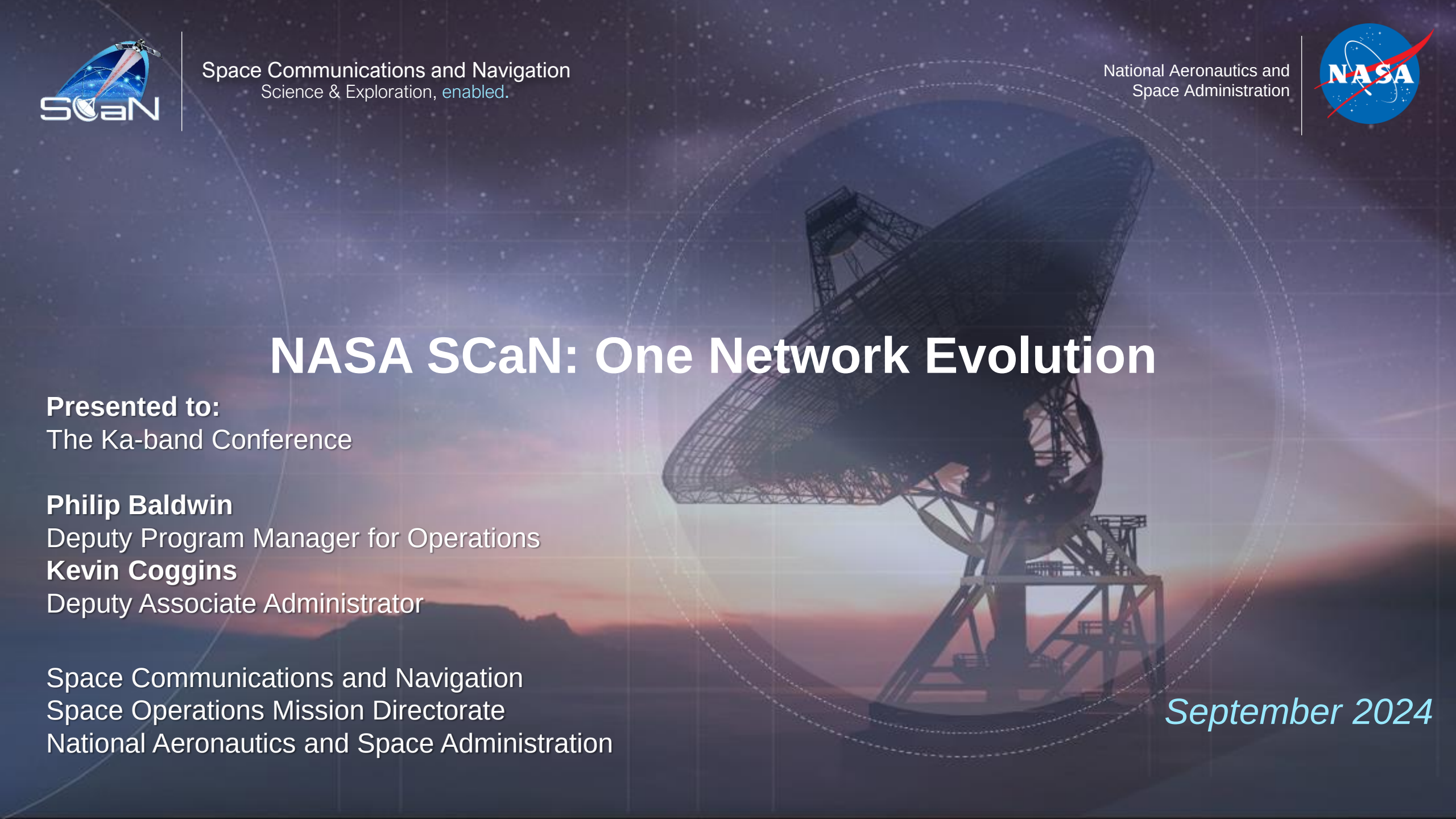
Space Communications and Navigation
Science & Exploration, enabled.

National Aeronautics and Space Administration



NASA SCaN: One Network Evolution

Presented to:
The Ka-band Conference

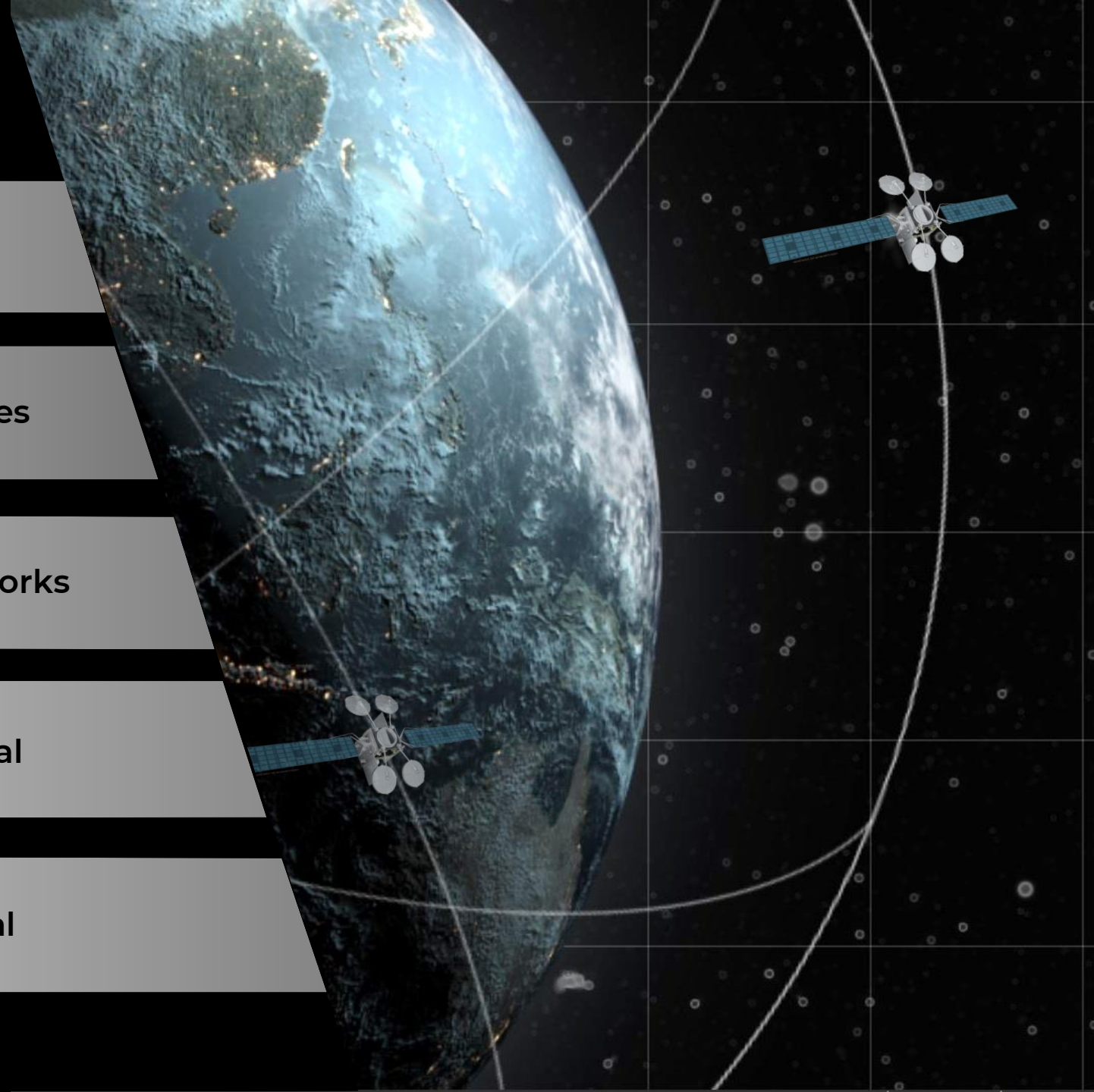
Philip Baldwin
Deputy Program Manager for Operations
Kevin Coggins
Deputy Associate Administrator

Space Communications and Navigation
Space Operations Mission Directorate
National Aeronautics and Space Administration

September 2024

Outline

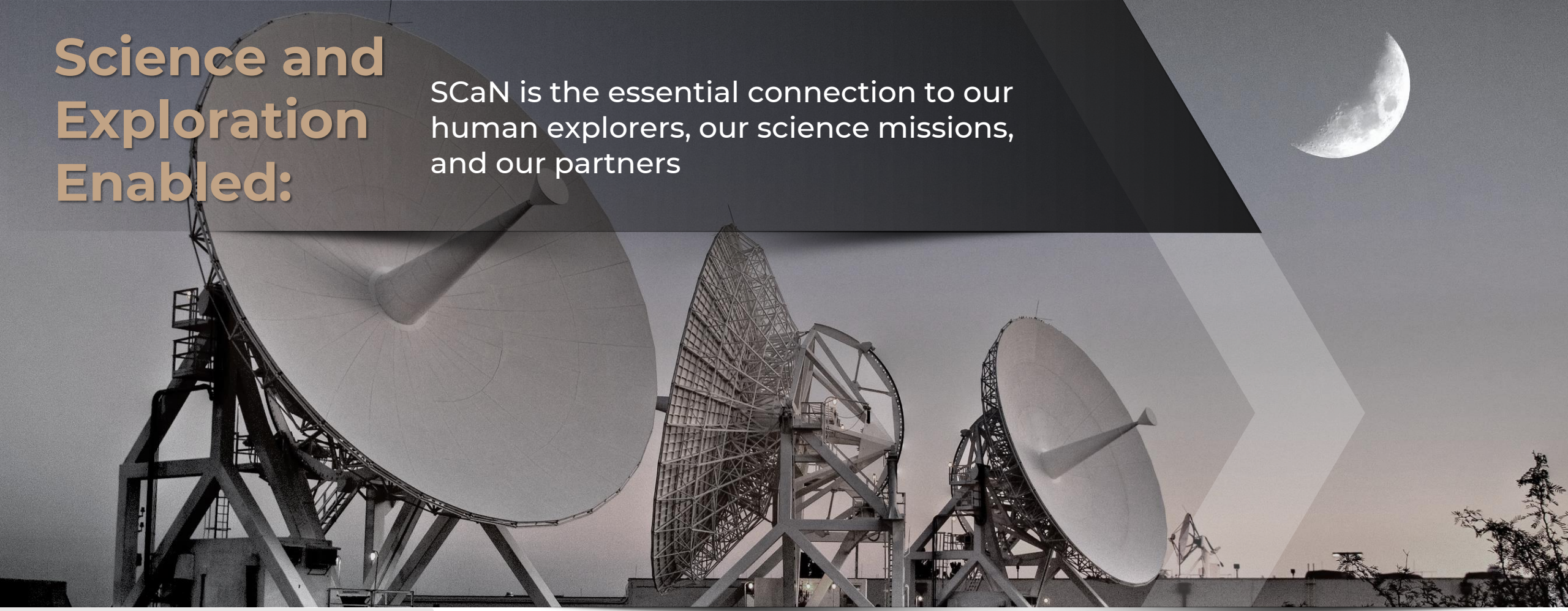
1. SCaN 101 and Resetting The Org
2. Demand and Infrastructure Challenges
3. “One Network” Evolution: SCaN Networks
4. “One Network” Evolution: International
5. “One Network” Evolution: Commercial



SCaN 101 and Resetting The Org

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

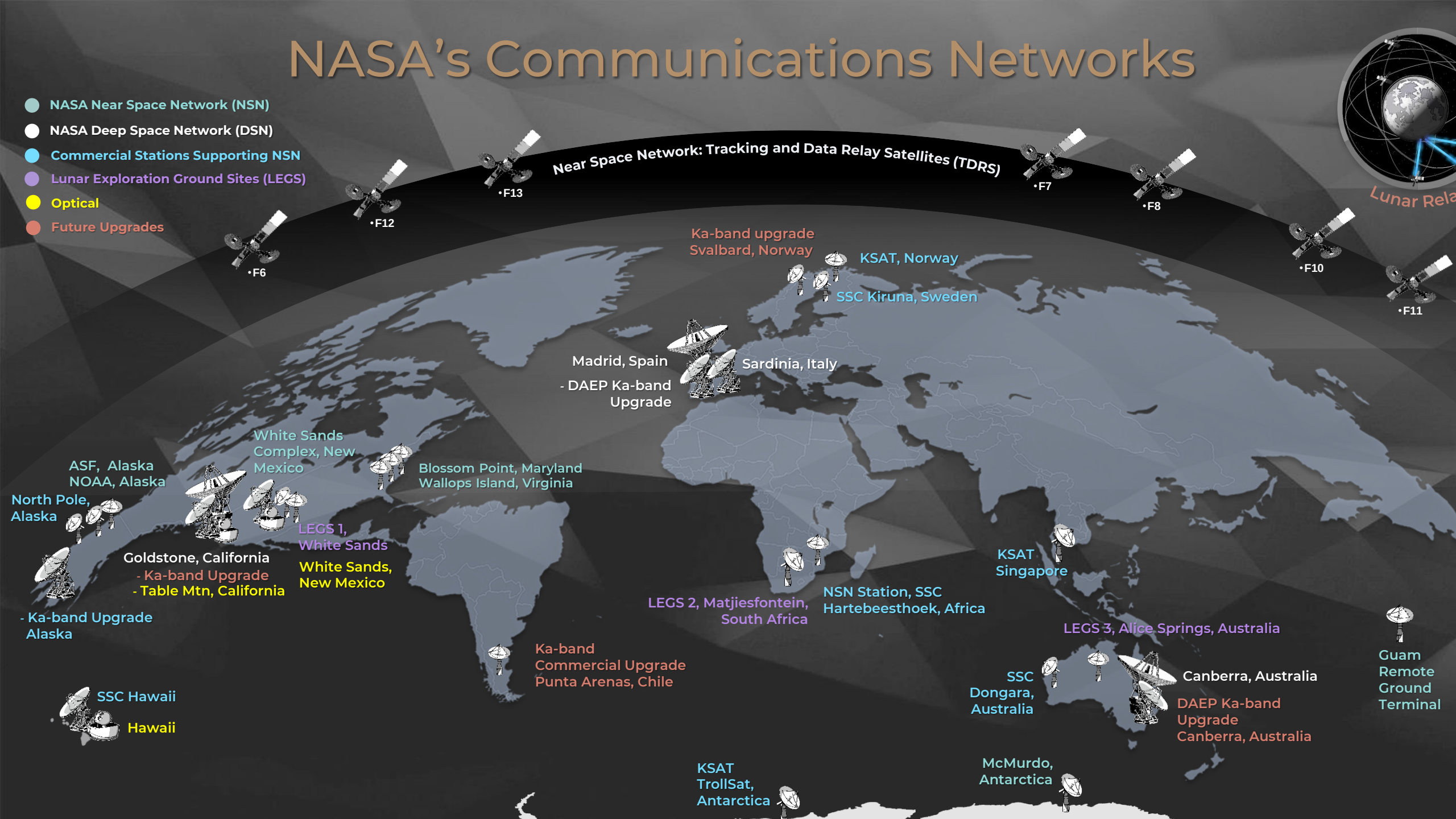
Engage
as One Team, One Mission, One Network

Execute
with Sound Technical and Programmatic Fundamentals

Evolve
the Network to Satisfy Mission Customer Needs of the Future

Empower
Our Science and Exploration Partners

NASA's Communications Networks



Becoming One Team: The SCaN North Stars

Putting Our Team in Alignment

Provide reliable, robust, and resilient space communications and navigation capabilities to enable safe execution of NASA missions.

Architect, develop, and partner to deliver the space communications and navigation capabilities of the future

Demonstrate world-class leadership through responsive engagement with communications and navigation stakeholders inside and outside the agency

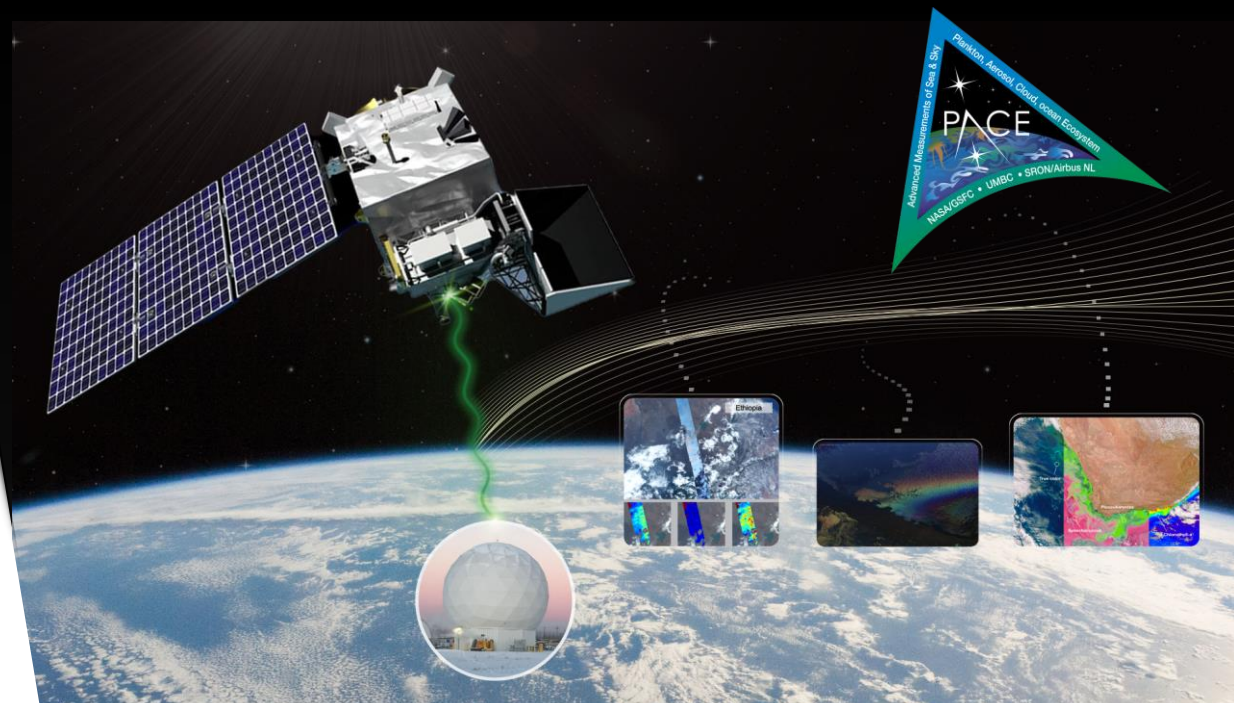
NASA SCaN Artist Concept

Demand and Infrastructure Challenges

SCaN Challenge: Highly Data Intensive Missions

- Evolving instruments, payloads, and needs are driving data volume demand
  - The Plankton, Aerosol, Cloud and Ocean Ecosystem (PACE) mission, launched in 2024, produces 5 terabits of data per day
  - The NASA-Indian Space Research Organization (ISRO) Synthetic Aperture Radar (NISAR) mission, to be launched in 2025, will produce 85 terabytes of data per day
- This class of mission creates three orders of magnitude more data than the Hubble Space Telescope (HST)
- Exponential demand growth will strain SCaN's service capabilities

NISAR
NASA - ISRO SAR Mission

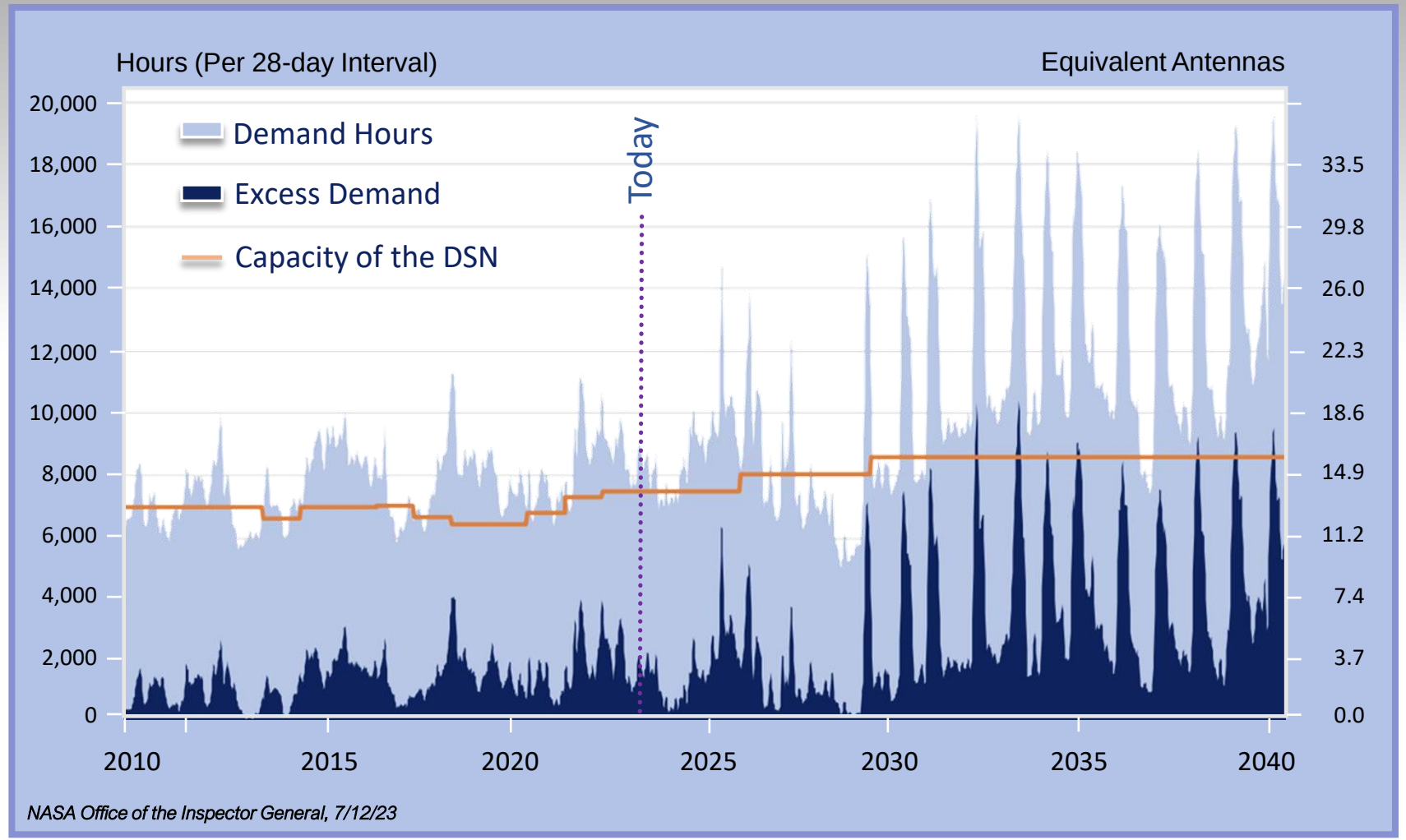


ESDIS Pathfinder Initiative Successfully Delivers Large-Scale Data in the Cloud | Earthdata (nasa.gov)

SCaN Challenge: Spiking DSN Demand

High-demand missions are already impacting the DSN

- JWST alone uses 10% of DSN capacity
- Each Artemis launch leads to a major demand spike; these challenges grow with later missions
- Infrastructure support has not kept up

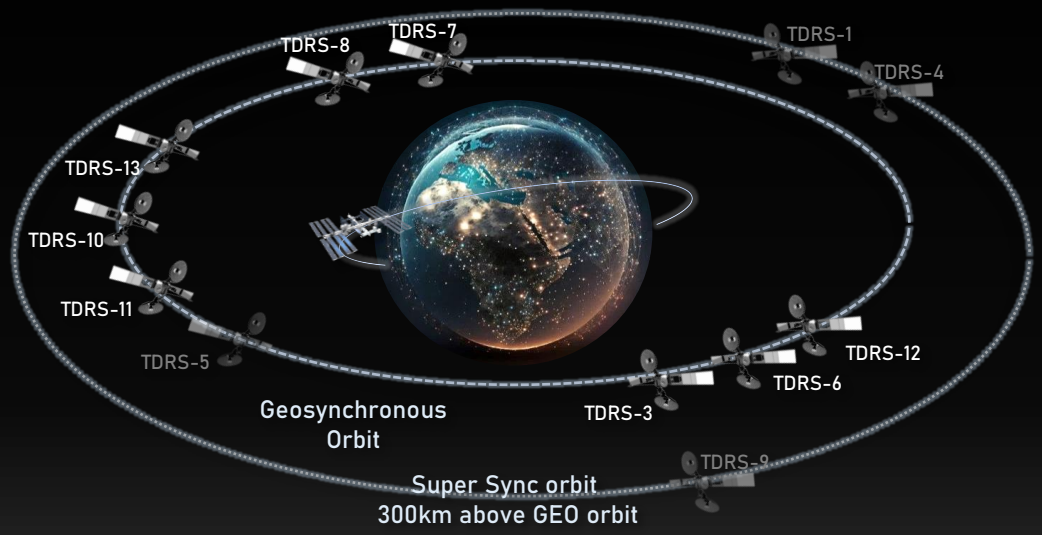


NSN Challenge: The Aging TDRS Network

- **The first NASA Tracking and Data Relay Satellite (TDRS) launched in 1983, the last in 2017**
- **Capabilities incrementally improved, but fundamental architecture remained consistent over 40+ years**
- **The TDRS system is in decline; to preserve capacity for existing users, NASA has decided to stop accepting new users on the 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 Decision

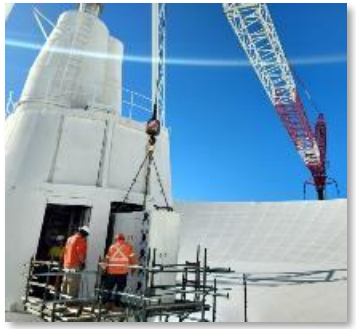
- Effective as of August 8, 2024, NASA will suspend acceptance of new mission commitments for TDRS support with the intent to remove TDRS services from the NSN catalog of available service offerings by November 8, 2024.



DSN Challenge: 20th Century Design and Infrastructure

- DSN design, as well as key elements of its physical infrastructure, date to the 1960's and 1970's
- Ongoing upgrade efforts are providing additional apertures, increased throughput, and access to bands like Ka, but network constraints continue to mount
- Contention for DSN assets and loss of in-flight communications during the Artemis I mission in November 2022 led to OIG investigation that cited deferred maintenance and aging hardware as the primary cause

1960's-era 70m dishes require constant sustainment



S400 klystron cabinet removal

S400 klystron Lift

Pump House removal

New Apex Access Gate

“One Network” Evolution: SCaN Networks

SCaN's "One Network" Approach Calls For Integration of Its Networks

To address challenges, SCaN is taking a **"One Network" approach that will unify its various networks** into one coherent and reliable entity.

This will require **a unification of processes by the DSN and the NSN's ground and TDRS space relay segments**, including scheduling and analysis

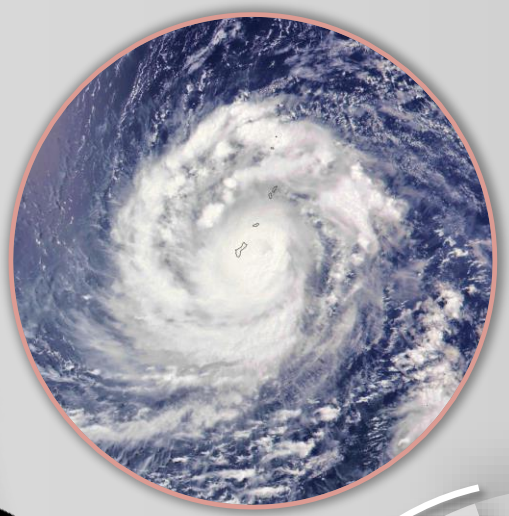
"One Network" means smoothing out these differences, ensuring all users can operate from the same rulebook, and **eliminating inefficiencies which diminish or endanger mission support**

SCaN is also working with Agency leadership to align our plans with NASA's strategic vision

DSN-NSN Cross-Network Support after Mawar

On May 24, 2023 Mawar, a Category 4 super typhoon, caused extensive damage to NASA's Guam Remote Station (GRS), one of three ground stations that support the TDRS constellation

The storm brought sustained winds of **150mph,** with gusts exceeding **200mph,** and rainfall rates of up to 5cm/hour



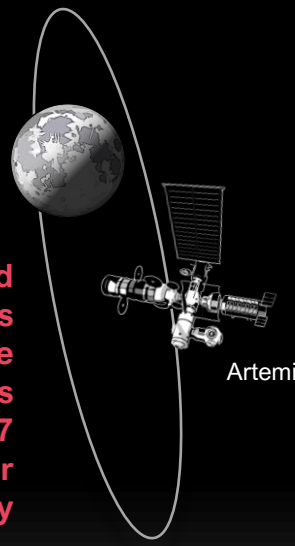
The storm impacted support of two NSN TDRS satellites, and in parallel with reliability challenges at the Australian TDRS Facility (ATF), put them "adrift"

The DSN team at NASA's Jet Propulsion Laboratory (JPL) and the Canberra Deep Space Communications Complex (CDSCC) stepped in to provide these TDRS S-band station-keeping support over several months

Integration NSN and DSN for the Lunar Exploration Ground Segment

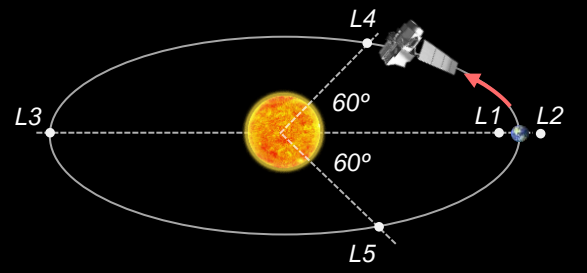
Lunar Exploration Ground Segment (LEGS) will provide critical NSN capacity for cislunar exploration and L1/L2 science missions

- NASA is building “18-m class” LEGS antennas at sites #1-3 in US, Australia and South Africa to be government owned and commercial operated
- Once LEGS is operational, missions will be supported by both DSN and NSN
- LEGS can only succeed with a clear and effective integration between NSN and DSN assets, with seamless support for cislunar missions across both networks
- This will serve both as a key test of the “One Network” approach, and a key forcing function for full integration of SCaN networks



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

Artemis Gateway



SMD Lagrange Missions

“One Network” Evolution: International

One Network: International

SCaN views international partners as a key component of its “One Network” approach, and is making a renewed effort to build collaborations

This builds on success; Spain and Australia have been key to the DSN for 60 years

The Agency and SCaN are exploring how potential partners with space communications infrastructure can help close anticipated capability gaps

SCaN is also exploring how to overcoming information security issues to make new partners fully integrated parts of its “One Network”

Strengthening International Partnerships

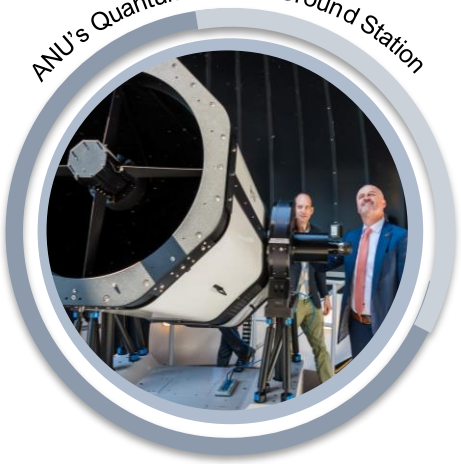
- SCaN exploring how to fold existing infrastructure into its "One Network," including:
  - The Parkes Observatory in New South Wales, is a 64-meter radio astronomy telescope that has supported several NASA missions including Apollo 11
  - Effelsberg Observatory in Germany is 100-meters, one of the largest fully steerable radio telescopes in the world, that has supported missions, including Voyager and Cassini.
- Conversations are ongoing to tie these and other assets into the DSN as contingency support, or even even for regular use

Parkes Observatory

Effelsberg 100m Telescope

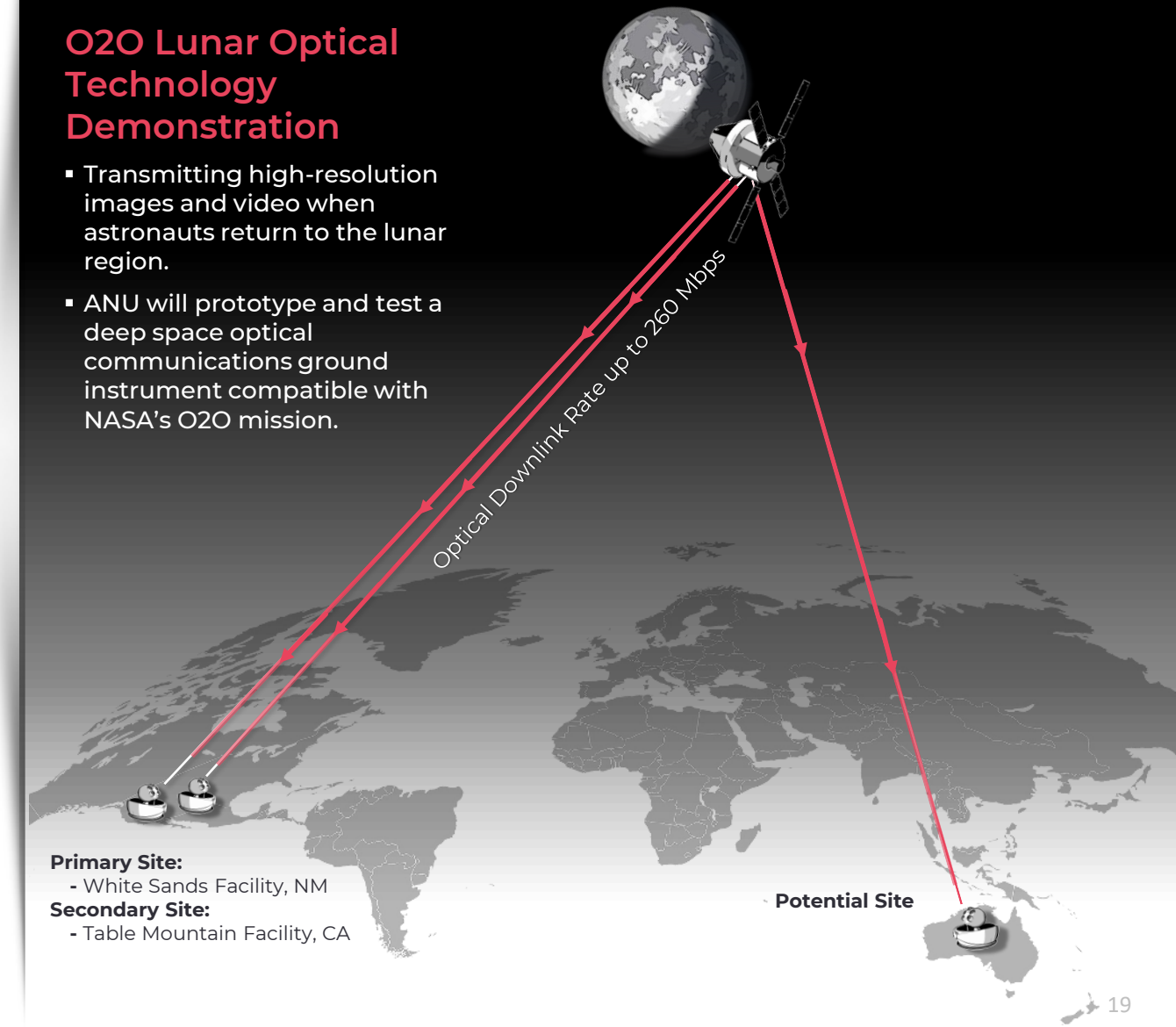
Australian National University & Artemis II

NASA is working with Australia and other international and commercial partners to explore the potential of additional optical ground terminals



O2O Lunar Optical Technology Demonstration

- Transmitting high-resolution images and video when astronauts return to the lunar region.
- ANU will prototype and test a deep space optical communications ground instrument compatible with NASA's O2O mission.

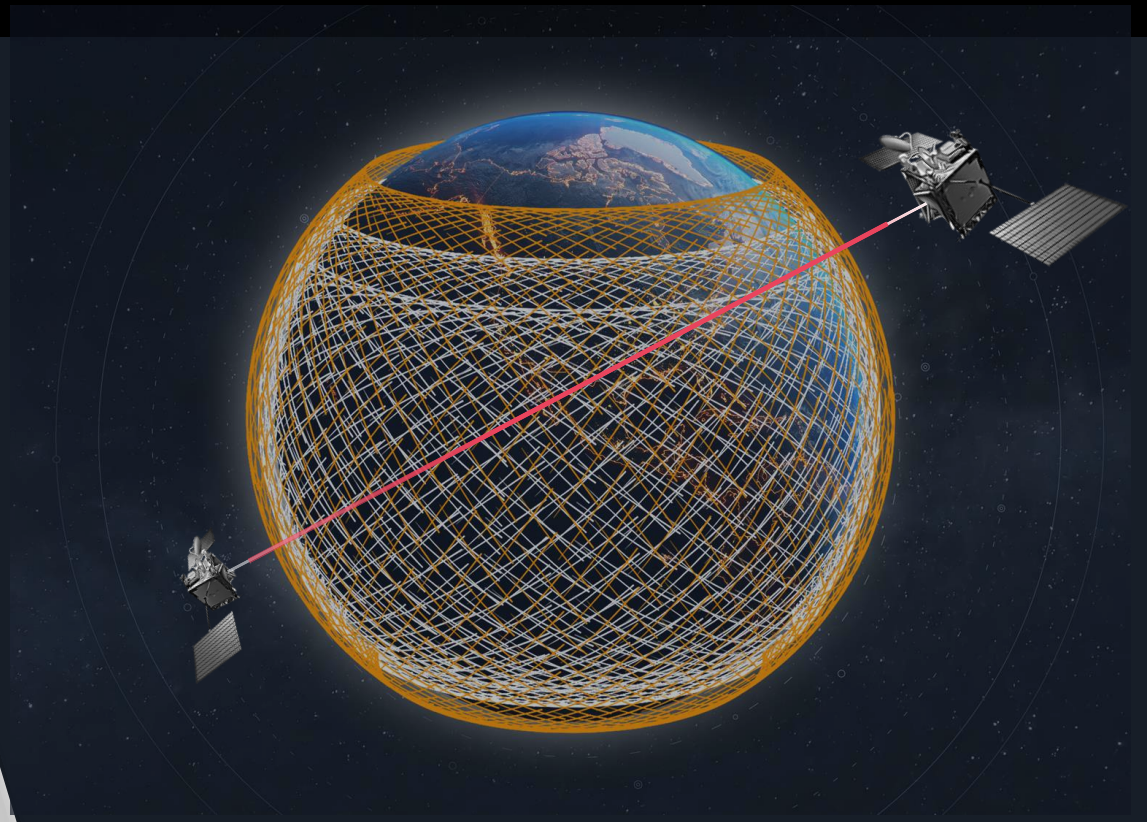


Australian National University

“One Network” Evolution: Commercial

One Network: Commercial

- Growth of commercial space sector has created robust non-governmental demand for space support services like communications
- Office of Management and Budget and National Space Policy encourage NASA SCaN to draw upon these commercial services wherever possible
- When there is a market case, commercial partnerships reduce costs and enhance capabilities—allowing NASA to focus its resources on pioneering forward work



Satellite constellation mesh network in space.

Image source: Amazon Kuiper Project

NASA Has Commercialized Most NSN DTE Services

- A gradual process to weave commercial DTE services seamlessly into the NSN has been proceeding successfully for decades
- Now, over 60% of DTE services to NASA are commercially provided
- This success serves as a model for how SCaN's renewed "One Network" approach can be applied to commercial capabilities

1990's

1997-1998
Svalbard Satellite Station Opened. NASA installed SG1 antenna to support EOS.
SG1 Government Owned / Contractor Operated.
SG2 Commercially owned / operated

2000 - 2010

2000
NASA begins to receive support from the USN Hawaii and Australia stations for missions including GOES, FAST, FUSE, GLAST…

2003-2006
SG3 added to the network - is Commercially owned / operated.
SG4 installed- is Partner owned / operated

2009
SSC purchases the USN. NASA obtains LRO support from SSC/USN

2010's

As of 2012, the NASA no longer owned or operated any antennas at commercial locations

2012
New KSAT owned SG1 antenna declared operational for NEN support. Aqua and Aura first missions supported

2015
Support through SSC grows to include THEMIS, MMS, and launch support

2020's

As of 2022, ~60% of all DTE Services to NASA missions are commercially provided

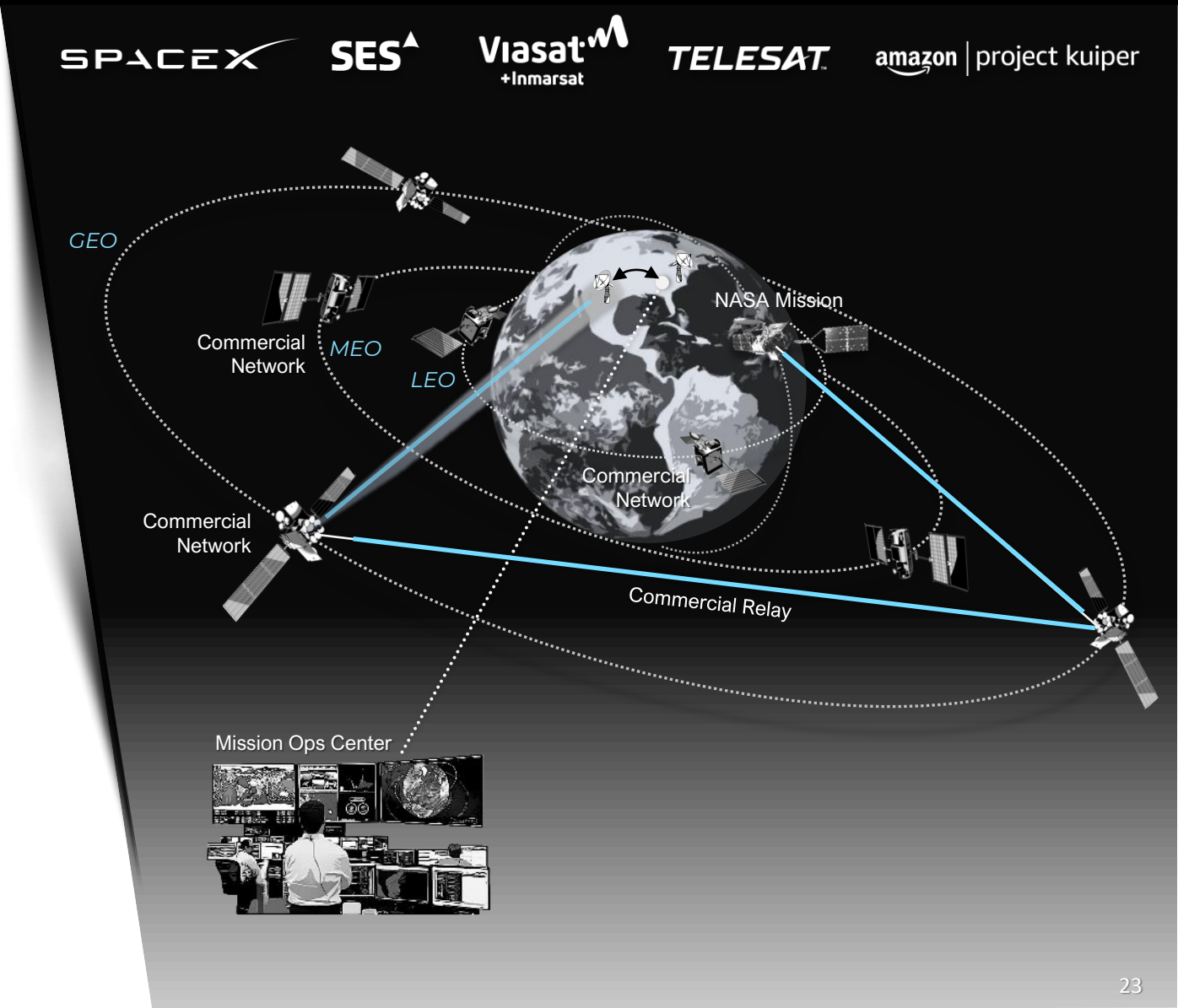
RFP Released in 2023 with goal to expand level of commercial services to near 100%

NASA tapping into a growing market of commercial DTE comms vendors

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

NASA is Now Commercializing NSN Space Relay

- In 2020, SCaN defined a strategy to transition NASA's Low Earth Orbit missions to commercial SR services
- Our Near Space Network (NSN) will maintain critical space relay capabilities including global coverage for TT&C
- NASA is also assessing whether TDRS backwards compatible commercial services are required and potential budget impacts



NASA's Space Relay Commercialization Plan is Progressing

- Commercial Geosynchronous Orbit (GEO) L-band relay network — inmarsat
- Optical Low Earth Orbit (LEO) network — amazon | project kuiper
- GEO C-band and Medium Earth Orbit (MEO) Ka-band networks — SES GOVERNMENT SOLUTIONS
- Optical LEO network — SPACEX
- RF relay networks offering C-band and Ka-band services for high — TELESAT
- GEO Ka-band relay network — Viasat

Communications Services Project (CSP)

NASA announced on April 20, 2022 that the CSP awarded contracts totaling **$278.5 million** to demonstrate how commercial satellites can support NASA missions.

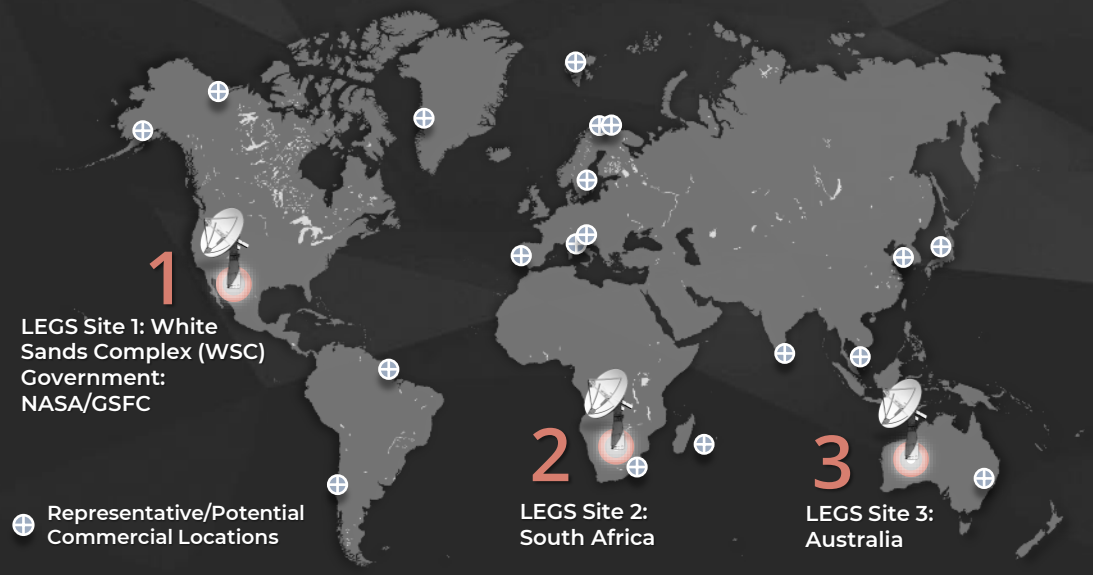
Six providers are matching / exceeding the awards with own funds. Estimated total investment of **$1.5 billion** over five years.

Vendors are progressing successfully through their agreed to milestones. Comprehensive on-orbit tests of services will occur in 2025-2026

The “One Network” Future:
Building Commercial Partners for Cislunar Space

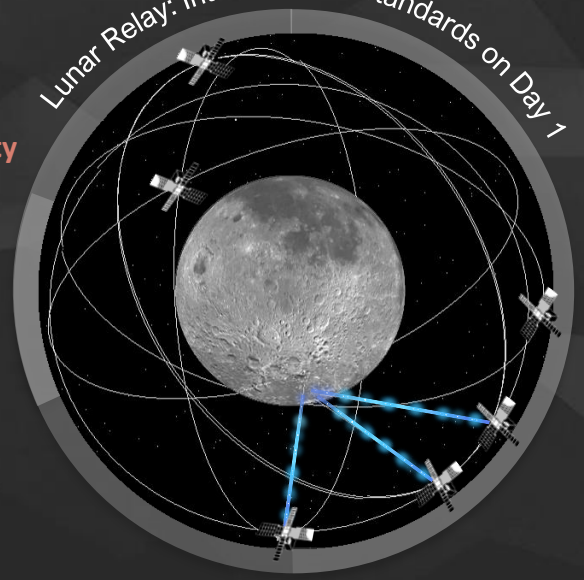
TWO SEPARATE approaches built on lessons from commercial services for LEO

- SCaN’s Lunar Exploration Ground Stations (LEGS) - Building three initial antennas
- Commercial vendors are preparing to offer services that are interoperable with this service architecture



- Interoperability and vendor lock remain a key challenge for LEO commercial relay

- SCaN has defined a LunaNet Interoperability Specification (LNIS) in partnership with ESA and JAXA that is traceable to M2M objectives



- SCaN has solicited for commercial lunar relay service providers
- ESA following SCaN’s acquisition model with their Moonlight program

- For lunar, on both DTE and relay, we have a “green field” opportunity to take a standards-first approach and ensure that our “One Network” philosophy is built in from day one

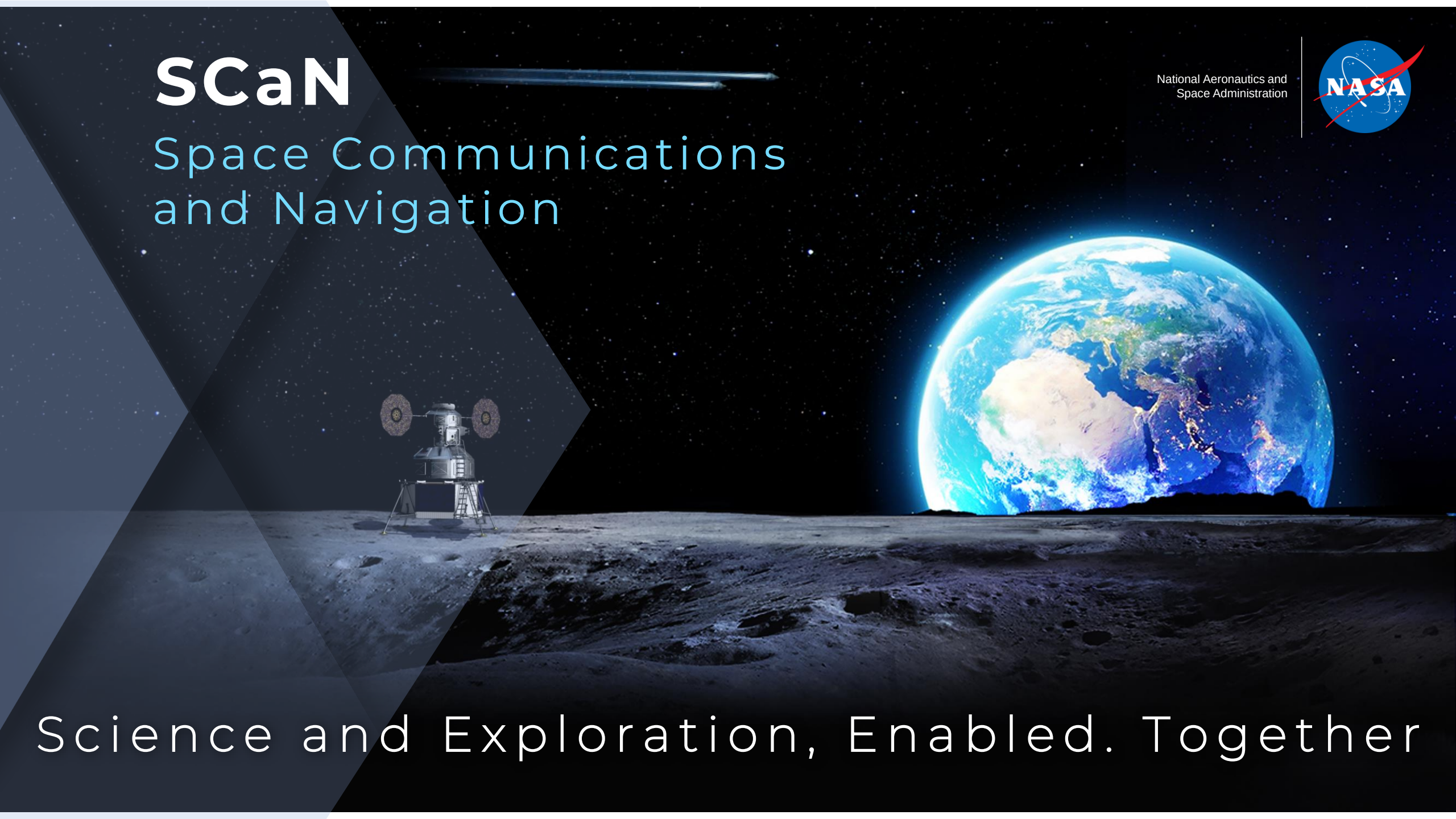
Synopsis

- SCaN is facing an unprecedented spike in network demand from next generation missions like JWST, PACE and Artemis
- In parallel, SCaN's NSN and DSN face major capacity limitations due to decades-old architectures and aging infrastructure
- Meeting this moment requires SCaN to embrace a "One Team, One Mission, One Network" approach
- We will become the world's leading 21st century space network by integrating internal and external assets under a "One Network" framework that includes our own NSN and DSN, international partner assets, and commercial services

SCaN

Space Communications and Navigation

National Aeronautics and Space Administration



Science and Exploration, Enabled. Together