



# NASA's Approach to Lunar Communication and Navigation Artemis and Beyond

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# Science and Exploration Enabled:

SCaN is the essential connection to our human explorers, our science missions, and our partners

**Space Communications and Navigation (SCaN)** Serves as the enterprise responsible for all of NASA's space communications activities.  
24/7 Global Near Earth and Deep Space Communications and Navigation Services  
100+ Missions currently enabled by SCaN

## Focal Points for Change: Strategic Evolution

**Engage**  
as One Team,  
One Mission,  
One Network

**Execute**  
with Sound Technical  
and Programmatic  
Fundamentals

**Evolve**  
the Network to  
Satisfy Mission  
Customer Needs of  
the Future

**Empower**  
Our Science and  
Exploration  
Partners

# The “Next Giant Leap”

We Continue to Push the Bounds of What is POSSIBLE

- Next step in human space exploration
- Sustained presence on Moon
- Laying groundwork for humans on Mars



# TOGETHER to the Moon



Gateway



Shared Possibilities



Artemis Lunar Habitats



Lunar Science Exploration



## ARTEMIS ACCORDS



United for Peaceful Exploration of Deep Space



# Artemis: Landing Humans On the Moon



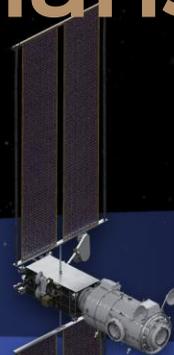
Lunar Reconnaissance Orbiter: Continued surface and landing site investigation



Artemis I: First human spacecraft to the Moon in the 21st century



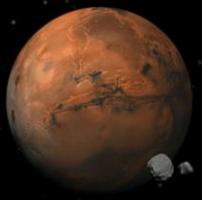
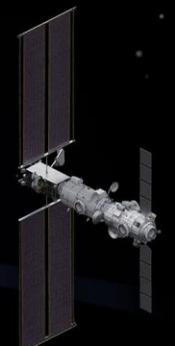
Artemis II: First humans to orbit the Moon and rendezvous in deep space in the 21st century



Gateway begins science operations with launch of Power and Propulsion Element and Habitation and Logistics Outpost



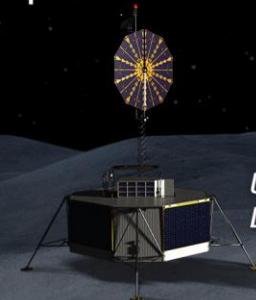
Artemis III-V: Deep space crew missions; cislunar buildup and initial crew demonstration landing with Human Landing System



**Early South Pole Robotic Landings**  
Science and technology payloads delivered by Commercial Lunar Payload Services providers



**Volatiles Investigating Polar Exploration Rover**  
First mobility-enhanced lunar volatiles survey



Uncrewed HLS Demonstration



**Humans on the Moon - 21st Century**  
First crew expedition to the lunar surface



## LUNAR SOUTH POLE TARGET SITE

# Artemis Base Camp Buildup

First lunar surface expedition through Gateway; external robotic system added to Gateway; Lunar Terrain Vehicle delivered to the surface

Sustainable operations with crew landing services; Gateway enhancements with refueling capability, additional communications, and viewing capabilities

Pressurized rover delivered for greater exploration range on the surface; Gateway enables longer missions

Surface habitat delivered, allowing up to four crew on the surface for longer periods of time leveraging extracted resources. Mars mission simulations continue with orbital and surface assets

Lunar Terrain Vehicle (LTV)

Crew Landing Services

Pressurized Rover

Fission Surface Power

ISRU Pilot Plant

Surface Habitat

**SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION**

MULTIPLE SCIENCE AND CARGO PAYLOADS | U.S. GOVERNMENT, INDUSTRY, AND INTERNATIONAL PARTNERSHIP OPPORTUNITIES | TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

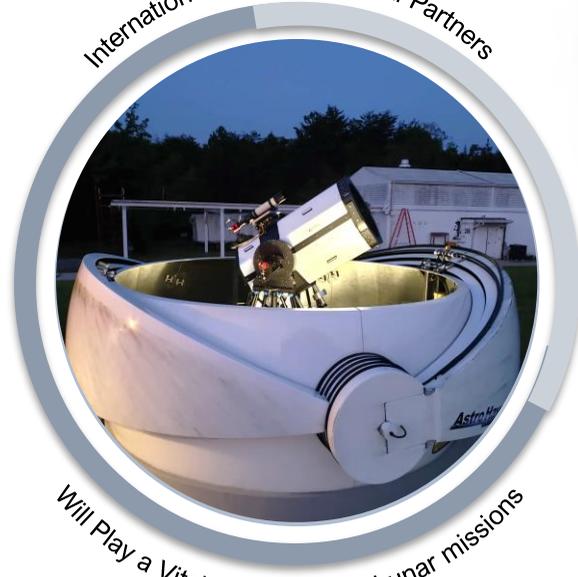
# Orion Artemis II Optical Communications (O2O)

Laser communications will empower our astronauts with more data than ever before

Artemis II Crew



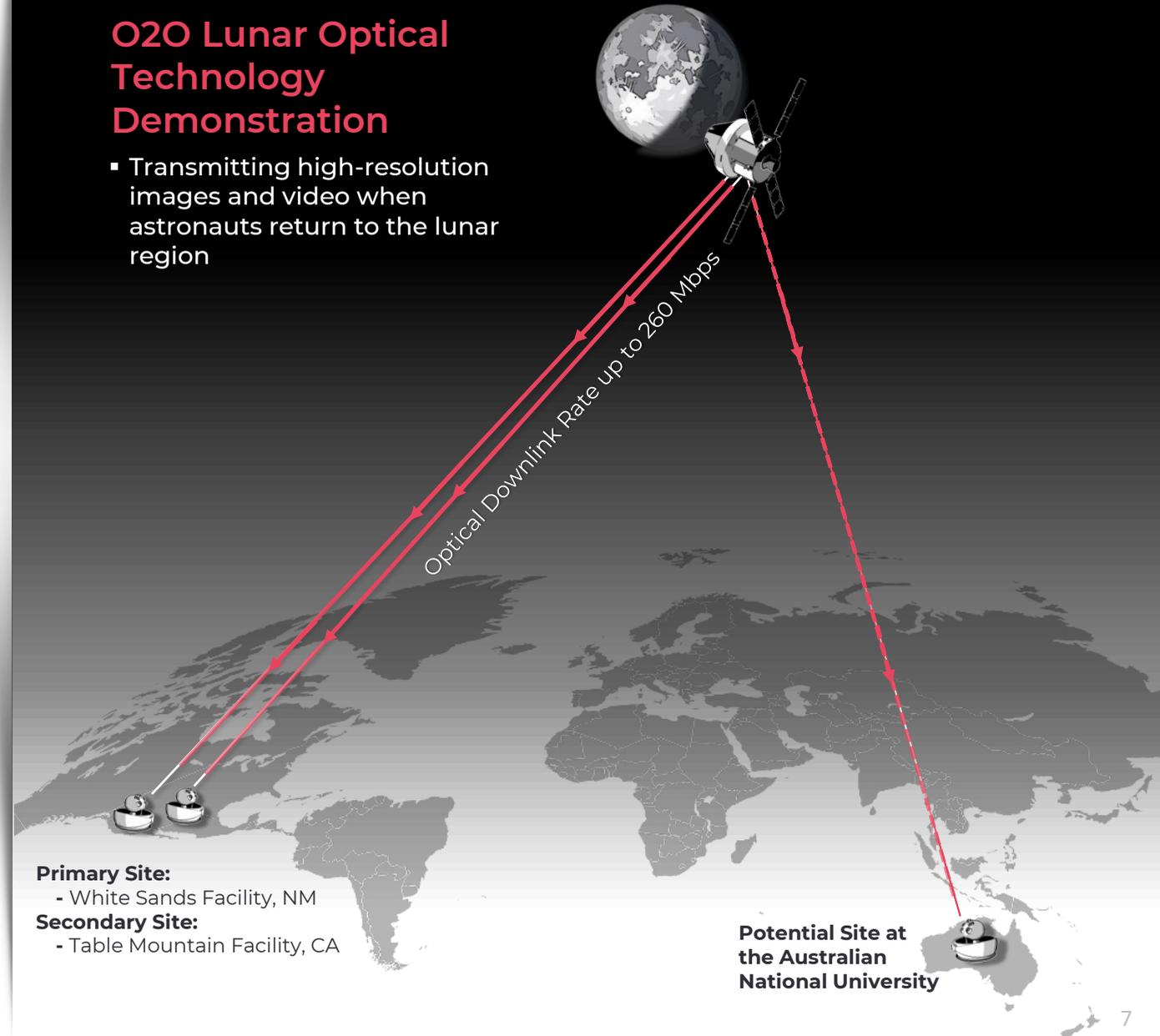
International and Commercial Partners



Will Play a Vital Role in NASA Lunar missions

## O2O Lunar Optical Technology Demonstration

- Transmitting high-resolution images and video when astronauts return to the lunar region



### Primary Site:

- White Sands Facility, NM

### Secondary Site:

- Table Mountain Facility, CA

Potential Site at  
the Australian  
National University

# DTE: Investments in Capacity and Commercial Opportunity

Lunar Exploration Ground Segment (LEGS): GOCO sites 1-3 geographically dispersed and augmented by commercial services.

**1** LEGS Site 1: White Sands Complex (WSC)  
Government: NASA/GSFC

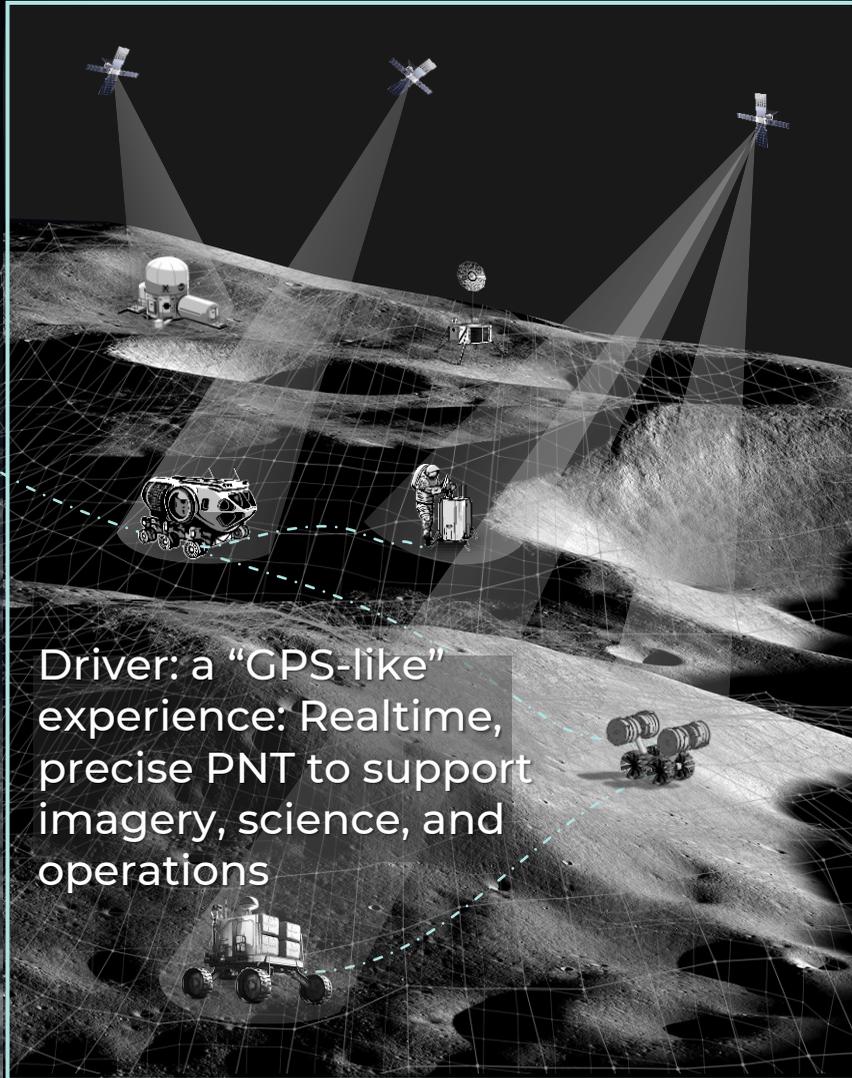
**2** LEGS Site 2: South Africa

**3** LEGS Site 3: Australia

⊕ Representative/Potential Commercial Locations



# Relay: Communications and Position, Navigation, and Timing at the Moon



# Surface Connectivity: 3GPP and 4G for Lunar Users

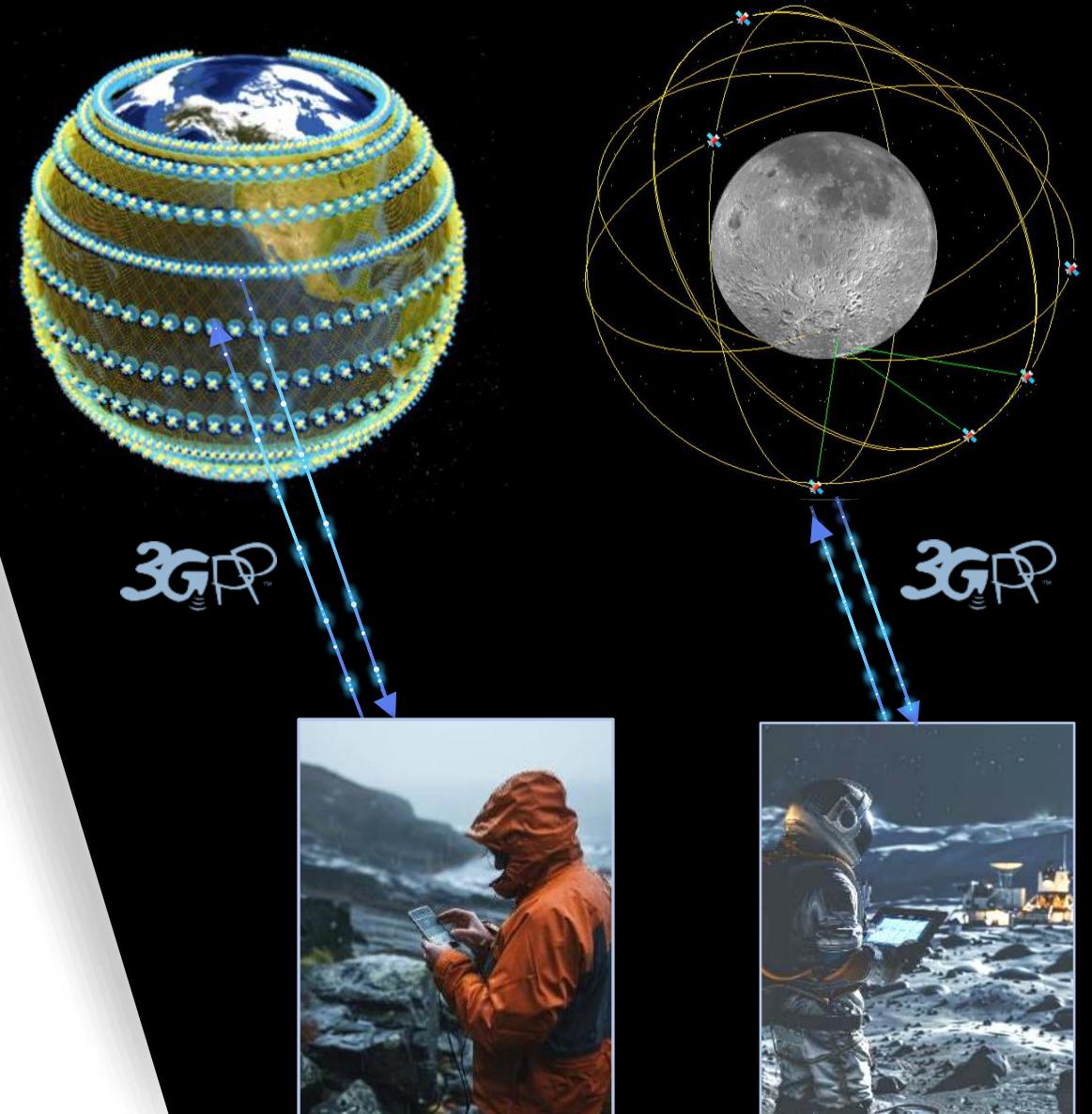
Standards like 3GPP could create a near-Earth service environment that extends all the way to the Moon

STMD Tipping Point Award to Nokia for 4G/LTE demonstration on lunar surface scheduled for 2025

Axiom selected Nokia for space suit comms



Artist rendering of the Lunar Outpost Mobile Autonomous Prospecting Platform rover with Nokia antennas extended  
Image credit: Nokia/Intuitive Machines.



# LunaNet and Interoperability



Various public and private sector providers will be able to offer comprehensive standards-based networking, navigation, communications, and messaging services to support various cislunar activities

“Together, we’re refining a **cutting-edge approach** that will meet the needs of **lunar missions** for many decades to come.” *Dave Israel, Goddard Communications Architect*

NASA, the European Space Agency (ESA), and the Japan Aerospace Exploration Agency (JAXA) are collaborating to further streamline the deployment of communications and navigation services on and around the Moon



National Aeronautics and  
Space Administration



# SCaN

Space Communications  
and Navigation

Science and Exploration, Enabled Together.

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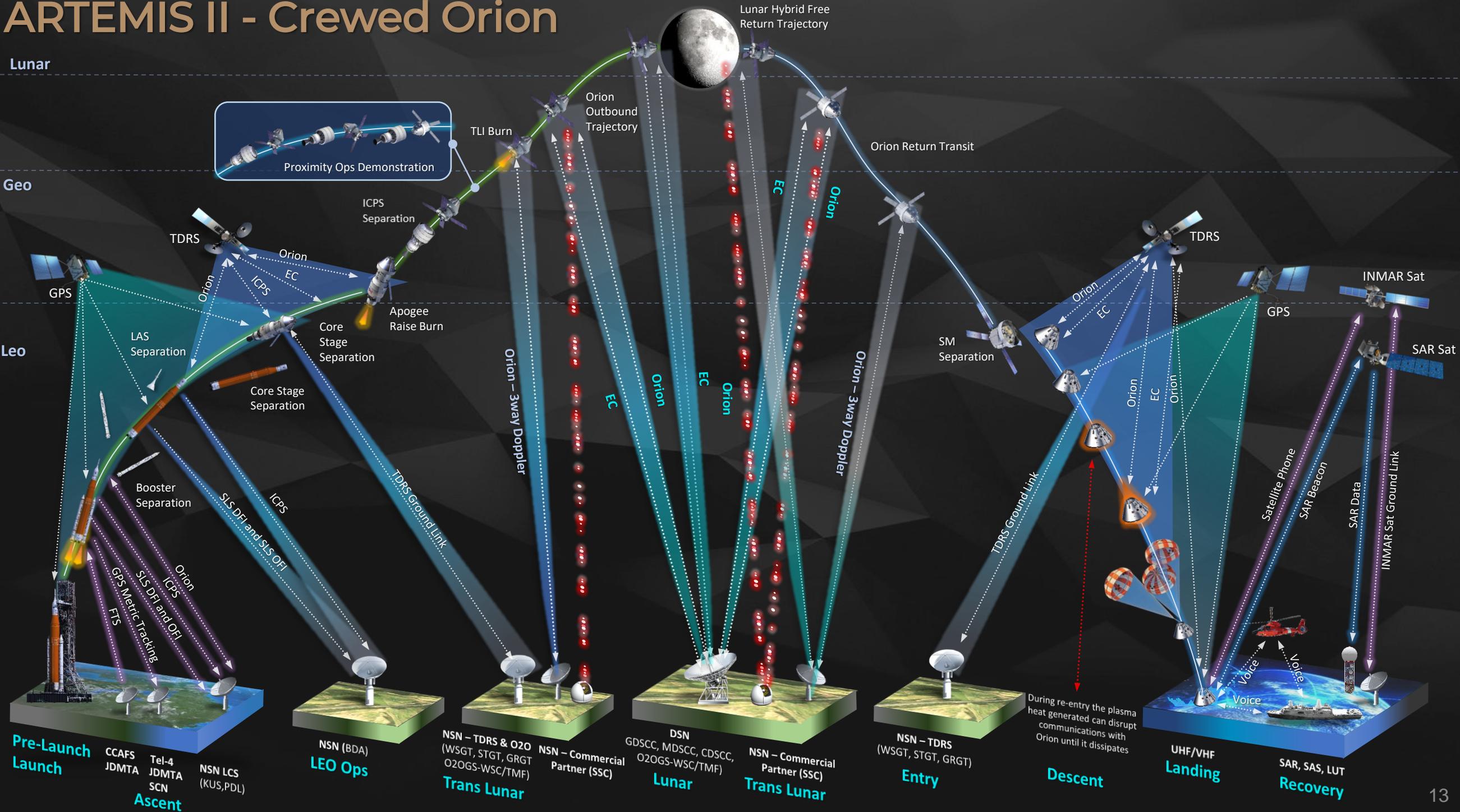
[www.nasa.gov](http://www.nasa.gov)

# ARTEMIS II - Crewed Orion

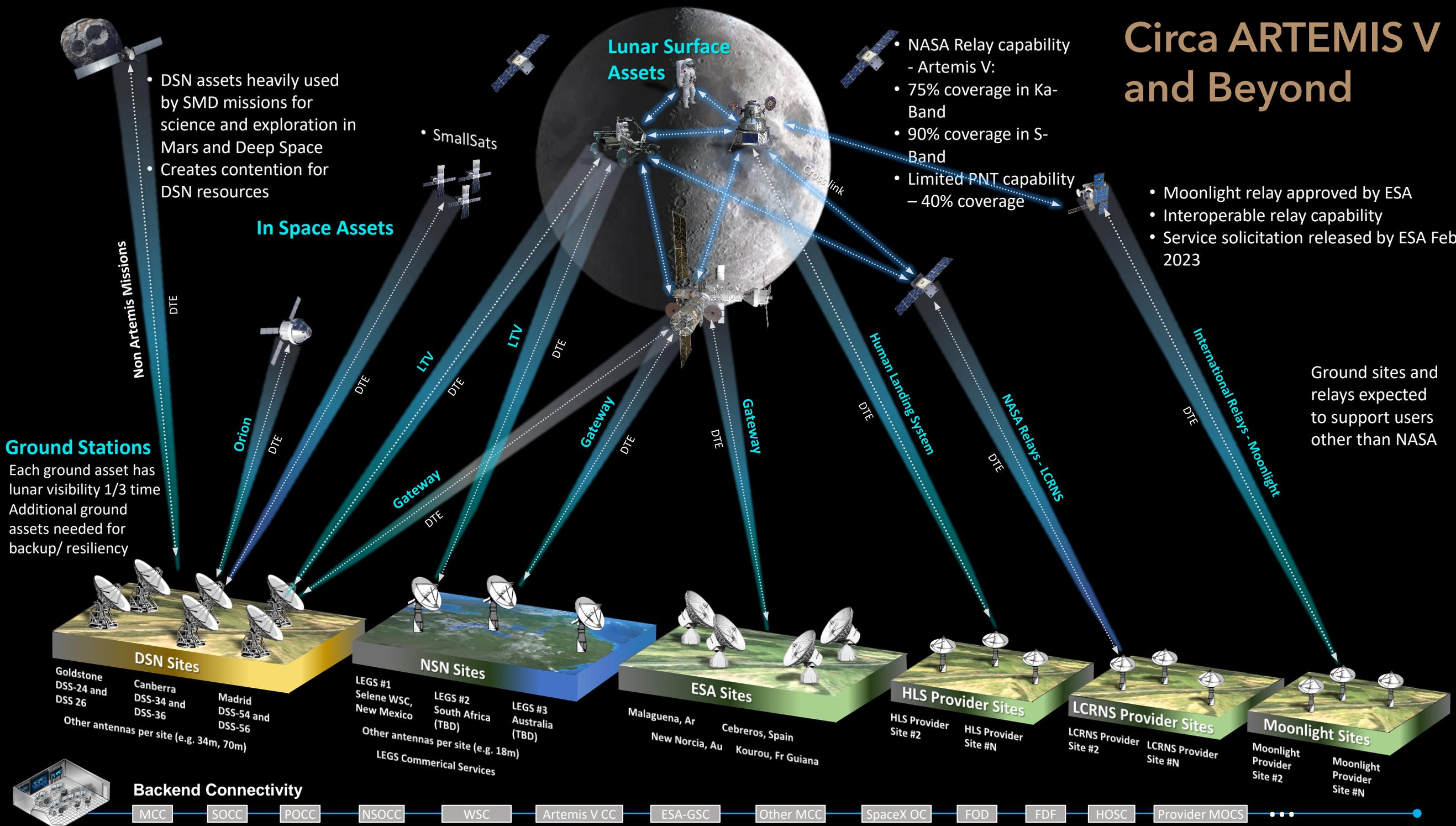
Lunar

Geo

Leo



# Circa ARTEMIS V and Beyond



## Ground Stations

- Each ground asset has lunar visibility 1/3 time
- Additional ground assets needed for backup/ resiliency

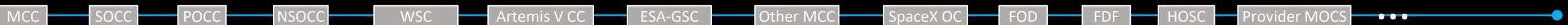
- DSN assets heavily used by SMD missions for science and exploration in Mars and Deep Space
- Creates contention for DSN resources

- NASA Relay capability - Artemis V:
  - 75% coverage in Ka-Band
  - 90% coverage in S-Band
  - Limited PNT capability – 40% coverage

- Moonlight relay approved by ESA
- Interoperable relay capability
- Service solicitation released by ESA Feb 2023

Ground sites and relays expected to support users other than NASA

## Backend Connectivity



**DSN Sites**  
 Goldstone DSS-24 and DSS 26  
 Canberra DSS-34 and DSS-36  
 Madrid DSS-54 and DSS-56  
 Other antennas per site (e.g. 34m, 70m)

**NSN Sites**  
 LEGS #1 Selene WSC, New Mexico  
 LEGS #2 South Africa (TBD)  
 LEGS #3 Australia (TBD)  
 Other antennas per site (e.g. 18m)  
 LEGS Commerical Services

**ESA Sites**  
 Malaguena, Ar  
 Cebrenos, Spain  
 New Norcia, Au  
 Kourou, Fr Guiana

**HLS Provider Sites**  
 HLS Provider Site #2  
 HLS Provider Site #N

**LCRNS Provider Sites**  
 LCRNS Provider Site #2  
 LCRNS Provider Site #N

**Moonlight Sites**  
 Moonlight Provider Site #2  
 Moonlight Provider Site #N