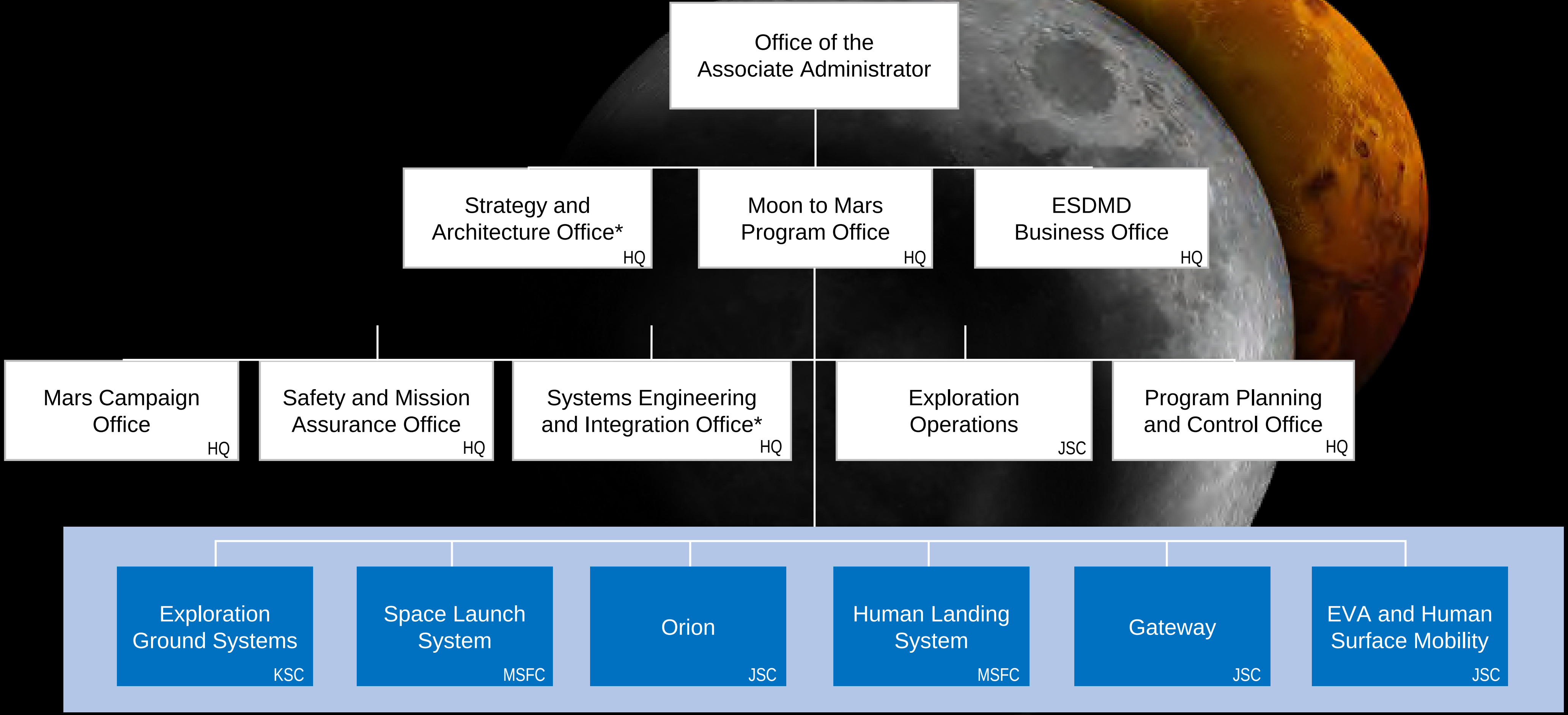
- Interim Chair
  - Ms. Lynn Cline
- Committee Members
  - Mr. Paul McConnaughey
  - Dr. George Sowers
  - Mr. Doug Ebersole
  - Dr. Ellen Stofan
  - Mr. Michael Lopez-Alegria – term ending Nov 2024
  - Mr. Jim Voss – term ending Nov 2024
  - Ms. Nancy Ann Budden – term ending Nov 2024
  - Dr. Pat Condon – term ending Nov 2024

Human Exploration & Operations NAC

- Two Committee meetings were held since last report to NAC
  - August 2024
  - September 2024
- Meetings addressed:
  - ESDMD Mission Status
    - Strategy and Architecture
    - Moon 2 Mars
  - SOMD Mission Status
    - Human Research Program
    - International Space Station
    - Commercial Crew Program
    - Commercial Low Earth Orbit Development
    - Space Communications and Navigation

Exploration Systems Development Mission Directorate Status

ESDMD Organizational Chart



Moon to Mars Manifest—FY2025 President's Budget Request

FY	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
ESDMD			**Artemis II** (Sep. 2025) Crewed Flight SLS Block 1/ Orion/ML1	**Artemis III** (Sep. 2026) Crewed Flight SLS Block 1/ Orion/ML1 HLS Crewed Lunar Demo xEVA Surface Suits *HLS Uncrewed Lunar Demo* *Gateway PPE/HALO Launch*	*Gateway PPE/HALO Arrival in NRHO*	**Artemis IV** (Sep. 2028) Crewed Flight SLS Block 1B/ Orion/ML2 I-Hab to Gateway Gateway Logistics Services Sustaining HLS Crewed Lunar Demo xEVA Surface Suits *Sustaining HLS Uncrewed Lunar Demo*		**Artemis V** (Mar. 2030) Crewed Flight SLS Block 1B/ Orion/ML2 ESPRIT to Gateway Sustaining HLS Crewed Lunar Demo xEVA Surface Suits LTV	**Artemis VI** (Mar. 2031) Crewed Flight SLS Block 1B/ Orion/ML2 Airlock to Gateway Gateway Logistics Services Gateway External Robotics System TBD Sustaining HLS Services xEVA Surface Suits	**Artemis VII** (Mar. 2032) Crewed Flight SLS Block 1B/ Orion/ML2 Gateway Operations TBD Sustaining HLS Services xEVA Surface Suits Pressurized Rover
SOMD	DSN Upgrades (DLEU) Completed DSS-36 [Canberra]	Completed DSS-24 [Goldstone]	DSS-34 [Canberra] DSS-56 [Madrid]		Lunar Communications Relay and Navigation Services (LCRNS)–Increment Increment Alpha	Lunar Exploration Ground Sites 1-3 DSS-54 [Madrid] Increment Bravo	Increment Charlie	Ongoing Science, Human Research Program, and Technology Development in LEO (ISS transition to CLD)		
SMD CLPS Flights Outlined	LRO Mars 2020:	ESCAPADE Attempted TO 2-AB Completed TO 2-IM TO 19D	TO 20A: VIPER HERMES ready for integration ESA Lunar Pathfinder delivered for launch AVATAR (Artemis II) TO PRIME-1 Lunar Trailblazer TO CP-11	Artemis III Surface Science Instruments MMX (MEGANE/ P-Sampler) TO CS-3&4 TO CP-12	LRO continued ops TO CS-06 TO CP-21 TO CP-22	Artemis IV Surface Science Instruments TO CS-6 TO CP-31	Rosalind Franklin Mission (RFM) Launch, Landing TO CP-41 TO CP-42 TO CP-51 TO CP-52 TO CP-61 TO CP-62	Artemis V Surface Science Instruments Artemis LTV Science Instruments	Artemis VI Surface Science Instruments	Artemis VII Surface Science Instruments
STMD	MOXIE; MEDA DSOC	CFM SpaceX TP Flight Demo	Surface Robotic Scouts (CADRE) TO PRIME-1: Drill; Nokia LTE/4G Comm; IM Deployable Hopper CFM ULA TP Flight Demo PPE SEP qual. environ. complete CFM Eta Space TP Flight Demo	CFM Lockheed Martin TP Flight Demo NEP Concept Design	DRACO Demonstration	TO LIFT-1: Lunar Surface Power Demo (i.e., RFC, VSAT, Wireless Charging); Lunar Surface Scaled Construction Demo 1; ISRU Pilot Excavator; ISRU Subscale Demo	SEP qual. complete			Fission Surface Power demo delivered for launch TO LIFT-2: Lunar Surface Scaled Construction Demo 2; Autonomous Robotics Demo; Deployable Hopper 2; ISRU Subscale Demo 2

Icons are representative only, and may not reflect final configurations, not to scale | Icons represent the fiscal year in which an event occurs | Based on FY 2025 President's budget request

Presentation Version: 040824

Strategy & Architecture Summary and Upcoming Milestones

- Significant progress made implementing new Moon to Mars Architecture pre-formulation process
- Focus on architecture analysis and decision process in a digital environment to seamlessly integrate Lunar and Mars efforts
- Focused Foundational Exploration segment analysis identified key gaps in lunar surface logistics/cargo delivery and mobility needs

Upcoming Milestones

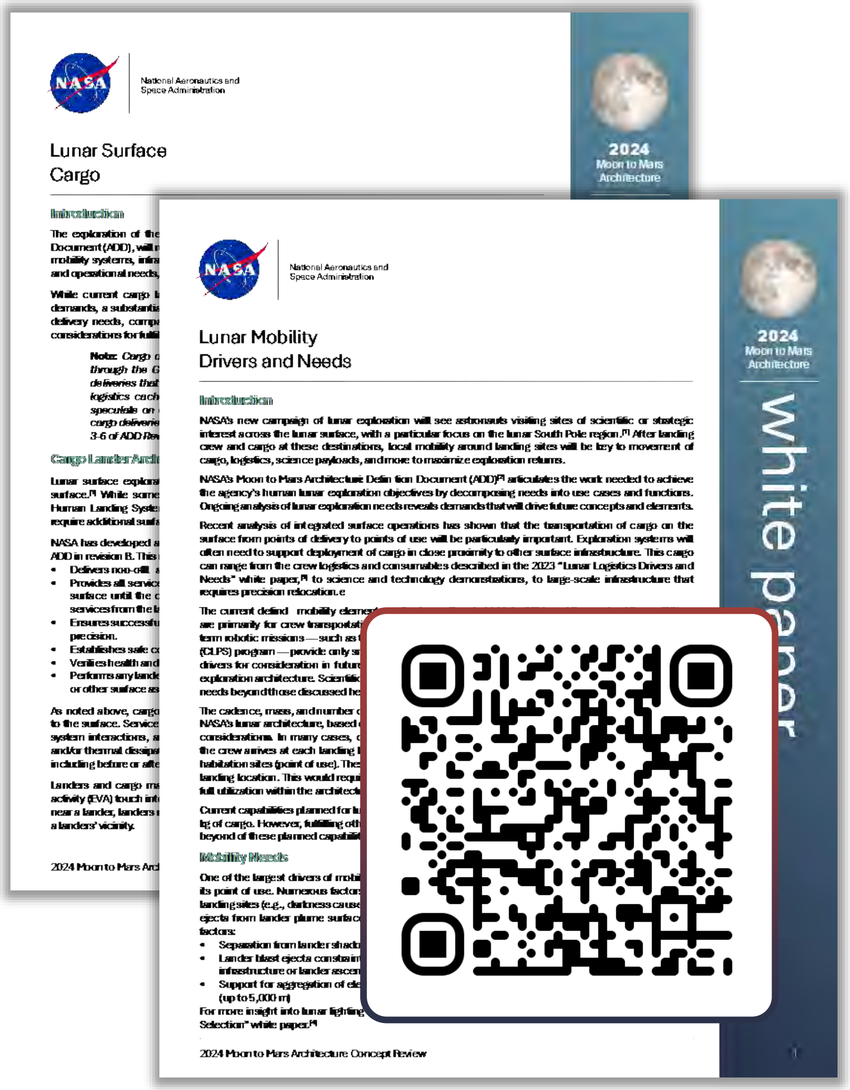
Architecture Concept Review (ACR)
November 12–14, 2024

ACR Product Release
December 2024

ACR Workshops
February 11–13, 2025

Sign up for Moon to Mars Architecture Updates

Mid-Cycle White Papers



- SAC24 and element analysis indicated a greater challenge to two architectural gaps than previously communicated
  - Cargo lander demand aggregated across logistics, demonstration elements, and other systems
  - Surface cargo/element mobility demand relative to technology/system readiness
- **Given the scope and scale of forward demand, NASA published to out-of-cycle white papers in June to signal these future needs to industry and grow awareness across the NASA stakeholder community**
  - White paper content underwent development and review similar-to-nominal ACR process with informal ESDMD-led stakeholder review and comment period

Lunar Surface Cargo Key Takeaways

Key Takeaways

- Foundational Exploration and Sustained Lunar Exploration segment goals require significant transportation of cargo to the lunar surface
- HDL is the only lander currently in the architecture that can deliver beyond 500 kg to the lunar surface
- NASA anticipates an aggregate demand for lunar surface cargo on the order of 2,000 to 10,000 kg per year
- To mitigate this capability gap, strategic considerations include engaging multiple providers across both international partners and industry over time, offering dissimilar redundancy
- Communication of cargo demand to the exploration community helps enable industry and international engagement

Lunar Mobility Background

- The architecture includes several mobility functions, some of which are currently fulfilled by Lunar Terrain Vehicle (LTV) and Pressurized Rover (PR)
- Analysis leading to and supporting surface logistics, potential utility rover concepts, and initial surface habitation mission concept review (MCR) revealed implications across the architecture strategy:
  - Functional gaps and services not yet available for mobility of large uncrewed assets
  - Relocation and surface placement demand
  - Technological gaps in performance for mobility assets
  - Integrated architectural strategic considerations
- **Lunar surface mobility is allocated to 34 functions in ADD Rev-A**

Pressurized Rover
JAXA/Toyota

Mobility has a higher proportion of functions, which indicates a frequency of need previously not identified

Lunar Mobility Key Takeaways

Key Takeaways

- Lunar exploration objectives require significant mobility of cargo and assets across the lunar surface from landing site to point of use at ranges of 5 to 5,000 m
- Currently, the surface mobility capability expressed in the architecture is limited to 800 kg; however, future mobility demands include aggregated logistics and larger elements as massive as 12,000 kg or more
- Large-scale mobility is not simply scaled up small-scale mobility; energy and environmental considerations are crucial to the design process
- Interoperability and autonomous or semi-autonomous capabilities on mobility systems enable mission planning flexibility and increase available crew utilization time

National Aeronautics and Space Administration

Space Operations Mission Directorate Status

SPACE OPERATIONS MISSION DIRECTORATE

Office of the Administrator
Associate Administrator
Ken Bowersox
Deputy AA
Joel Montalbano
Deputy AA for Management
Tonya McNair
Senior Advisor, Commercial Collaboration
Phil Mcalister
Senior Advisor, Sustainability
Trudy Kortes (Detailee)
Executive Assistant
Sasha Ricks (ADS)

Cross-Directorate Technical Integration
Director, Alvin Drew

Strategic Integration & Management Division
Director, Diana K. Oglesby

Resources Management Office
Director, Elaine Slaugh

Space Communications & Navigation Division
Deputy Associate Administrator, Kevin Coggins

Launch Services Office
Director, Bradley Smith

Commercial Space Division
Director, Robyn Gatens (acting)

- Commercial Crew Program
  *Steve Stich
  KSC
- Commercial Low Earth Orbit Development Program
  Angela Hart
  JSC

International Space Station Division
Director, Robyn Gatens

- ISS National Laboratory Interface Managed by ISSNL Program Executive at HQ and CATO
  JSC
- International Space Station Program
  *Dana Weigel
  JSC

Human Spaceflight Capabilities Division
Director, Benjamin Neumann

- Rocket Propulsion Test Program
  Michele Beisler (acting)
  SSC
- Human Research Program
  *David Baumann
  JSC

Launch Services Program (under Launch Services Office)
*Albert Sierra
KSC

*Program Manager Reports to the AA, Space Operations Mission Directorate

SOMD OVERARCHING STRATEGY

- **Maintains a safe and sustained human presence in LEO**

- **Provides *mission-critical* support to NASA and non-NASA customer missions**
  - Continues providing space communication and navigation services to missions and developing capabilities to ensure lunar communication and navigation support for Artemis system needs
  - Continues providing launch and test services
  - Continues providing training and readiness to support crew health and safety and mission success
  - Continues researching and developing capabilities to safeguard our astronaut explorers

- **Continues research to advance discoveries that benefit life on Earth and support Exploration**
  - Continues support of ISS operations and research

- **Supports development of an American-led space infrastructure and commercial economy in LEO**

- **Implements ISS End of Life activities**

Low-Earth Orbit Transition: ISS to Commercial Destinations

FY 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032

International Space Station (ISS) Operations

U.S. Deorbit Vehicle Development *Delivery* *Deorbit*

Commercial LEO Destinations (CLDs) Development — CLD Operations

Phase 1: Early Design Maturation — *Phase 2: Certification & Services*

Continue valuable science and research on ISS through end of life

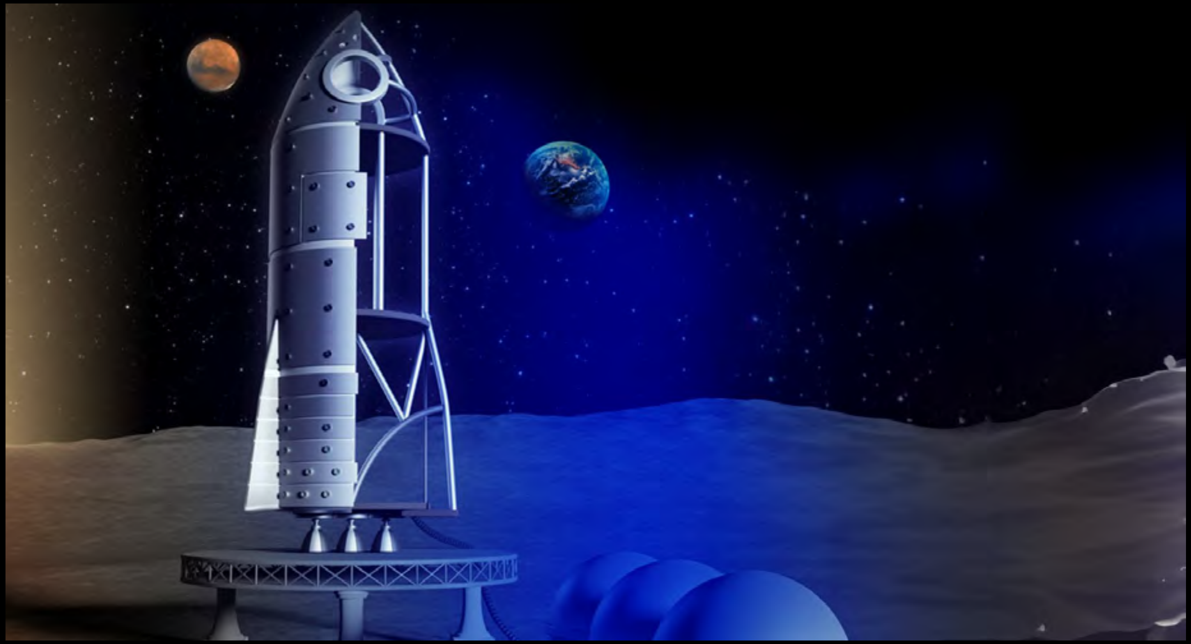
Develop U.S. Deorbit Vehicle to safely deorbit ISS at end of useful life

Balancing 3 Priorities

Partner with U.S. commercial space industry to develop and deploy commercial destinations to ensure American access to LEO

LEO MICROGRAVITY STRATEGY

Learning from Moon to Mars



In 2022, NASA released and finalized its Moon to Mars Strategy, using many of the same guiding principles that are being employed for the LEO Microgravity Strategy. However, there are some key differences between the two approaches.

A Wholistic Approach

Recognizing that there are a diverse number of areas where we have microgravity expertise that we want to either maintain or enhance, we are leveraging diverse perspectives to develop goals and objectives.

Consultation

NASA is seeking feedback on its goals and objectives for the LEO Microgravity environment from international partners, industry, and academia.

Objective Decomposition

The LEO Microgravity Strategy will use an architecture process that distills the goals and objectives into capabilities and needs that will drive requirements for future elements.

Intermediate Outcomes

Acknowledging the LEO market may evolve in new ways, we recognize that we need to look at objectives in a staged approach.

LMS Timeline

AUG

AUGUST 2
Gap Analysis Complete

AUGUST 6
Fed Board review

AUGUST 13
Fed Board w/Center Directors

MID-AUGUST
U.S. Government Stakeholder Engagement

AUGUST 26
Draft Goals and Objectives Published for Public and Internal Comment

SEP

SEPTEMBER 6 & 13
International and Industry Workshops

SEPTEMBER 27
Goal and Objective Comment Period Closed

OCT

OCTOBER 27
Goal and Objective Comment Adjudication Complete

NOV

MID-NOVEMEBER
Acquisition Strategy Meeting for Commercial LEO Destinations

DEC

EARLY DECEMBER
LMS Executive Council Meeting

DECEMBER 15
Finalized Goals and Objectives Published

Radiation Risk Key Points

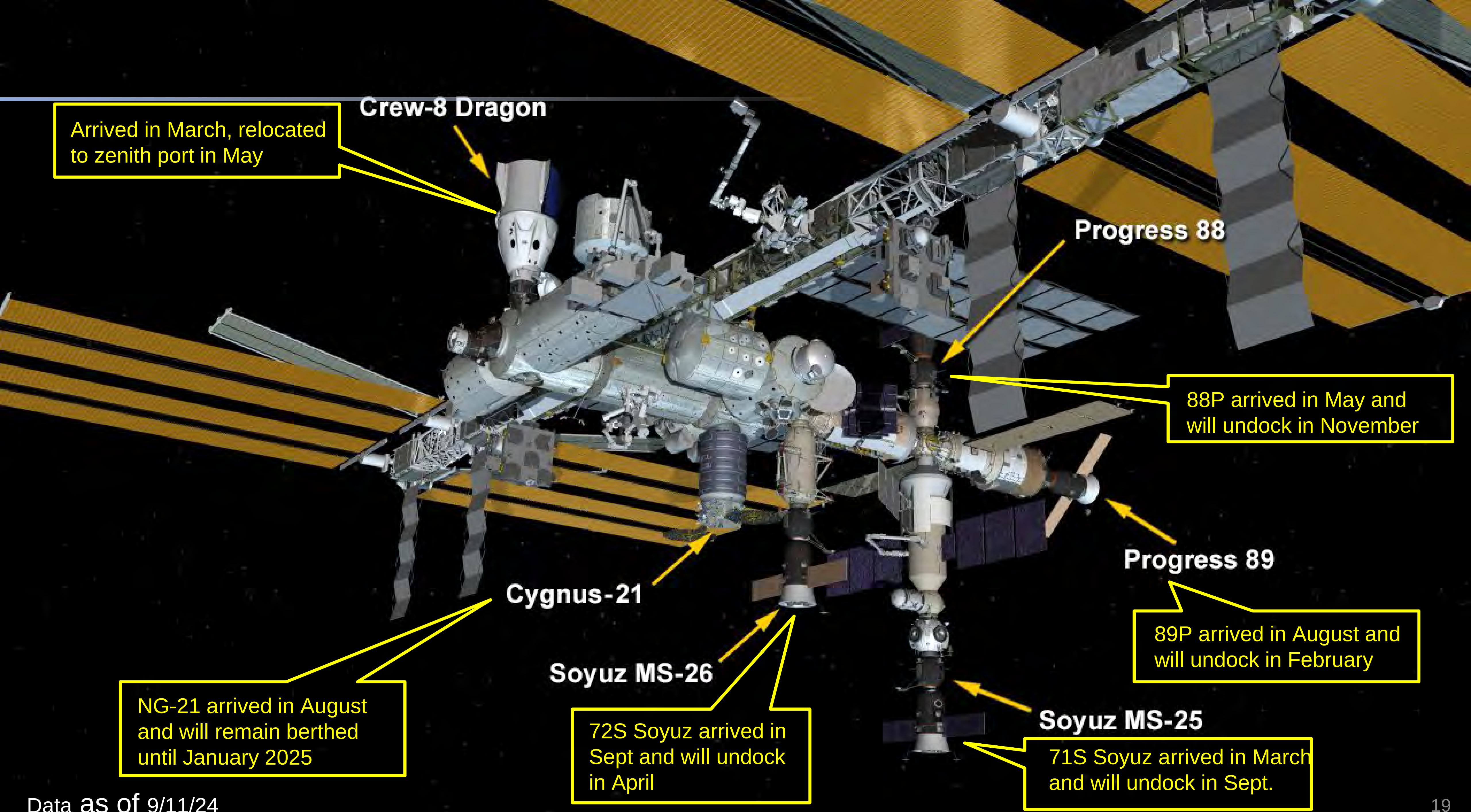
Mars Mission Duration: 870 to 1250 days; 30 days on surface;
Exposure: ~685 mSv to >1700 mSv

- Exposure levels outside spaceflight experience (~300-400 mSv) and exceed career limit of 600 mSv

- Mars mission will have potential long-term health risks
  - Cancer
  - Cardiac, vascular, cerebrovascular, neurocognitive diseases

- Potential exists for CNS performance impairments during return transit
  - Strategies identified to ensure achievable mission objectives

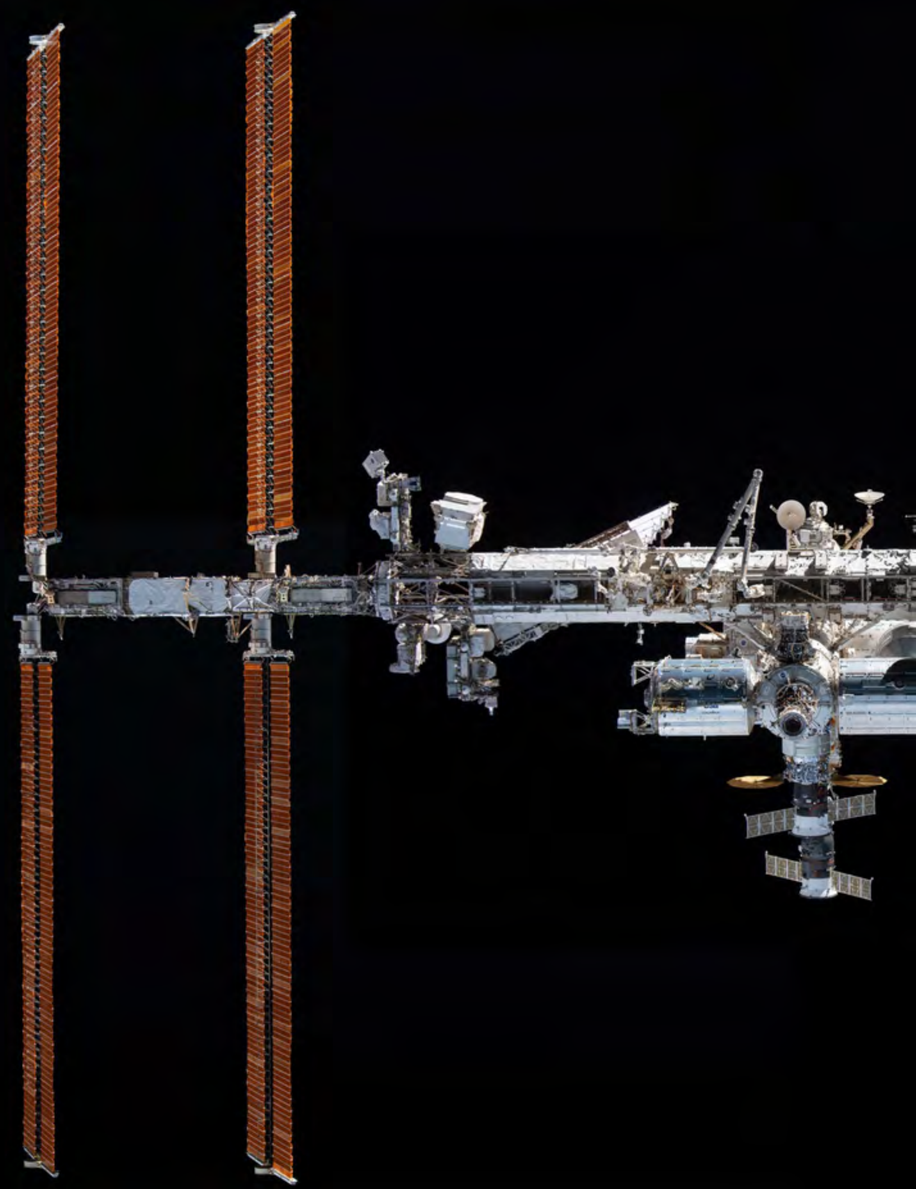
- Research continues to improve understanding of performance/health risks to crew & countermeasure strategies



Data as of 9/11/24

ISS National Lab (CASIS) Status

- ISS Research and Development Conference held July 29th through August 1st in Boston, MA
  - 909 participants (up from 860 in 2023)
  - Piloted a student day in which jr. college, undergraduate, and graduate students participated. Students spent the day meeting researchers, government agencies, industry, and potential employers. Program was successful and we have already received financial commitment to expand the program in Seattle.
  - Next conference will be in Seattle, WA July 28th through 31st 2025
- Future National Laboratory Planning
  - Going forward, calling “The Institute”, full name TBD
  - NASA-internal workshops held in May 2024 and July 2024
  - Initial review by NASA leadership completed July 2024
  - Presented plan to OSTP LEO S&T IWG July 2024
  - Planning external engagement with NSpC, the Hill, then Industry and International Partners



Commercial Crew Program
Continuing Safe Operations in 2024

Crewed Rotation Complete
SpaceX Crew-7 to SpaceX Crew-8 Handover

Goal: Provide safe transport of NASA & International Partner crew members & cargo to the International Space Station in support of a 6-month science & research expedition.

Boeing Developmental Flight Test Complete
Crew Flight Test (CFT)

Goal: Obtain remaining system performance data required for NASA certification ahead of crewed rotation missions to the International Space Station.

Crewed Rotation On Deck
SpaceX Crew-8 to SpaceX Crew-9 Handover

Goal: Provide safe transport of NASA & International Partner crew members & cargo to the International Space Station in support of a 6-month science & research expedition.

Crew Flight Test Overview (Prelaunch to Station Rendezvous)

Crew: Butch Wilmore (Commander) and Suni Williams (Pilot)

Boeing's Starliner successfully launched atop a United Launch Alliance Atlas V rocket & reached orbit without incident on June 5.

- NASA expects all flight test objectives associated with the prelaunch phase to be confirmed complete following post-flight data reviews.
- Completed objectives involving activities with the crew and critical support from integrated ground teams to execute a crewed launch countdown, scrub, and/or prelaunch contingency as needed.

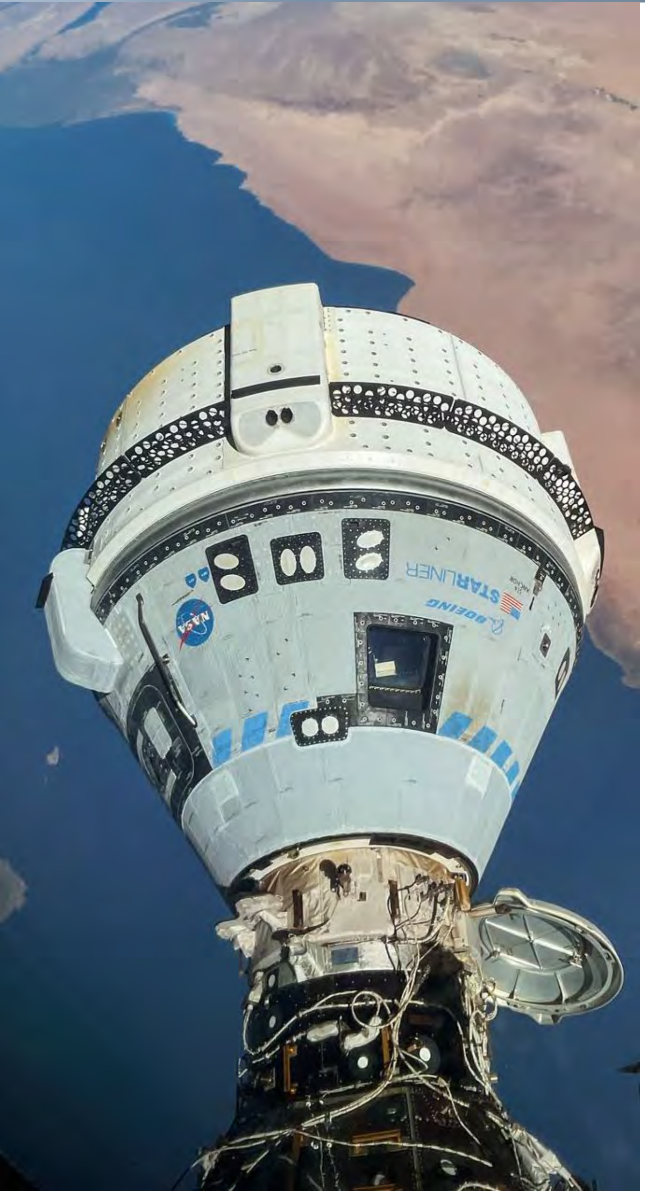
Significant accomplishments were also completed during the launch and rendezvous phases of flight.

- Starliner ground teams and test pilots completed key objectives in testing manual and automated navigation, assessing spacecraft thruster performance, and successfully executing manual piloting demonstrations for evaluating crew controls, displays, and response timing.

Inflight Observations: Performance issues were identified in Starliner's service module propulsion system during free flight and rendezvous with the space station.

- Small Helium system leaks were observed, in addition to the one cleared prior to launch.
- Fail offs of five reaction control system thrusters. Operations teams performed a series of hot-fire tests which re-enabled four of the five thrusters.

Crew Flight Test Overview (On-orbit Testing & Decision-Making)



Starliner successfully completed an autonomous docking to the forward-facing port of the station's Harmony module on June 6.

- Significant accomplishments were completed during the docked phase of flight including the execution of normal hatch open/close procedures, transfers of equipment, spacecraft low-power mode configurations, and "Safe Haven" operations.

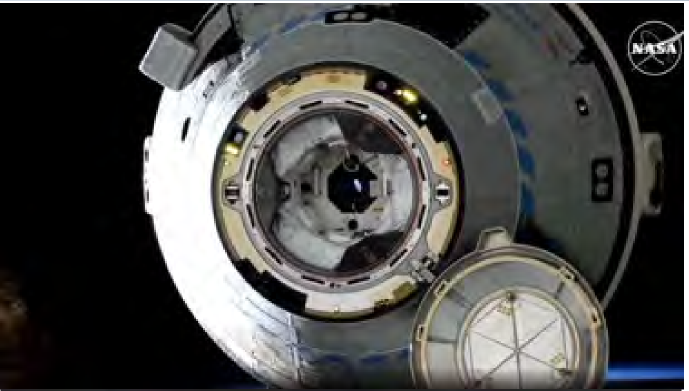
While Starliner remained safely docked to station, teams performed extensive testing & analysis to evaluate Starliner's performance & return readiness.

- NASA & Boeing conducted additional in-space and ground testing to study system mechanics, establish probable cause, and better predict performance for the return flight.
- An extensive fault tree investigation was initiated and independent experts from across the agency and Boeing provided their assessments and recommendations.

CCP worked to enable an effective NASA decision-making process to evaluate a crewed return without schedule pressure or compressed timelines.

- CCP engaged with ISS and commercial partners on contingency planning & operational flexibility. The program worked closely with independent Technical Authorities and NASA's Engineering and Safety Center to analyze performance data, evaluate risk, and make the best, safest decision possible.
- **Ultimately, the Agency decided to return Starliner uncrewed.**

Crew Flight Test Overview (Return & Path Forward)



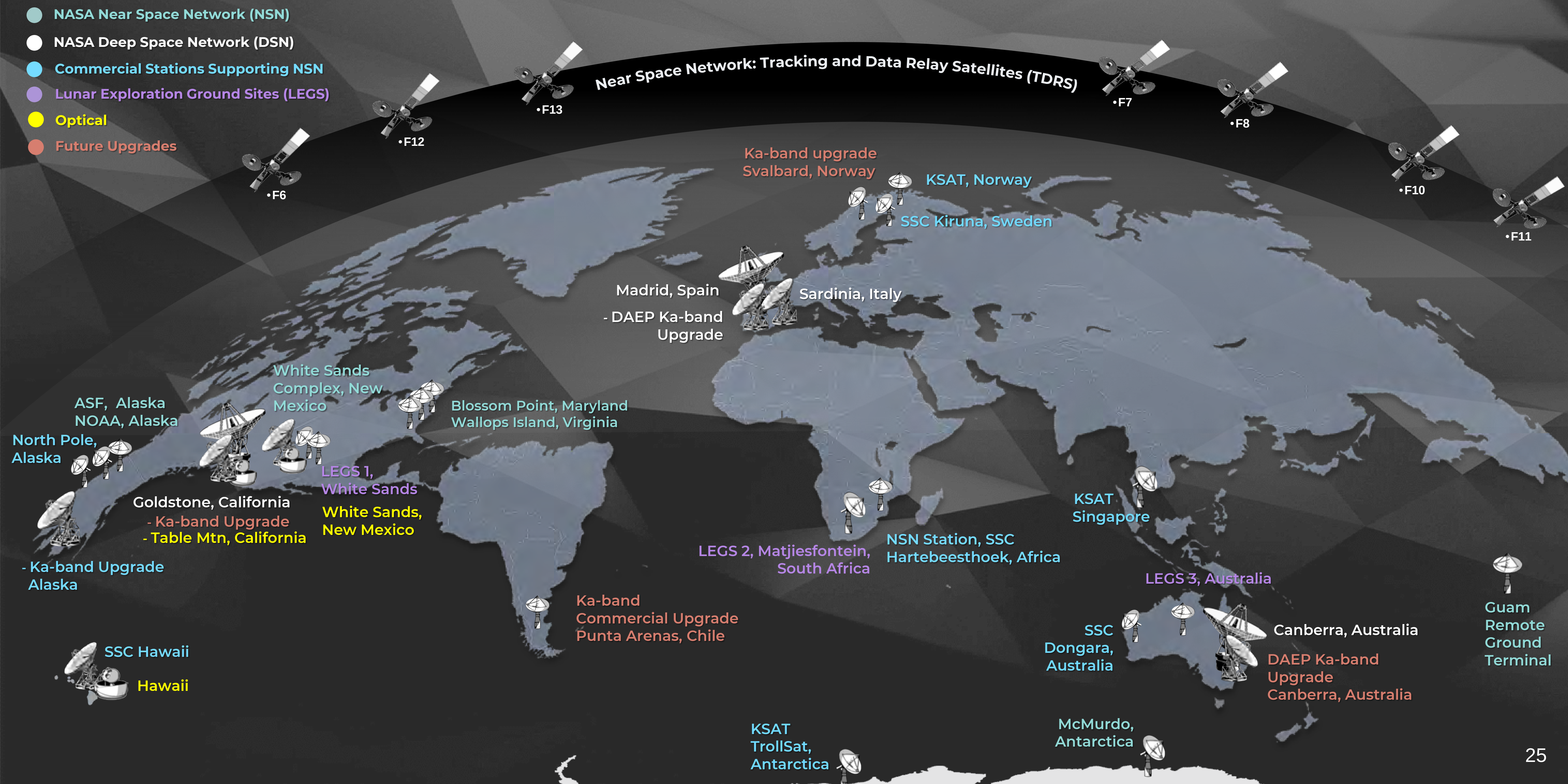
Starliner completed an uncrewed autonomous undocking from station on September 6, followed by a successful de-orbit, spacecraft separation, descent, landing and recovery on September 7.

- Overall, Starliner performed well across all major systems in the undock, deorbit, and landing sequences.
  - The service module propulsion system performed well. Helium system leaks remained in family requiring no inflight management and service module thrusters remained healthy.
- NASA is fortunate to have instrumentation and data collection capability to allow most of the return test flight objectives to be met, even without a crew.
- As a result of the extended flight test duration, considerable lessons have also been learned that will benefit NASA and Boeing in support of Starliner rotation missions.

Forward Work Toward Certification:

- A complete list of remaining certification requirements will be determined upon completion of post-flight data reviews.
- NASA will work to validate system performance and assess long-term solutions to the propulsion system issues encountered on this flight.
- NASA will complete a thorough, independent investigation into the CFT anomalies and determine any lessons learned for future flights and other NASA development programs.

NASA's Communications Networks

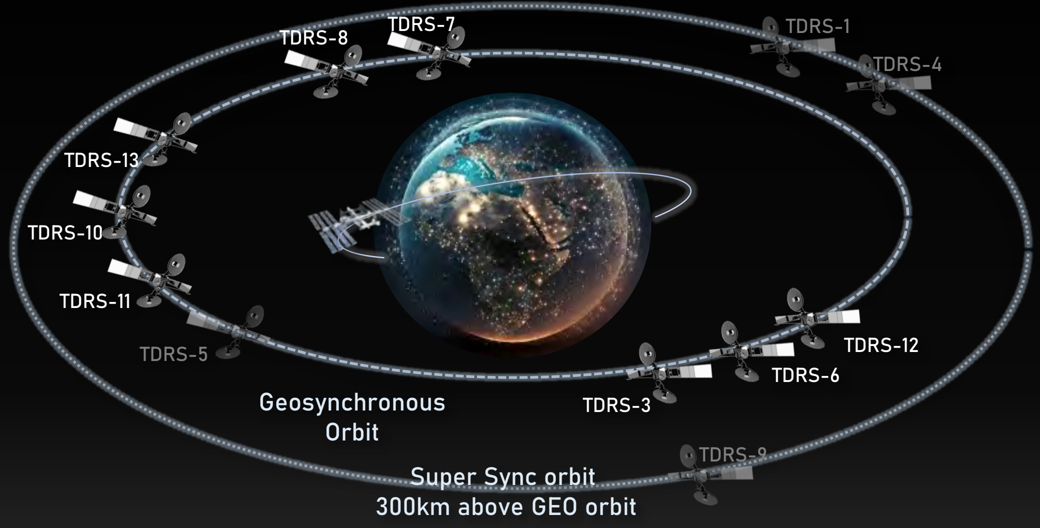


Space Relay Continuity: Phasing out TDRS

- **The NASA Tracking and Data Relay Satellite (TDRS) system is in decline**
- **To preserve capacity for existing users and avoid introducing new risks, NASA has decided to stop accepting new users on the TDRS network**
- **O&M of the remaining TDRS fleet will be focused on retaining global coverage into the 2040s for current users (e.g., Hubble Space Telescope)**
- **NASA is assessing whether TDRS backwards compatible services are required and potential budget impacts**

NASA Decision

- Effective as of August 8, 2024, NASA will suspend acceptance of new mission commitments for TDRS support with the intent to remove TDRS services from the NSN catalog of available service offerings by November 8, 2024.



Space Relay Continuity: CSP will Deliver Services by 2031

1

Demonstrations Continue

- Flight demos between 2024 - 2027
- Current partners expected to have operational services as early as 2025

2

Requirements Development

- Continue to collaborate with the mission community to finalize Service Requirements
- Identify need for backward compatible services and cost to deliver

3

- Pursue acquisition and prepare for transition

Provider Pool & Catalog of Validated Services

Provider A	Provider B	Provider C
L-band TT&C	High Rate Optical	Low Latency Fwd/Rtn
Launch Service	Always on connectivity	Ka-band HDR
Wide Field of View		

All services are verified & validated before being added to the Catalog and made available to Missions

4

Verification & Validation

- Validate capabilities before transitioning to operations

5

Target: Portfolio of Services

- Managed by the Near Space Network
- Portfolio approach provides diversity
- NASA as one of many users / buyers

Synopsis

- SCaN is resetting to be the leading 21st century space network by reorganizing to support our core functions and address customer needs
- Stakeholder collaboration is driving the program forward and has already yielded an integrated priority list for all SCaN activities
- Capability gaps are being identified that SCaN must address in future years, including at Mars and for deep space
- Commercial will be the key to meeting user requirements while operating within budget
- It is time for a sustainable, partnership-driven approach to commercial vendors that can support Agency users while facilitating a dynamic space marketplace

For NAC ESDMD Recommendation (1 of 1)

Title of Recommendation: Audit Burden on NASA Mission Directorates

Recommendation: Recommend that the NASA Administrator seek relief from the burden of multiple external audits by asking the Administration and Congress to restrict organizations within their purview from performing audits unless specifically required by law.

Major Reason for Recommendation: Although we recognize the value of audits, multiple external audits imposed on NASA Mission Directorates add substantial burden to staff and take time away from critical program work. They require thousands of hours to gather information and write responses that consume organizational resources.

Consequences of No Action on the Recommendation: NASA Mission Directorate personnel will have less time than needed to work on mission critical tasks causing program delays.

For NAC SOMD Findings

Title of Finding: International Partnerships

Finding: The committee commends NASA for starting the process of developing a Low Earth Orbit (LEO) Microgravity Strategy. With regard to international partnerships, the Committee suggests NASA consider how to encourage commercial entities to work directly with international partners in addition to NASA's traditional international partnerships

Title of Finding: Importance of Commercial Crew and Cargo Programs

Finding: Despite budget pressures, NASA needs to continue robust Commercial Crew and Cargo programs to provide significant up and down mass critical for continued operations of the International Space Station (ISS), prepare for exploration, and ensure development of robust commercial LEO destinations.

Title of Finding: No Gap in Continuous Human Presence in LEO

Finding: We strongly support NASAs plan to avoid a gap in continuous human presence in LEO, but the committee is concerned about schedule risk, due to current funding constraints and ISS retirement date of 2030.

Title of Finding: New Approach to Space Communications Planning

Finding: The committee commends Space Communications and Navigation program on its new approach to retire legacy systems, transition to commercial systems and develop new capabilities where appropriate. This approach includes engaging stakeholders to enhance decision making.

Backup

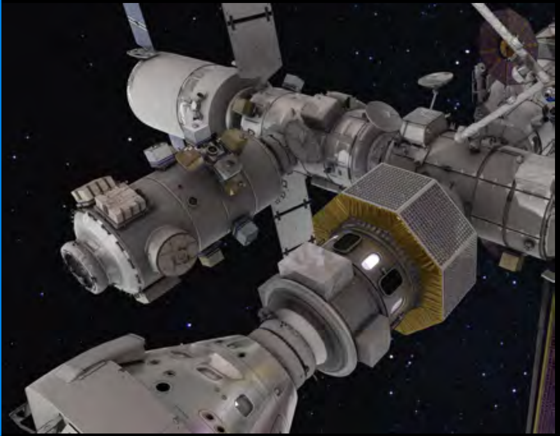
International Collaborations | Global Partners

PEOPLE

Artemis II will be the first to send crew around the Moon and will include a Canadian crew member

NASA’s annual Moon to Mars Architecture Workshops engage space agencies from around the world. In 2024, 18 countries were represented

HARDWARE



Artist's concept of Gateway, including Canadarm3 and United Arab Emirates Artemis Lunar Gateway Airlock

European Service Module for Orion, provided by the European Space Agency, involving 10 European countries

LUNAR SCIENCE

NASA completes agreement with Japan for the provision of the Pressurized Rover, which will also host multiple science instruments

PAYLOADS

Several international partner science payloads were flown on Artemis I; NASA currently negotiating with several entities, including international partners, to again fly CubeSats

SPACE COMMUNICATIONS AND NAVIGATION

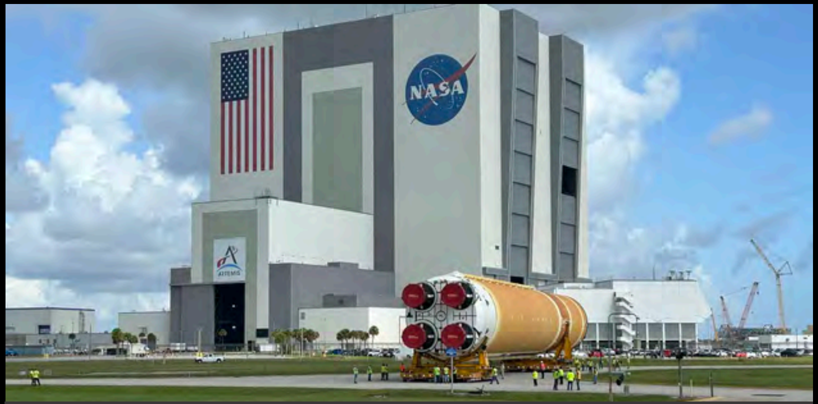
Deep Space Station 53 is a new waveguide antenna that went online in February 2022 at NASA's Deep Space Network's ground station in Madrid

ARTEMIS ACCORDS

- Angola
- Argentina
- Armenia
- Australia
- Bahrain
- Belgium
- Brazil
- Bulgaria
- Canada
- Colombia
- Czech Republic
- Ecuador
- France
- Germany
- Greece
- Iceland
- India
- Israel
- Italy
- Japan
- Lithuania
- Luxembourg
- Mexico
- Netherlands
- New Zealand
- Nigeria
- Peru
- Poland
- Republic of Korea
- Romania
- Rwanda
- Saudi Arabia
- Singapore
- Slovakia
- Slovenia
- Spain
- Sweden
- Switzerland
- Ukraine
- United Arab Emirates
- United Kingdom
- United States of America
- Uruguay

United for Peaceful Exploration of Deep Space

Artemis II Progress



Artemis II core stage arrives at
Kennedy Space Center


Mobile launcher 1 preparations for Artemis II launch


Artemis II crew practice maneuvers inside Orion mock-up


EGS teams test four emergency egress baskets at
Launch Complex 39B


Launch vehicle stage adapter (LVSA), which connects SLS core stage to
upper stage, *en route* to Kennedy


Andre Douglas, NASA's backup astronaut for Artemis II

Artemis III Progress


NASA astronauts Andre Douglas, right, and Kate Rubins participate in JETT 5

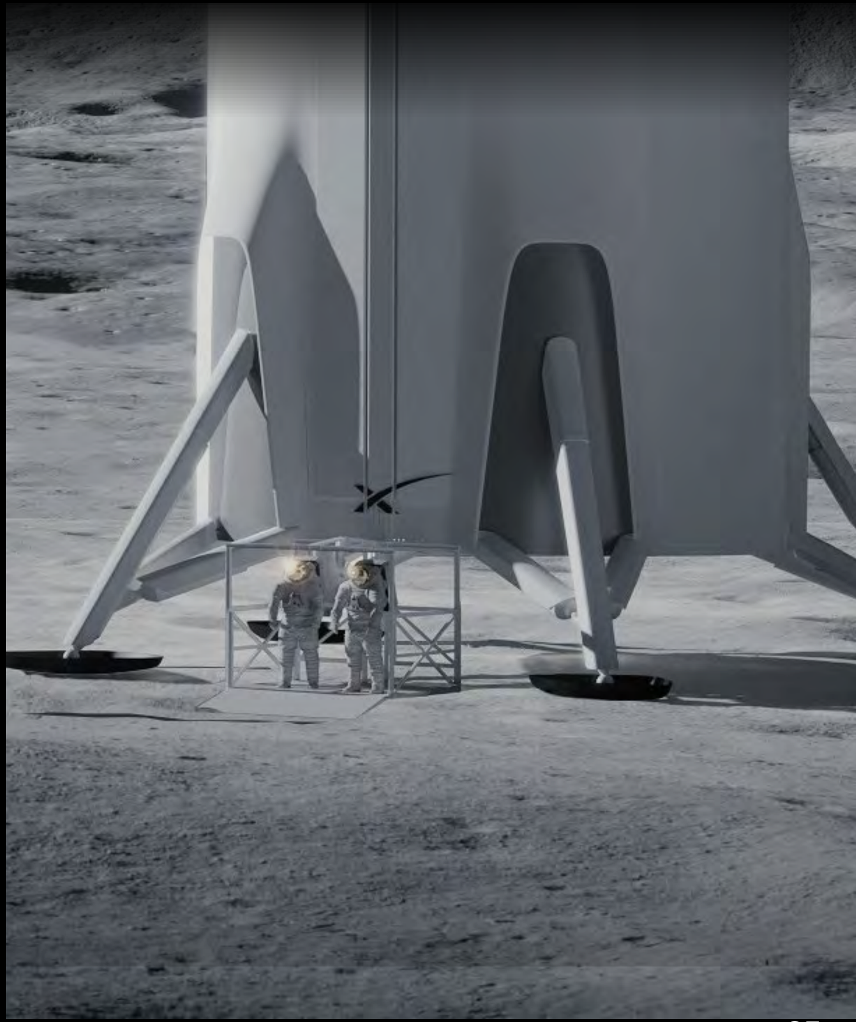

SpaceX's Starship Flight 4 test from Starbase at Boca Chica Beach, Texas, on June 6, 2024


Interim cryogenic propulsion stage final testing and checkout


Astronauts in pressurized spacesuits interact with full-scale mock-up of SpaceX Starship HLS airlock


RS-25 flight set completes processing

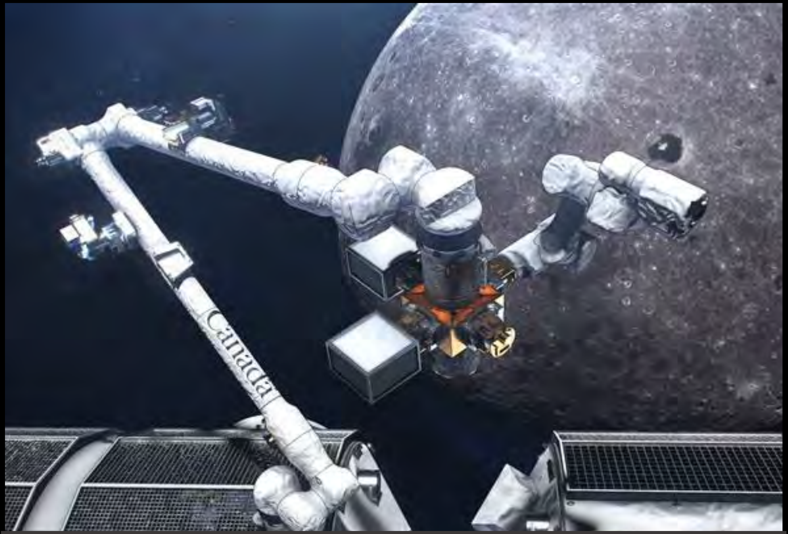

Core stage liquid oxygen tank at Vertical Assembly Center at Michoud



Gateway Progress

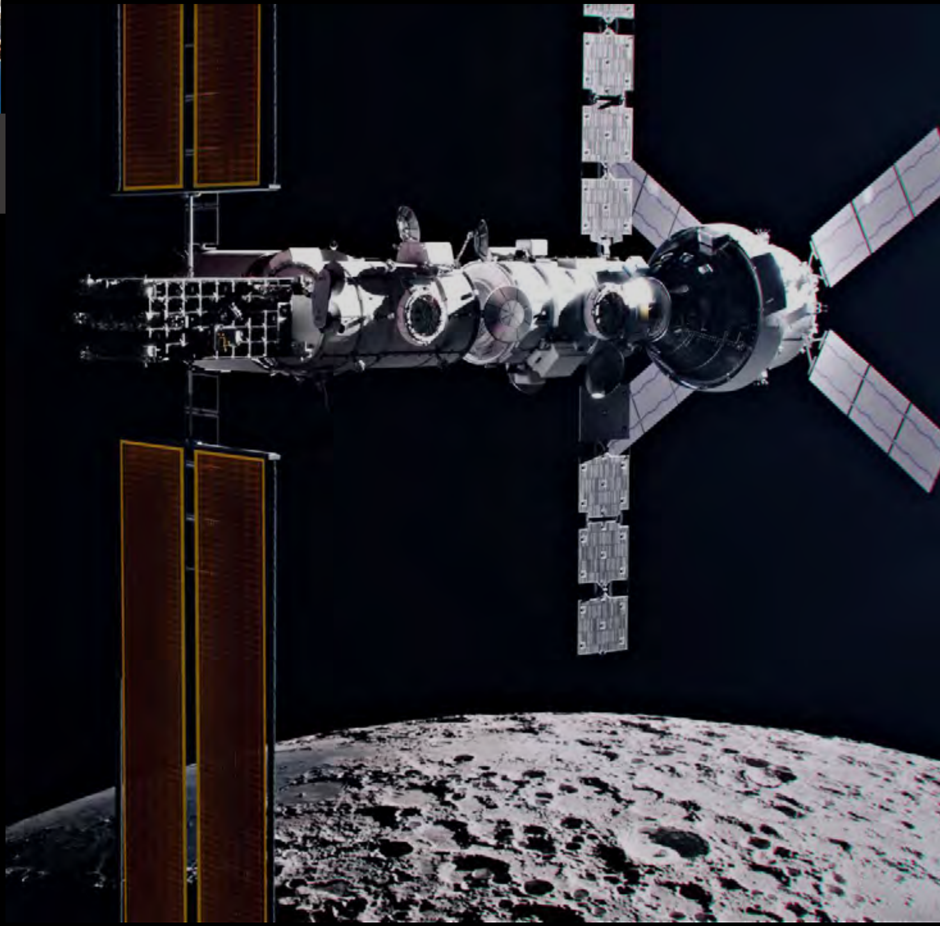
Maxar technicians install xenon tanks into Power and Propulsion Element (PPE) central cylinder for Gateway

Gateway Habitation and Logistics Outpost (HALO) undergoes stress testing at Thales Alenia Space facility on June 10



Work begins on the new Canadarm3 robotic arm on June 27, to launch no earlier than 2029

NASA astronaut Nicole Mann participates in virtual reality testing of Gateway to ensure its comfort and safety



Artemis IV Progress

Mobile Launcher 2 ‘Jack and Set’ milestone

Liquid hydrogen tank for core stage in progress

Progress on the ML2 base build-out
as seen from above as of August 20, 2024

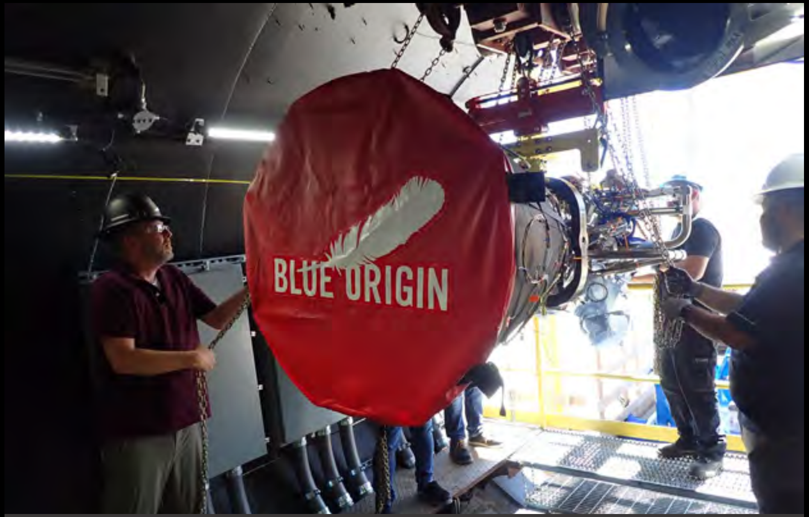
All four universal stage adapter structural qualification article panels
are aligned and loaded on Vertical Assembly Tool

Artemis V+ Progress

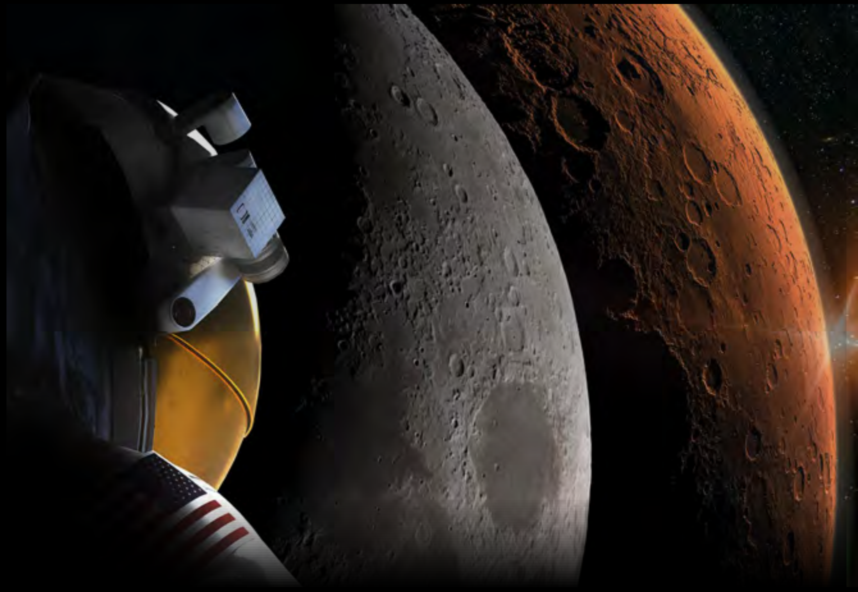
Japan will design, develop, and operate
the enclosed and pressurized rover

New Glenn's first stage test of its six landing legs prior to first launch later this year

Trial Booster Obsolescence and Life Extension (BOLE) composite case winding toward SLS Block 2



Blue Moon HLS's in-space engine BE-7 hotfire test in a vacuum cell at Edwards Air Force Base



Increment 71 Overview

- Soyuz 70S Undock ✓
- SpaceX CRS-30 Undock ✓
- SpaceX Crew-8 Relocate ✓
- RS EVA 62 ✓
- Progress 86 Undock ✓
- Progress 88 Launch/Dock ✓
- US EVAs (RFG, ERDC R&R, IROSA prep) – deferred to Increment 72
- Northrop Grumman CRS-20 Unberth ✓
- Northrop Grumman CRS-21 Launch ✓
- Progress 87P Undock ✓
- Progress 89P Launch/Dock ✓
- Boeing Crew Flight Test (CFT) ✓
- Soyuz 72S Launch/Dock ✓
- Soyuz 71S Undock

Flight Engineers Alexander Grebenkin (Roscosmos) Tracy Caldwell-Dyson (NASA), Michael Barratt (NASA), Nikolai Chub (Roscosmos), Matt Dominick (NASA), Commander Oleg Kononenko (Roscosmos), Jeanette Epps (NASA) , Suni Williams (NASA) and Butch Wilmore (NASA)

Increment 72 Overview

- SpaceX Crew-9 Launch/Dock
- SpaceX Crew-8 Undock
- SpaceX Crew-9 Relocate
- SpaceX CRS-31
- Progress 88P Undock
- Progress 90P Launch/Dock
- Dream Chaser Cargo Mission (DCC-1)
- Northrop Grumman CRS-21 Release
- US EVAs (IROSA Prep 2A + RGA, CARD, RFG 2.5, IROSA Prep 3B)
- Progress 89P Undock
- Progress 91P Launch/Dock
- SpaceX Crew-10 Launch/Dock
- SpaceX Crew-9 Undock/Splashdown
- SpaceX Crew-32 Launch/Dock
- Soyuz 73S Launch/Dock
- Soyuz 72S Undock

Aleksey Ovchinin (Roscosmos) Don Petit (NASA), Nick Hague (NASA), Ivan Vagner (Roscosmos), Aleksandr Gorbunov (Roscosmos), Suni Williams (NASA) and Butch Wilmore (NASA)