

UPDATE FROM

NASA Space Communications and Navigation Program (SCaN)

National Academies – Space Science Week

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SPACE COMMUNICATIONS and NAVIGATION

SCaN Overview and Forward Vision

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 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

NASA's Communications Networks



Lunar Relay

- NASA Near Space Network (NSN)
- NASA Deep Space Network (DSN)
- Commercial Stations Supporting NSN
- Lunar Exploration Ground Sites (LEGS)
- Optical
- Future Upgrades

Near Space Network Tracking and Data Relay Satellites (TDRS) And Future Commercial Relay

• Commercial Relay B

• Commercial Relay A

• Commercial Relay C

• Commercial Relay D

• TDRS F8

• TDRS F10

• TDRS F11

• TDRS F13

• TDRS F12

• TDRS F6

Ka-band upgrade
Svalbard, Norway

KSAT, Norway

SSC Kiruna, Sweden

Madrid, Spain
DAEP Ka-band Upgrade
S-band Upgrade

Sardinia, Italy

White Sands
Complex, New
Mexico

Blossom Point,
Maryland
Wallops Island, Virginia

LEGS 1, White
Sands
White Sands,
New Mexico

Goldstone, California
Ka-band Upgrade
S-band Upgrade
Table Mtn, California

ASF, Alaska
NOAA, Alaska
North Pole,
Alaska

Ka-band Upgrade.
Alaska

SSC Hawaii
Hawaii

LEGS 2, Matjiesfontein,
South Africa

Ka-band
Commercial Upgrade
Punta Arenas, Chile

NSN Station, SSC
Hartebeesthoek,
South Africa

KSAT
Singapore

LEGS 3, Dongara,
Australia

SSC
Dongara,
Australia

Canberra, Australia
DAEP Ka-band Upgrade
S-band Upgrade

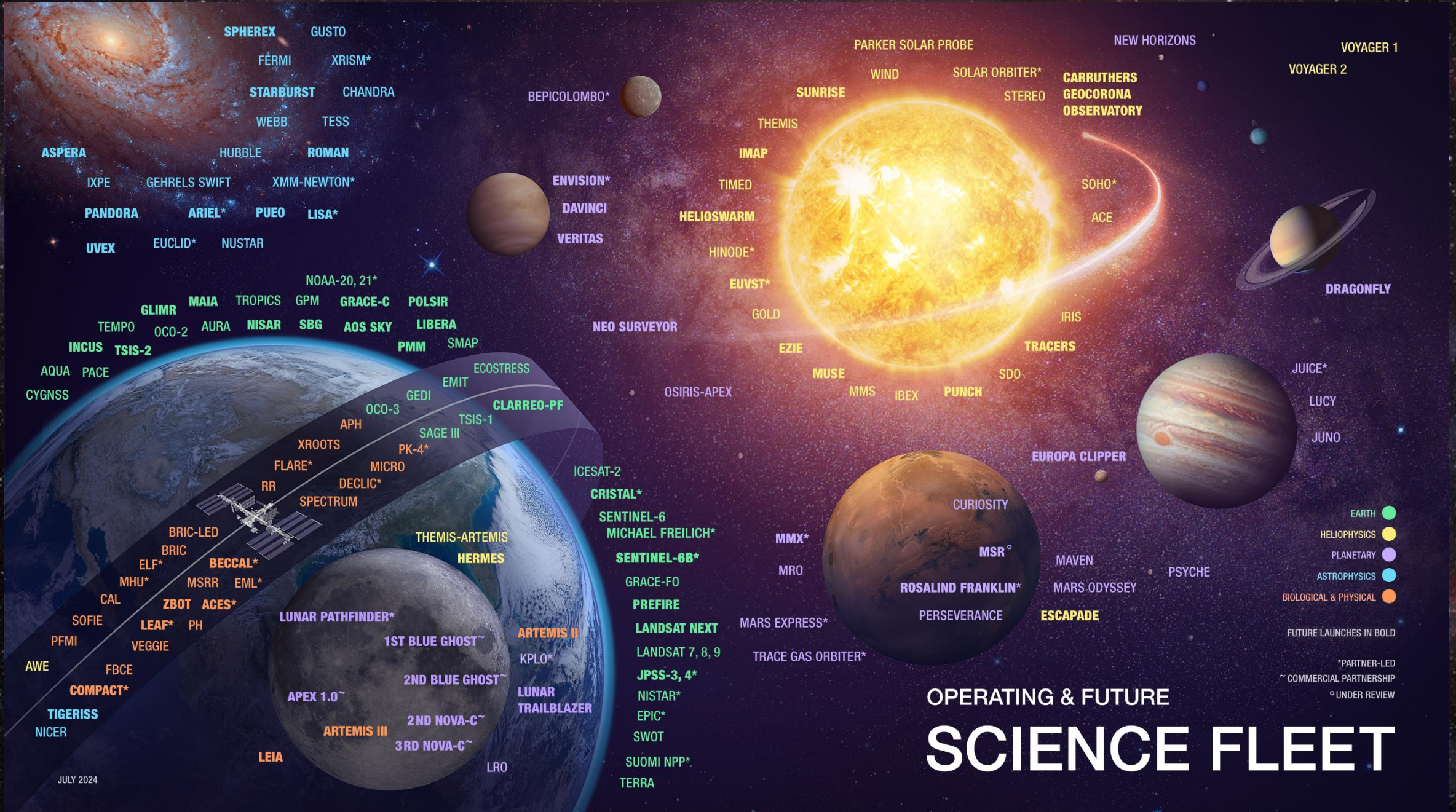
Guam Remote
Ground
Terminal

KSAT
TrollSat,
Antarctica

McMurdo,
Antarctica

Space Missions

Missions rely on SCaN for critical communications and navigation capabilities



SCaN is adopting commercial solutions to provide cost-effective, global, low latency, high throughput services to users

Building on decades-long relationships with **commercial DTE** providers, and **integrating new providers** based on robust multi-player—and multidomain—market.

Approaching relevant technology projects to **leverage COTS products and build-in pathways to commercialize** end capabilities.

Continuing to **collaborate with stakeholders** to define NASA's future network architecture and the strategies for its implementation.





CRITICAL TOPIC 1

TDRS Flyout and Next Gen Relay

NASA's Tracking and Data Relay Satellite (TDRS) system is in decline

TDRS is used by NASA missions, international, and commercial partners

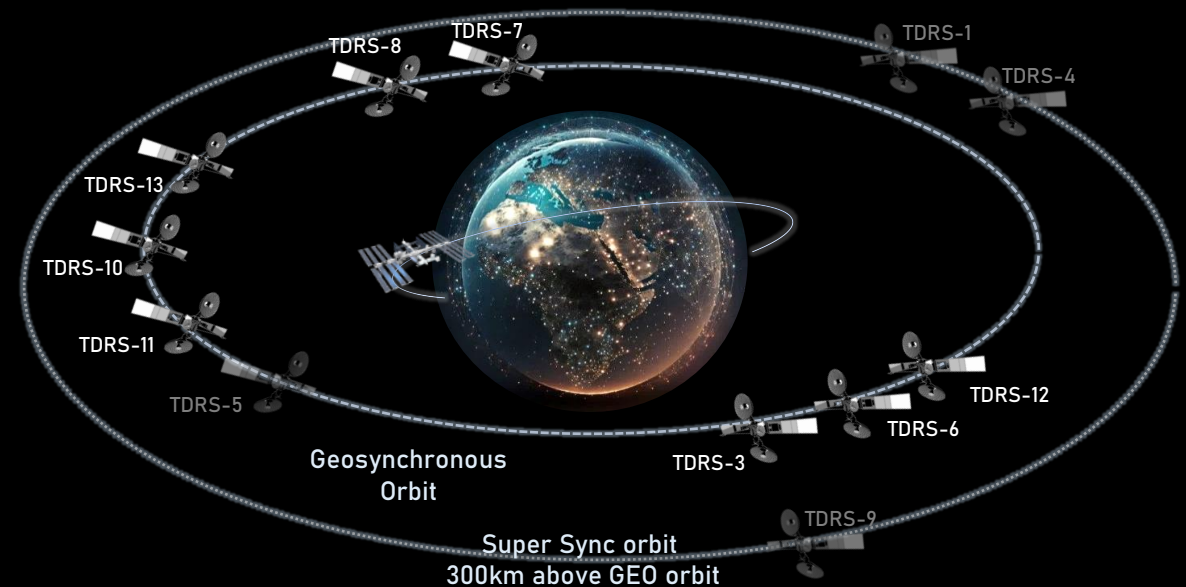
The TDRS fleet was built up over decades in three generations of satellites

- The first TDRS was launched in 1983
- Several spacecraft are 30+ years old
- 7 aging spacecraft still provide services
- **The space segment will not be replenished**

To preserve capacity and manage risks, NASA has stopped accepting new users on the TDRS network

NASA Decision

Effective November 8, 2024, NASA discontinued offering TDRS services as part of the Near Space Network (NSN) service catalog



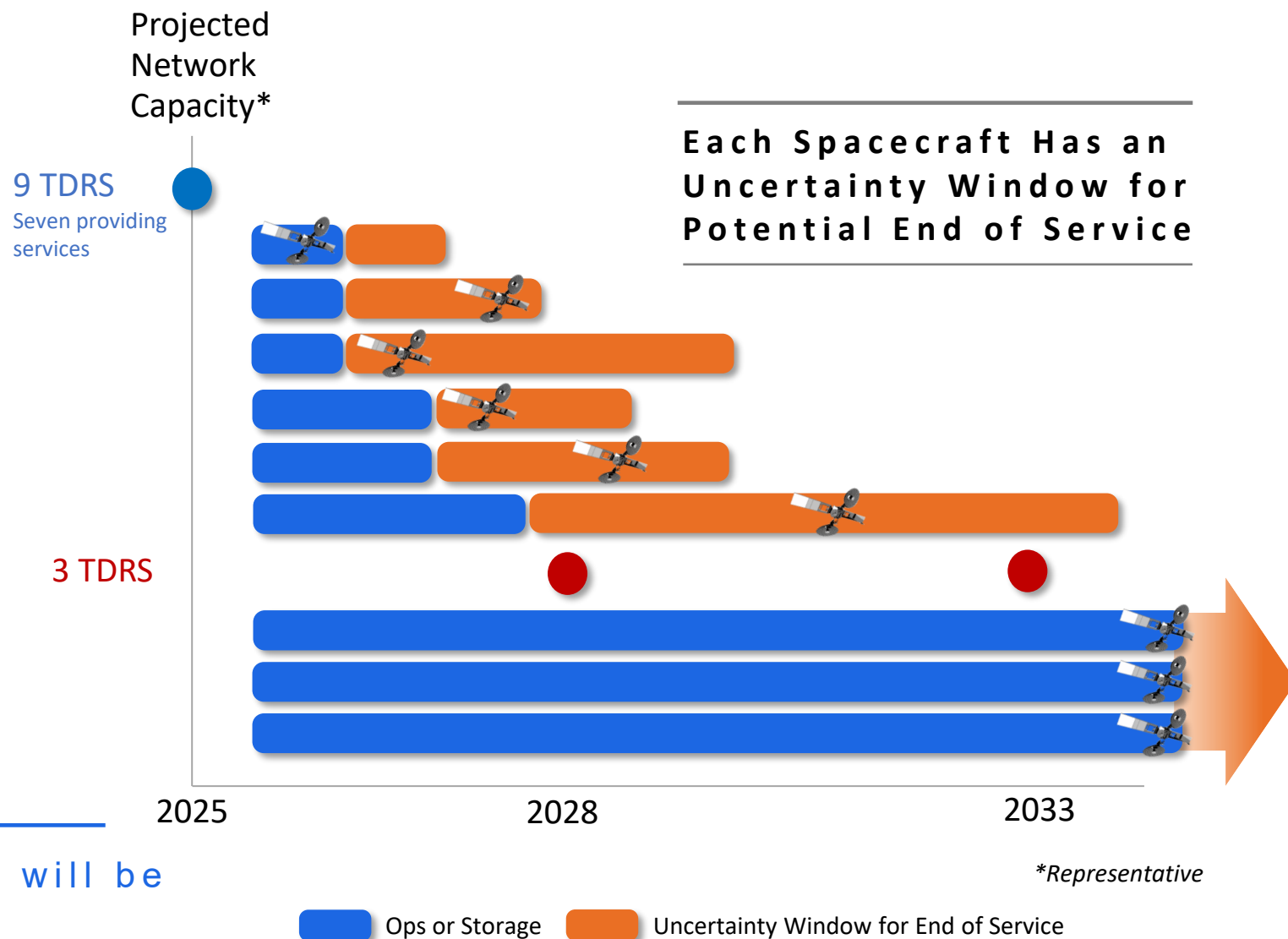
TDRS Capacity Projections

Several spacecraft are predicted to fail in the next 1-5 years

Projected decline indicates a reduction from 7 to 3 satellites by 2033; potentially as early as 2028

With a ~60% decline in capacity, NASA must actively manage utilization of the resource

Network capacity in final "3 ball" state will be less than half of today's value



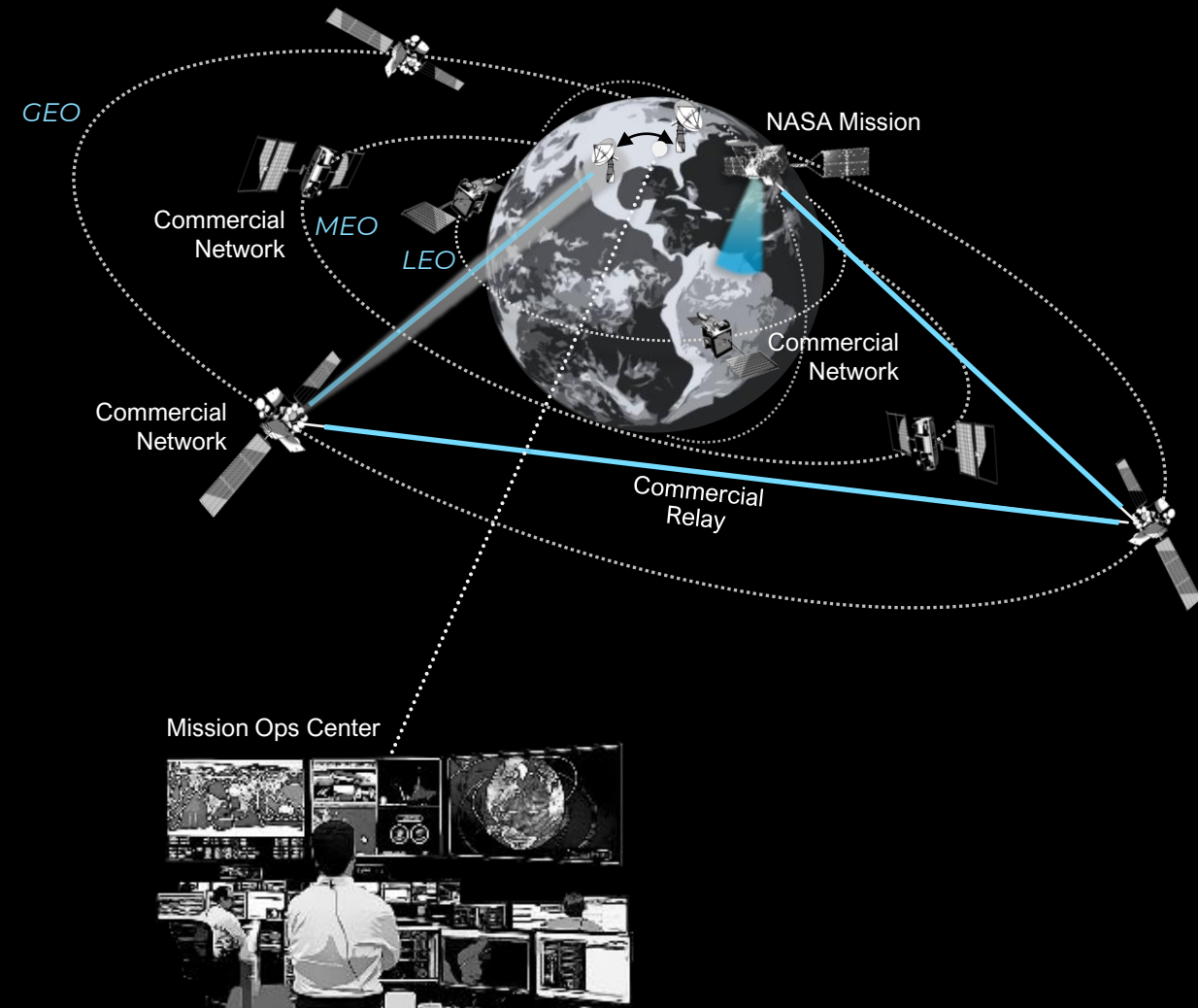
SCaN is adopting commercial solutions to continue providing relay services to near-Earth users

Continuing to execute against and mature a strategy developed in 2020 to maximize commercial services

Initiated Funded Space Act Agreements in 2022 to **share investment and risk with industry**

Executing **risk mitigating tech demos** to address commercial satcom's use of different frequencies, proprietary waveforms and protocols






Commercial Space Relay (SR) will provide transformative new capabilities to science missions



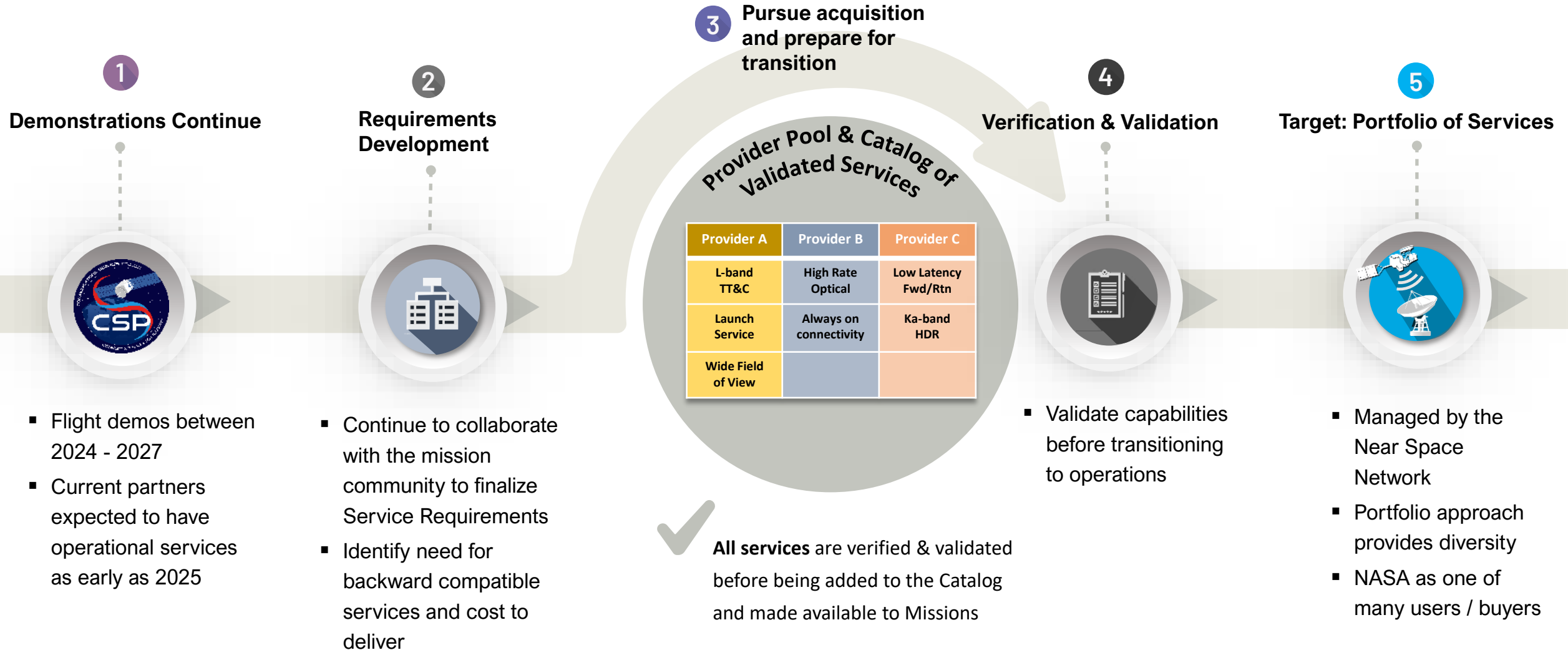
Looking Ahead

- **NASA FSAA investment: \$278.5M**
- **Commercial matching investment: \$1.5B**
- Vendors are progressing through their agreed milestones through mid-2027

CSP's Six FSAA Partners are Demonstrating Services for Relevant NASA Use Cases

Partners	Service Type Demonstration	Use Case	Band	Architecture
	File Delivery	Science data	Optical	LEO
	File Delivery	Mission data	Optical	LEO
	File Delivery	Science data	Ka	GEO
	Direct Access	LEOP and TT&C	L	GEO
	File Delivery	Science data	Ka	MEO
	Direct Access	LEOP and TT&C	C	GEO
	File Delivery	Science data	Ka	LEO
	Direct Access	LEOP and TT&C	C	GEO

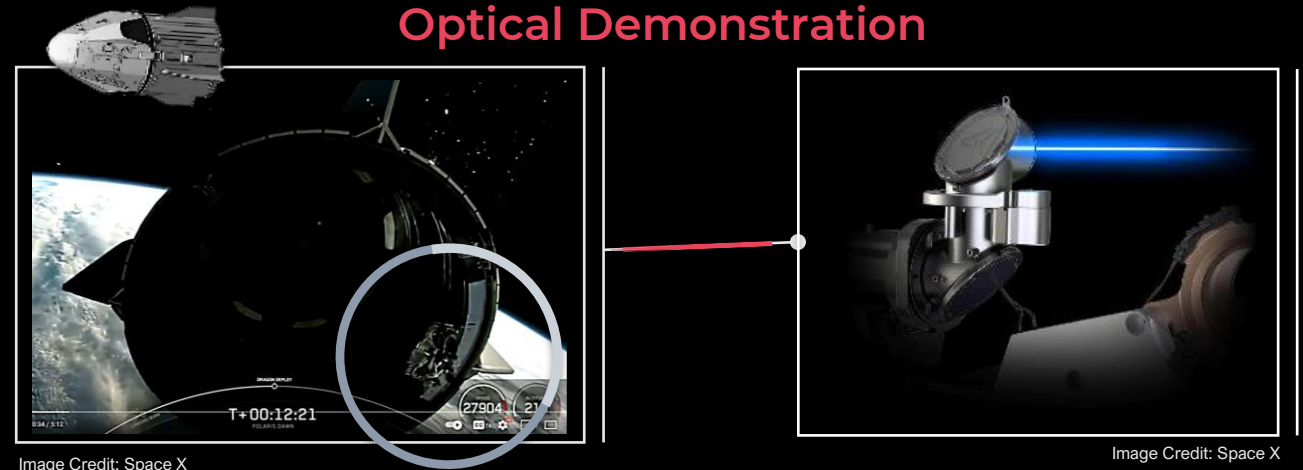
Space Relay Continuity: CSP will Deliver Services by 2031



Space Relay Momentum: CSP Providers are on Schedule

- SES's Ka-band testing with mPOWER and Planet spacecraft a success
- Amazon Kuiper prototype satellites launched and tested
- Starlink optical connectivity with crewed Dragon spacecraft demonstrated
- Viasat and Rocket Lab partnered to demonstrate data relay services
- Inmarsat will demo with Blue Origin New Glenn launch
- Polylingual Experimental Terminal (PEXT) is launching; will demo of services with multiple vendors

Optical Demonstration



Polaris Dawn and Starlink Plug and Plaser



CSP can provide information on direct commercial services to missions seeking SR services before 2031 validations



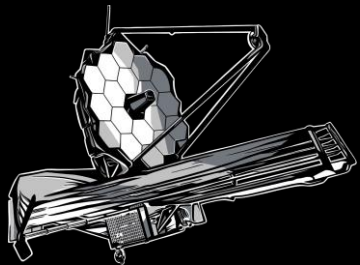
CRITICAL TOPIC 2

Next Gen Lunar and Solar L1/L2 Support

DSN Demand is Rising

High-demand missions are already impacting the DSN

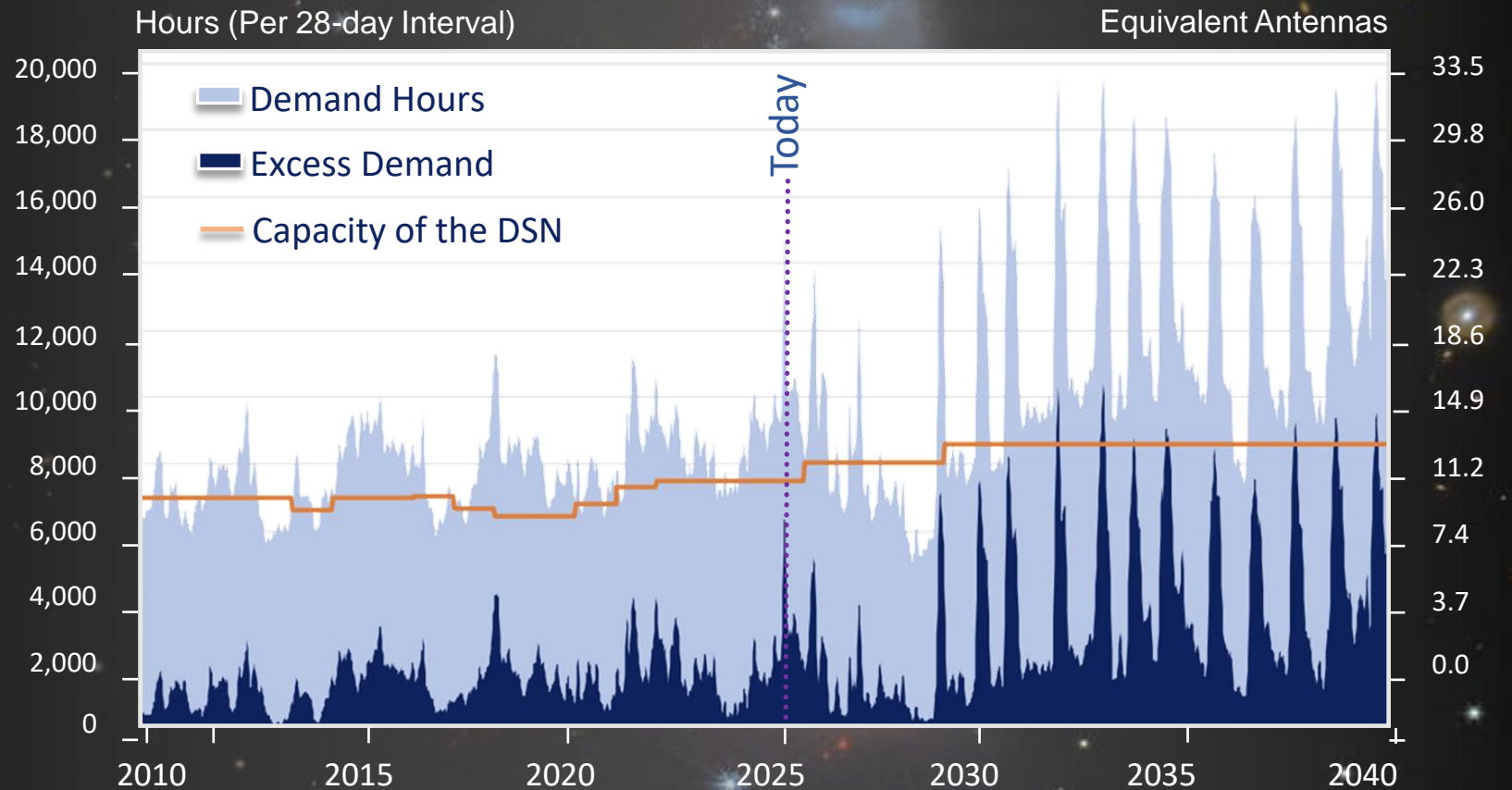
- Each Artemis launch leads to a major demand spike; these challenges grow with later missions
- Infrastructure support has not kept up
- New antenna builds to be completed by 2030 will alleviate some load



JWST



SLS



NASA Office of the Inspector General, 7/12/23

Lunar Exploration Ground Segment (LEGS)

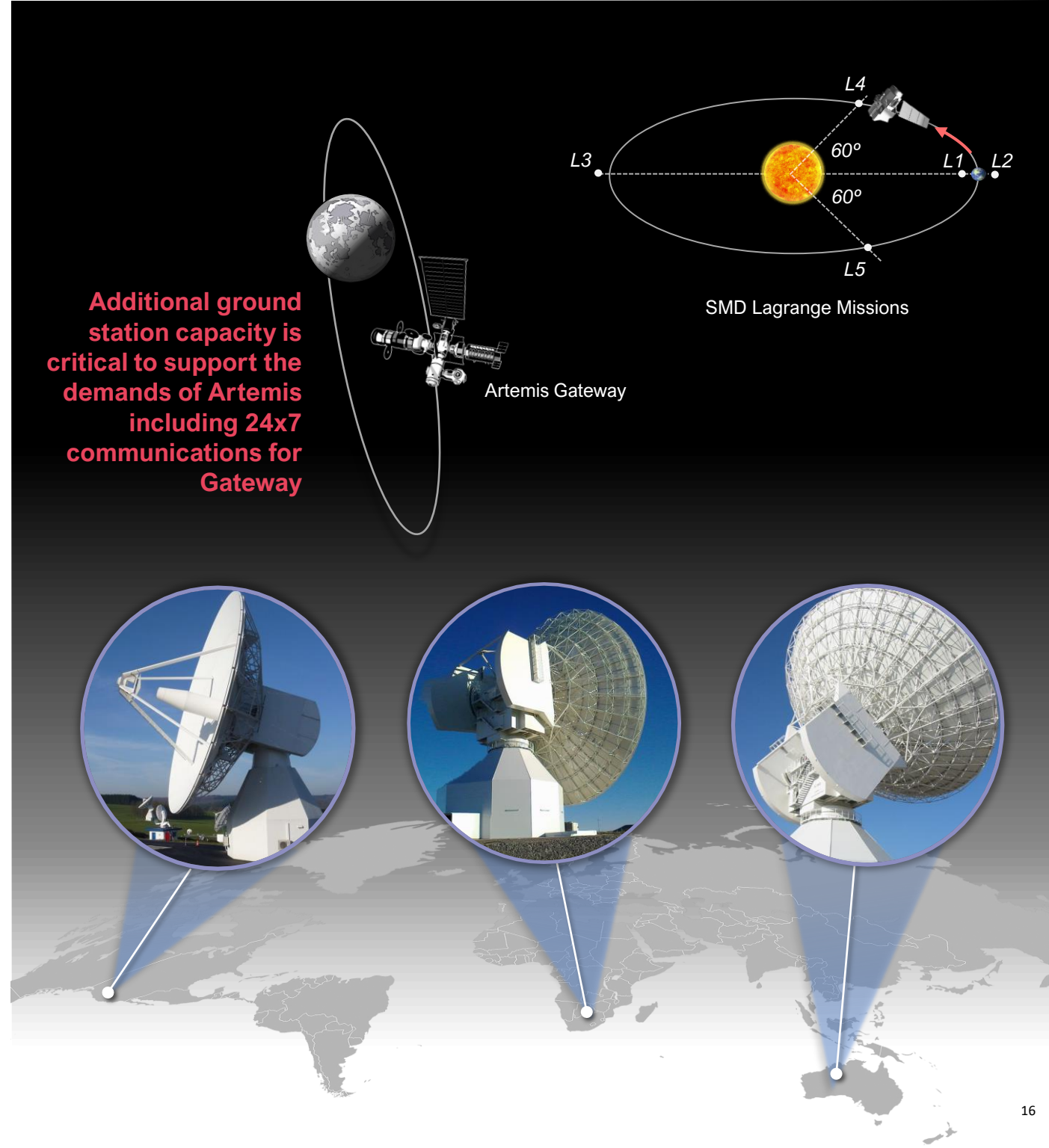
Lunar Exploration Ground Segment (LEGS) will provide critical capacity for cislunar and L1/L2 users via NSN

NASA is building “20-m class” LEGS antennas in US, Australia and South Africa to be government owned and commercial operated

LEGS 1-3 will ensure 24x7 service for Gateway; will be operational in time for Artemis IV

KSAT and Intuitive Machines were selected as part of NSN RFP to offer interoperable “LEGS-Class” services using same service architecture, augmenting availability

Missions proposing inside the 2m km bubble should baseline to LEGS for DTE support



Additional ground station capacity is critical to support the demands of Artemis including 24x7 communications for Gateway

Artemis Gateway

SMD Lagrange Missions



NASA SCaN and its Partners are Building Lunar Relay Infrastructure

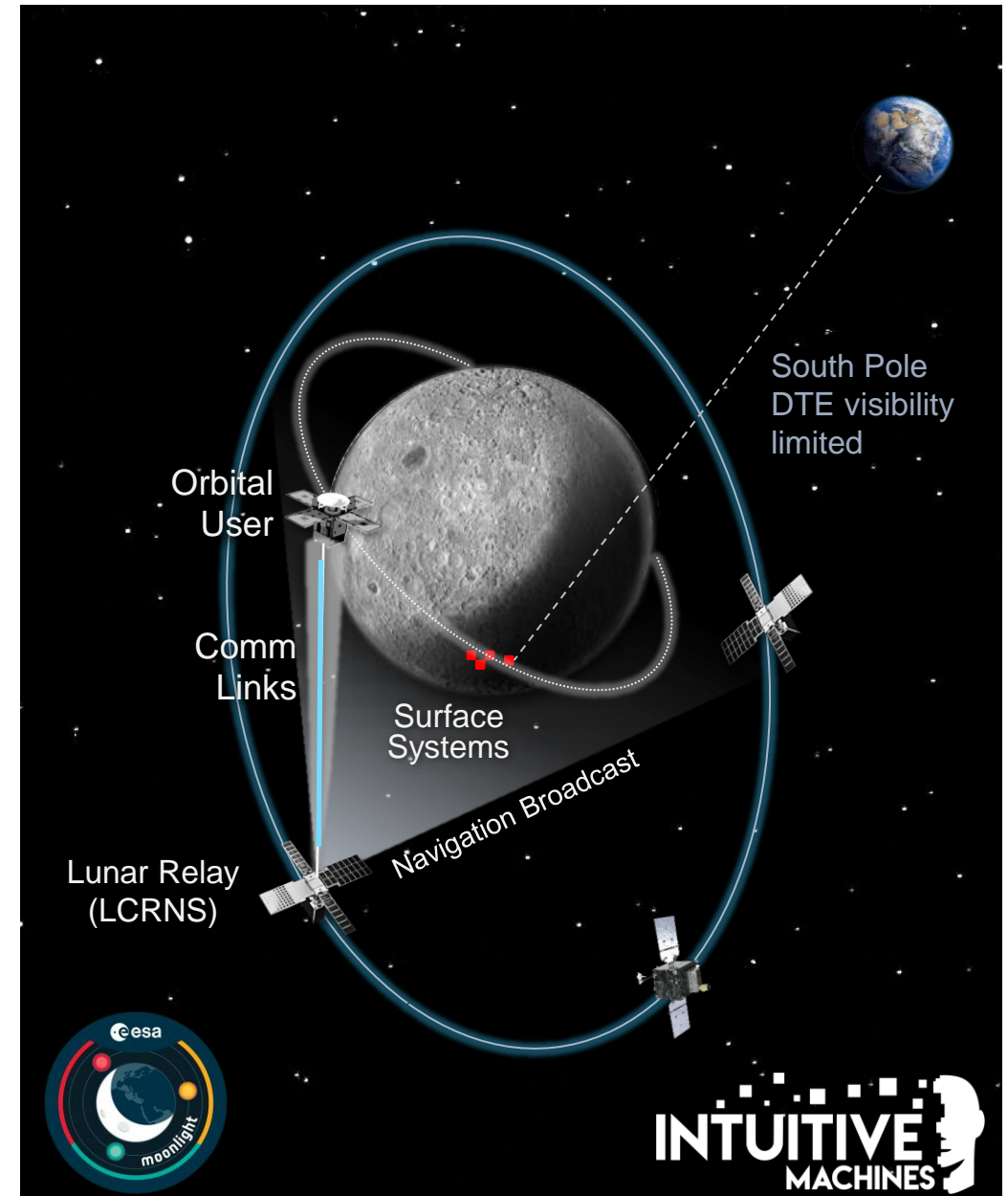
SCaN awarded Intuitive Machines (IM) a contract for Lunar Communications Relay and Navigation Systems (LCRNS)

SCaN is establishing standards (LunaNet Technical Baseline) for interoperable C&PNT for both its commercial and international partners (e.g., ESA moonlight)

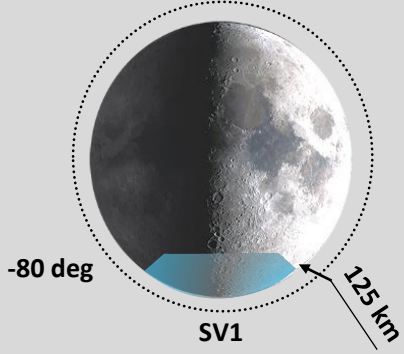
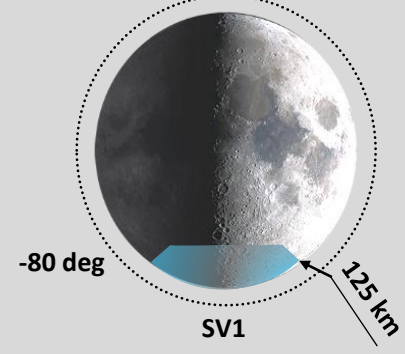
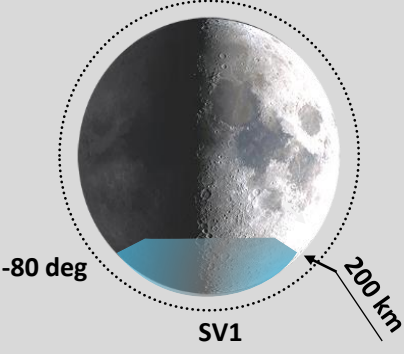
SCaN's plan for lunar relay will:

- Address the lunar south pole coverage gap and nav challenges
- Alleviate pressure on the DSN by aggregating surface comms
- Reduce the user burden

Pre-validation services may be available directly via IM, or via the LCRNS project in a “test subject” capacity for flight-level checks



Requirements and Increments

Increment	Alpha	Bravo	Charlie
Service Volume	 <p>-80 deg SV1 125 km</p>	 <p>-80 deg SV1 125 km</p>	 <p>-80 deg SV1 200 km</p>
Capabilities	<ul style="list-style-type: none"> • Communication support • % Coverage of Earth Day – 70% (all bands) • RF and waveform compatibility with LunaNet Interoperability Specification • Single augmented forward signal (AFS) (position, navigation and timing (PNT)) 	<ul style="list-style-type: none"> • Enhanced communication support • % Coverage – 75% Ka-band, 90% S-band, 70% AFS (2 links) • RF and waveform compatibility with LunaNet Interoperability Specification • Multiple augmented forward signal (PNT) 	<ul style="list-style-type: none"> • % Coverage - 75% Ka-band, 90% S-band, 40% AFS (4 links, max spatial GDOP<6) • Full set Lunar Communications Relay and Navigation Services (LCRNS) Services Requirements Document (SRD) and Initial Operating Capability (IOC) requirements
Readiness	ARTEMIS III	ARTEMIS IV	ARTEMIS V
M2M Relay Comm Need	Demo Opportunity	Required	Required
M2M Relay PNT Need	Demo Opportunity	Demo Opportunity	Required

Synopsis and Conclusion

- SCaN is evolving the network to meet new challenges, and support its users
- NASA is suspending acceptance of new mission commitments for TDRS; CSP will deliver near-Earth space relay services through the NSN by 2031
- **SCaN will provide guidance to NASA missions who intend to work directly with space relay providers**
- DSN is oversubscribed; missions that seek DSN support will compete for limited resources with high-priority users such as Artemis and JWST
- LEGS and LCRNS will help relieve the oversubscribed DSN and are moving forward rapidly
- **Missions proposing inside 2m km should baseline to LEGS and/or LCRNS, depending on requirements**





Scan artist concept only