



# **NASA Space Operations**

## GROUND SYSTEMS ARCHITECTURE WORKSHOP

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# MY STORY (SOME OF IT...)

## EDUCATION:

Bachelor of Business Administration in finance, University of New Mexico;  
Bachelor of Science and Master of Science in industrial engineering,  
New Mexico State University

## NASA CAREER:

Quality engineer, White Sands Test Facility propulsion lab,  
supporting the Space Shuttle program

Manager, Commercial Orbital Transportation Services Integration  
Office, supporting the International Space Station program at  
NASA's Johnson Space Center

Manager, Commercial Crew Program at NASA's Kennedy Space Center

Associate Administrator, NASA's Human Exploration and  
Operations Mission Directorate at NASA Headquarters

Associate Administrator of NASA's Space Operations  
at NASA Headquarters





# NASA Space Operations

Nurturing the capabilities required to build a new future in space



**INTERNATIONAL SPACE  
STATION**

**COMMERCIAL LOW-EARTH  
ORBIT DEVELOPMENT**

**EXPLORATION OPERATIONS**

**LAUNCH SERVICES  
PROGRAM**

**SPACE COMMUNICATIONS  
& NAVIGATION**

**HUMAN SPACEFLIGHT  
CAPABILITIES**





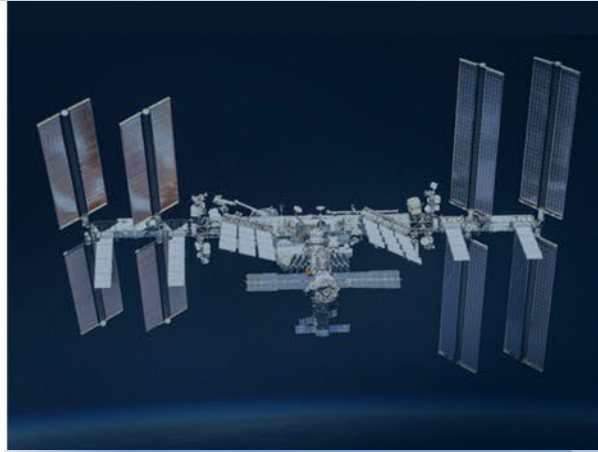
# Current and Planned Operations Across Multiple Platforms



## TERRESTRIAL

Earth-based facilities, operations, capabilities and workforce enable our exploration of space.

Examples include ground stations for Space Communications, Rocket Propulsion testing facilities, the Neutral Buoyancy Lab, ground tests at the Neil A. Armstrong Test Facility, Mission Control at Johnson Space Center, construction at Michoud Assembly Facility, ground analogs for human research, and ground operations at Kennedy Space Center.



## LOW-EARTH ORBIT

Operations in low-Earth orbit provide a home to our astronauts aboard the International Space Station, which serves as training ground for long-duration missions off Earth and a proving ground for deep space operations.

Activities aboard station prove science and technology capabilities, characterize humans in long-duration spaceflight, allow for human- and robotic-tended Earth observation, and spur innovation that enables a robust economy.



## CIS-LUNAR

Plans for cislunar space have spurred the development of the Artemis transportation systems and infrastructure needed to create an active presence on and around the Moon.

Gateway operations will provide a crew-tended environment for scientific discovery and technological demonstrations, including a long-duration checkout in preparation for crewed missions to Mars.

Capabilities include Lunar Communication Relay and Navigation Services (lunar relays); Gateway will also serve as a relay.



## LUNAR SURFACE

A sustainable presence on the lunar surface involves a close strategic relationship with NASA's Exploration Systems Development, Science, and Space Technology Mission Directorates, and collaboration with our industry and international partners.

Investment in advanced space systems, communications, and robotics will teach us how to maintain human operations and crew health away from Earth for extended periods of time.



## 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

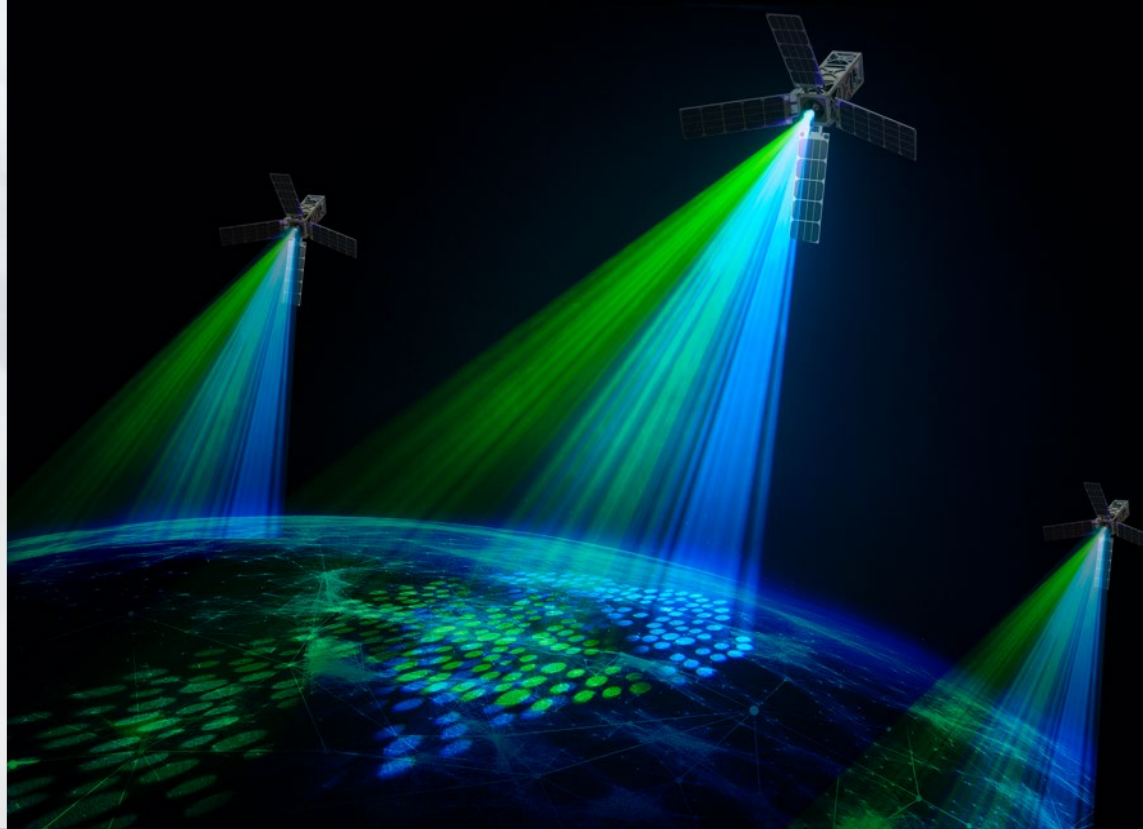
Spectrum Management

Search and Rescue

Networks Development

# Space Communications and Navigation

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



## 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



# NASA's Communications Networks

-  NASA Near Space Network (NSN)
-  NASA Deep Space Network (DSN)
-  Commercial Stations Supporting NSN
-  Optical
-  Future Upgrades





# Advancing Communications Capability for Artemis

- > Three tightly coupled activities are necessary to provide the services needed for the evolving robotic, scientific and human spaceflight Artemis missions



## 34-Meter Antenna Upgrades

- Upgrades to two Deep Space Network (DSN) antennas at each of the three complexes (totaling six upgraded antennas)



## 18-Meter Antenna Subnet Development

- A dedicated new set of antennas, designed to support lunar missions, to help alleviate the user load on the current 34-meter subnet, to allow for a focus on deep space support



## Lunar Relay and Interoperable Lunar Network

- Lunar landing opportunities are increased by 40% by removing driving DTE line-of-sight communication constraint with a lunar relay
- Continuous communication during HLS descent is easier supported through a relay link than a DTE link





# ARTEMIS I

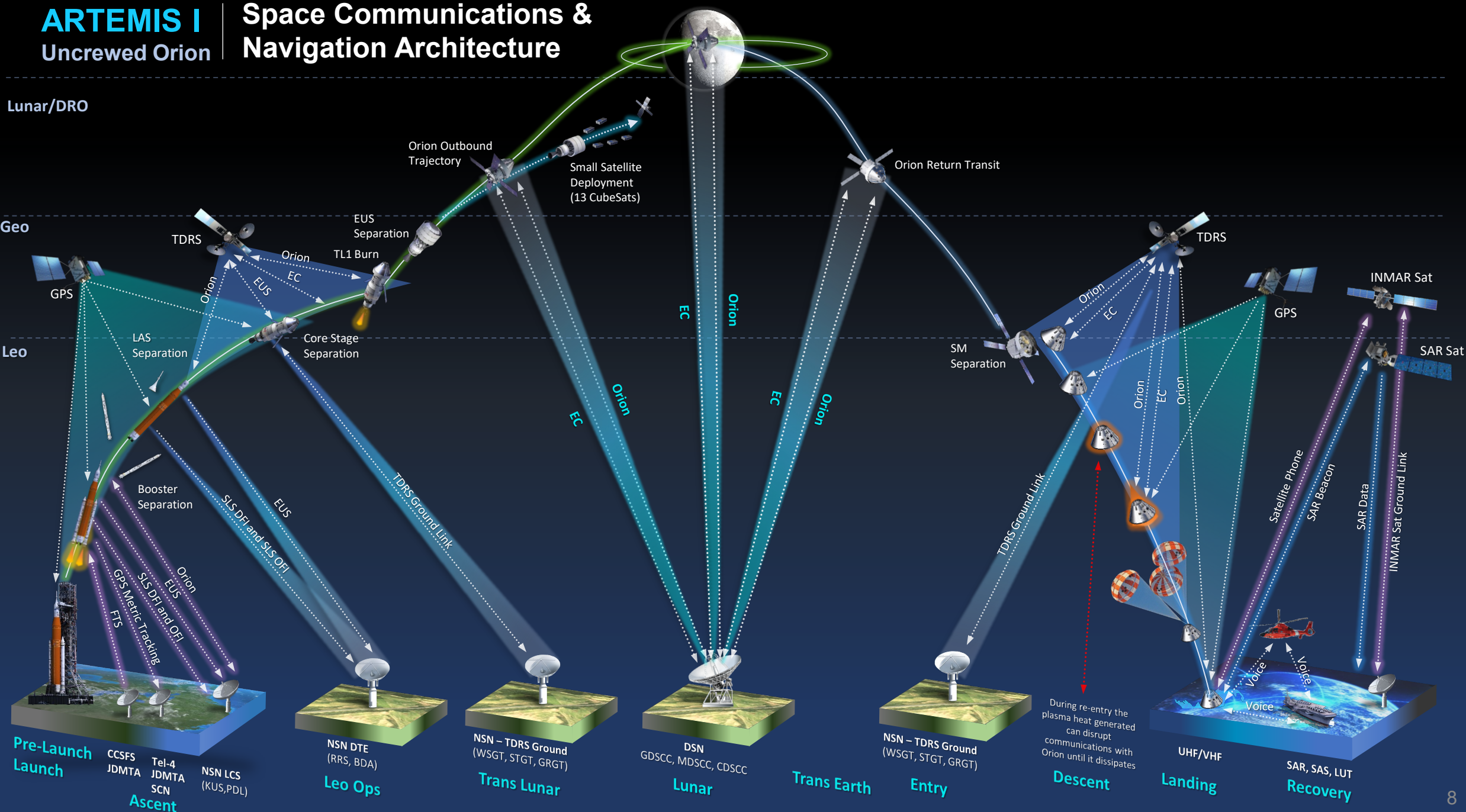
## Uncrewed Orion

# Space Communications & Navigation Architecture

Lunar/DRO

Geo

Leo





# Key Initiatives for Interoperability



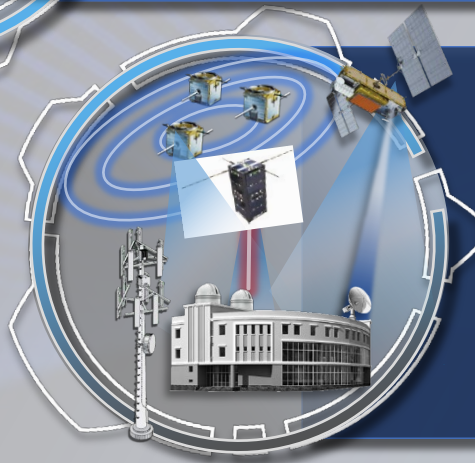
- Supporting standards bodies such as CCSDS
- Adopting commercial standards whenever possible
- Creating new standards to fill the gaps: optical, network management, bundle protocol
- Infusing standards into operations

## Standards



- Working with the space community to identify the spectrum needs of a growing space market
- Working to remove regulatory barriers that impede progress

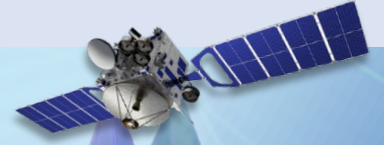
## Spectrum Access



- Investing in low TRL, high impact technologies
- Wideband receivers that allow operation across all Ka-band
- Cognitive Networks to provide dynamic, flexible user access, increased security and resiliency

## Technology

***...create an interoperable space communications and navigation environment that can leverage civil, commercial, domestic, and international capabilities to enable the seamless transfer of information.***



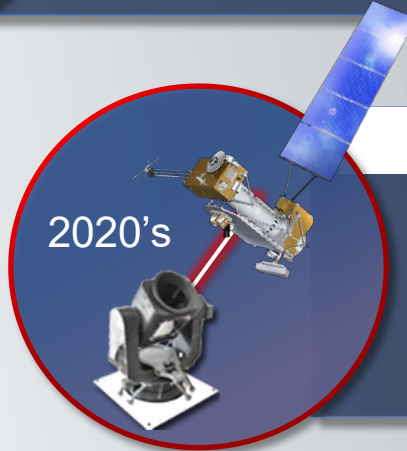
# Push the Envelope on Communication Capabilities



## Conventional Radio

- > Communication antennas are typically 10's of meters to a few centimeters

- > Data capacities are very limited due to the large geometries and limited spectrum



## Optical

- > Optical systems use lasers and telescopes to communicate

- > Very high data capacities, enables trunk lines
- > RF spectrum relief
- > Enables quantum comm



## Quantum

- > Quantum systems use single photons to communicate  
**OVER OPTICAL NETWORKS**

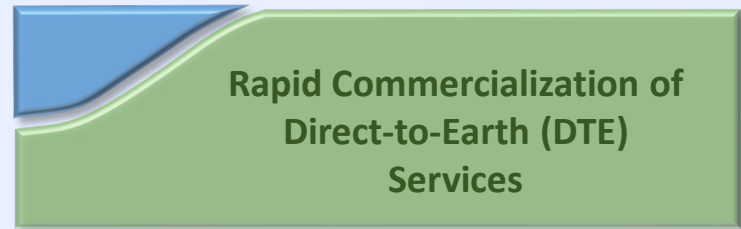
- > Quantum Networks will have capabilities never before available, e.g., quantum security



# Plan for Commercial Communications Services



Ground Stations:  
Commercialization Target



2020 2030

- In 2020, ~36% of mission passes were provided by commercial partners
- Near-term increase in services provisioned by current commercial & partner ground sites

- **Targeting 2023 for 100% commercial service;** applies to existing and new missions
- Infuse new vendors drawing on vibrant and growing market
- GSFC-led team realigned to better support service through virtual network management
- **Goal is more commercial providers of interoperable comm & tracking services**



*\*Companies listed are illustrative of market activity, not indicative of NASA preference or commitments*



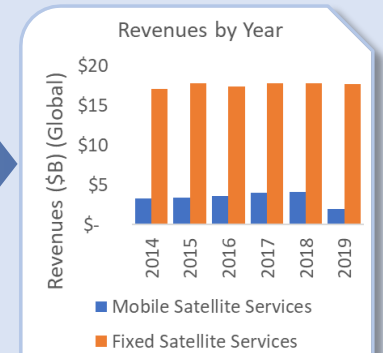
TDRS:  
Commercialization Target



2020 2030

- Time required to gradually transition since commercial market does not exist
- Commercial SATCOM capability used for new missions; legacy missions fly out on current government capability

- NASA will no longer build/deploy Tracking and Data Relay Satellites (TDRS); current network can support users into the early 2030's
- Commercial SATCOM infrastructure exists, but capability is tailored to non-space users
- GRC's Communications Services Project (CSP) focused on demonstrating the feasibility
- Rolling wave approach of demonstrating new/expanded services over the 2020s
- **Goal is several commercial providers of interoperable comm & tracking services**





# Upcoming Events



## **Geostationary Operational Environmental Satellite-T (GOES-T) – March 2022**

NASA and NOAA's latest weather satellite, GOES-T, launching from Florida



## **Axiom Mission 1 (Ax-1) – March 2022**

First private astronaut mission to the International Space Station; duration ~8-10 days long



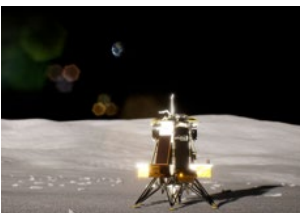
## **NASA's SpaceX Crew-4 – April 2022**

Crew-4 launching from Florida to the International Space Station



## **CAPSTONE – Spring 2022**

NASA CubeSat to validate new navigation technologies and verify dynamics in Gateway's planned orbit; launching from New Zealand



## **Intuitive Machines Flight – Spring 2022**

Carrying six payloads to *Oceanus Procellarum*, a scientifically intriguing dark spot on the Moon, in early 2022



# Upcoming Events



## **Astrobotic's CLPS Flight – Spring 2022**

Astrobotic will carry 11 payloads to *Lacus Mortis*, a larger crater on the near side of the Moon



## **SpaceX Cargo Resupply Services (CRS-25) – May 2022**

Science and Cargo Resupply to and from the International Space Station, including delivery of a new Earth-observing climate instrument



## **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



## **Artemis I – May 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

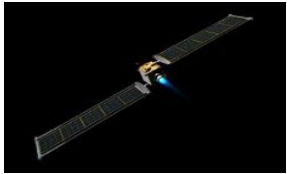


# Upcoming Events



## **Northrop Grumman Cargo Resupply (NG-18) – Summer 2022**

Cargo and Science Resupply to the International Space Station



## **DART – September 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 – September 2022**

Crew-5 launching from Florida to the International Space Station



## **SpaceX Cargo Resupply Services (CRS-26) – Fall 2022**

Science and Cargo Resupply to and from the International Space Station



## **Intuitive Machines Award – Winter 2022**

NASA awarded a task order to deliver the PRIME-1 drill to the Moon by December



## **Artemis II Crew Announcement – TBD 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



# Space Operations Mission Directorate

*We are...*

Maintaining a foothold in space

Gathering more experience each day

Opening the door of opportunity

Acting as a multiplier of our benefits

Returning value to our nation and world





**QUESTIONS?**