National Aeronautics and Space Administration

SCaN Update: TDRSS, DSN, and LEGS

SCaN Space Communications and Navigation

Exploration, enabled.

Presented to:
NASA Astrophysics Advisory Committee (APAC)
October 20th, 2023

Presented by:
Dr. Jeffrey Hayes
Discipline Scientist, Science Mission Directorate
On Detail to the Space Communications and Navigation (SCaN) organization
Space Operations Mission Directorate
National Aeronautics and Space Administration

Enabling Human Space Exploration and Science

1. Develop, operate and manage all NASA space communications capabilities
2. Develop technologies to enable and enhance future mission experience
3. Manage NASA spectrum; represent NASA on national and international spectrum management forums
4. Develop space communication standards as well as positioning, navigation, and timing policies
5. Represent and negotiate on behalf of NASA on all matters related to space communications and navigation



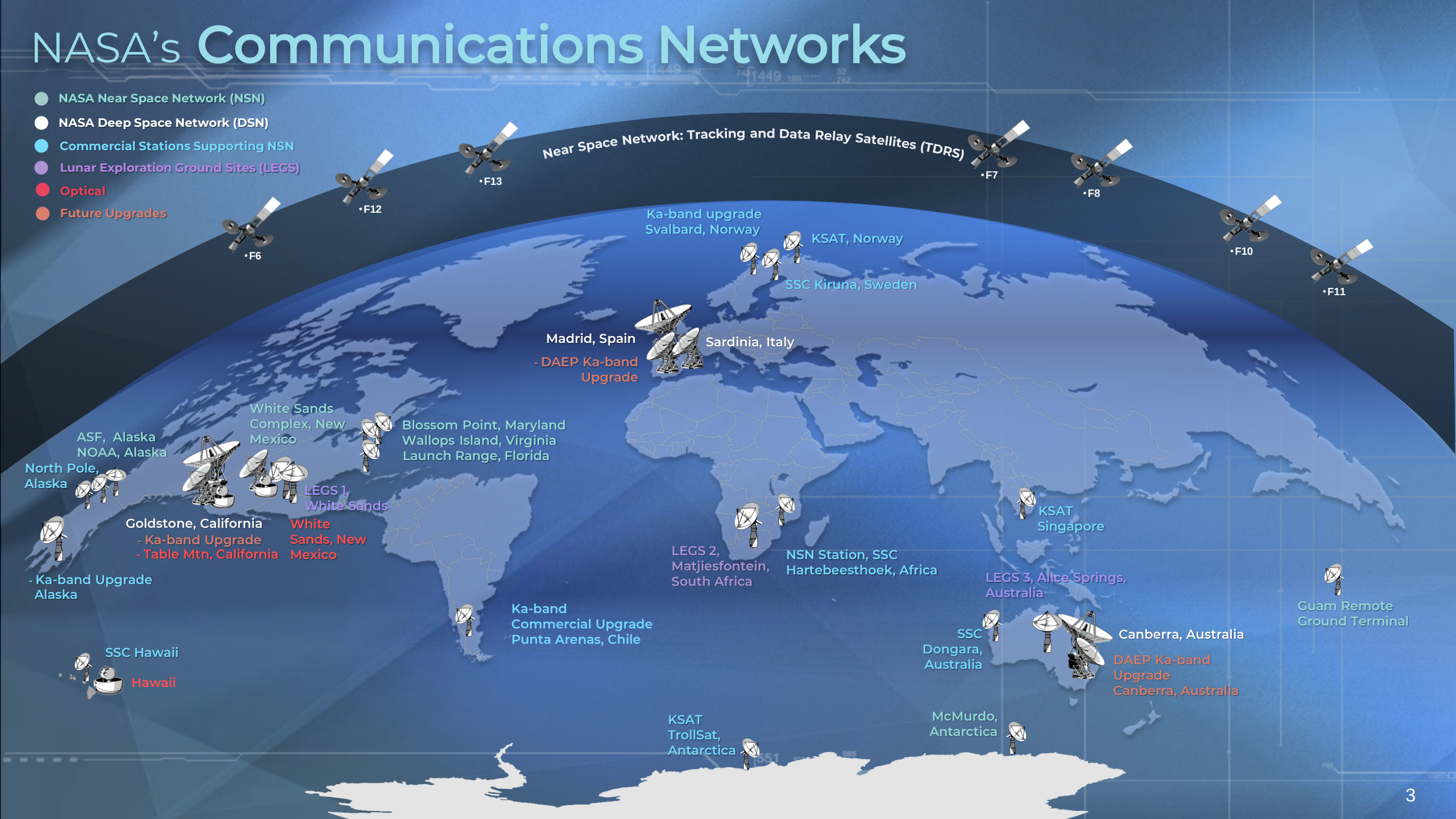


Space Communications and Navigation (SCaN) serves as the Program Office for all of NASA's space communications activities

24/7 Global Near Earth and Deep Space Communications and Navigation Services

100+ Missions currently supported by SCaN

NASA's Communications Networks



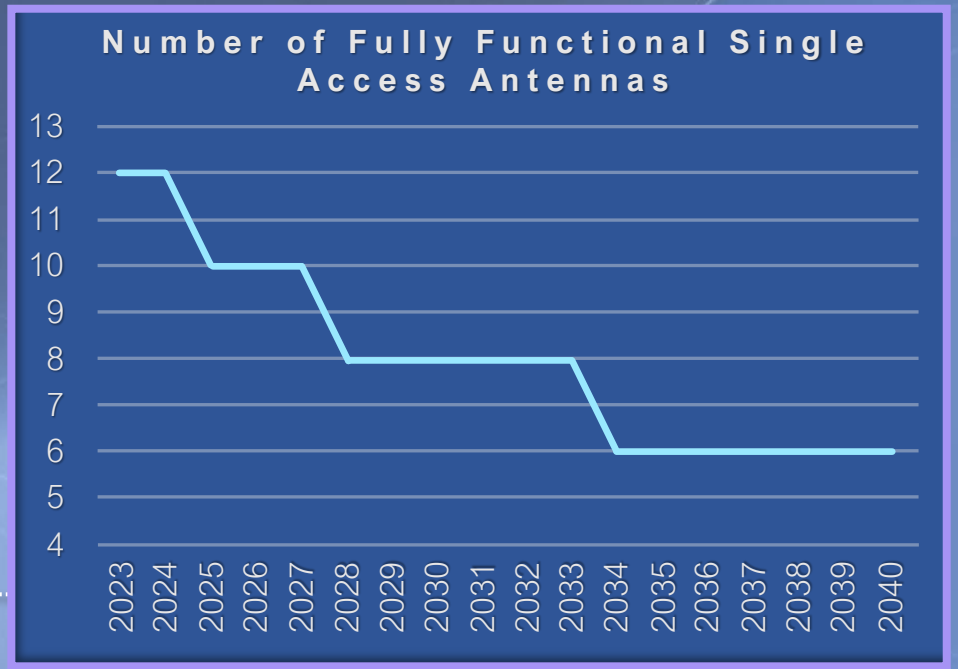
Near Earth Challenge: NASA Must Phase Out TDRSS

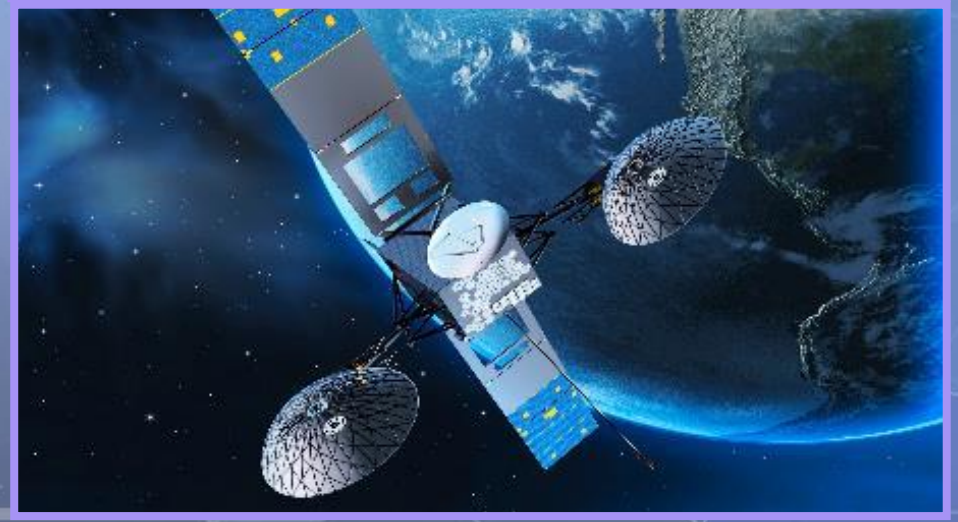
NASA does not have the dollars (~$1.3B) to unilaterally launch replacement satellites for the Tracking and Data Relay Satellite System (TDRSS), nor the political or policy support

- Option for final 3rd generation spacecraft (TDRS-N) was rejected by the Office of Management and Budget (OMB) and Congress
- OMB has communicated that NASA should transition away from TDRSS and towards commercial, aligning with National Space Policy

SCaN will maintain and fly out the constellation <u>to support existing missions</u> based on spacecraft health

- TDRS 11, 12, and 13 are projected to last into the 2040s





Myth Busters

Myth 1
SCaN is terminating TDRSS in 2026

- SCaN will maintain TDRSS into the 2040's

Myth 2
"This commercial thing is totally new" … and therefore risky

- SCaN has worked with commercial ground providers since 1997

Myth 3
TDRSS is a dedicated SMD resource

- NASA shares TDRSS with other government users

Myth 4
Commercial SATCOM will be backward compatible with TDRSS

- Commercial SATCOM will not be backwards compatible with TDRSS

Solution: Commercial Options for Near Earth Relay

Pioneering the Future of NASA's Near Earth Space Communications

- GEO **Ka-band** relay network
- Routine launch and mission support
- High and low-rate communications services

Viasat

- **Optical** LEO network
- Supporting routine, contingency, and early operations
- High and low-rate services

amazon | project kuiper

- GEO network with **C-band and Ka-band**
- Supporting routine, contingency, launch and ascent, and early operations
- High and low-rate services

SES GOVERNMENT SOLUTIONS

- **Optical** LEO network
- Routine, contingency, launch and ascent, and early operations support
- High and low-rate services

SPACEX

- RF relay networks offering **C-band and Ka-band** services for high and low-rate communications
- Support to routine missions

TELESAT

- Commercial GEO **L-band** relay network
- Support to routine missions, contingency operations, launch, ascent, and early operations
- Low-rate SATCOM services

inmarsat

NASA announced on April 20, 2022 that the Communications Services Project (CSP) awarded contracts totaling **$278.5 million** to test how commercial satellites from LEO to GEO could support NASA missions.

The Agency is funding agreements to seed a market for commercial SATCOM to supplant use of TDRSS for future NASA missions.

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

Solution: Wideband Multilingual Terminal

Interoperability is a challenge presented by commercial SATCOM systems

Concept: wideband/multilingual user terminal can access both government and commercial capacity in Ka-band, from 17.7 – 31.0 GHz

A wideband multilingual terminal payload has been integrated into a York Space Systems S-Class bus for flight demonstration

Key Milestones:

- APL was selected (end of FY21) to proceed to flight demonstration activity
- Planning for launch on Transporter-11 in Q4 2023
- Flight demo operations (~6 months) targeted to start February 2024

Post flight demo opportunity and actions

- Leverage existing partnerships to transfer wideband design / technology to industry
- Include resultant wideband terminal options in NSN services catalog

Inmarsat Global Xpress

- GEO Constellation
- 28 Steerable Antennas in orbit
- 7 new satellites

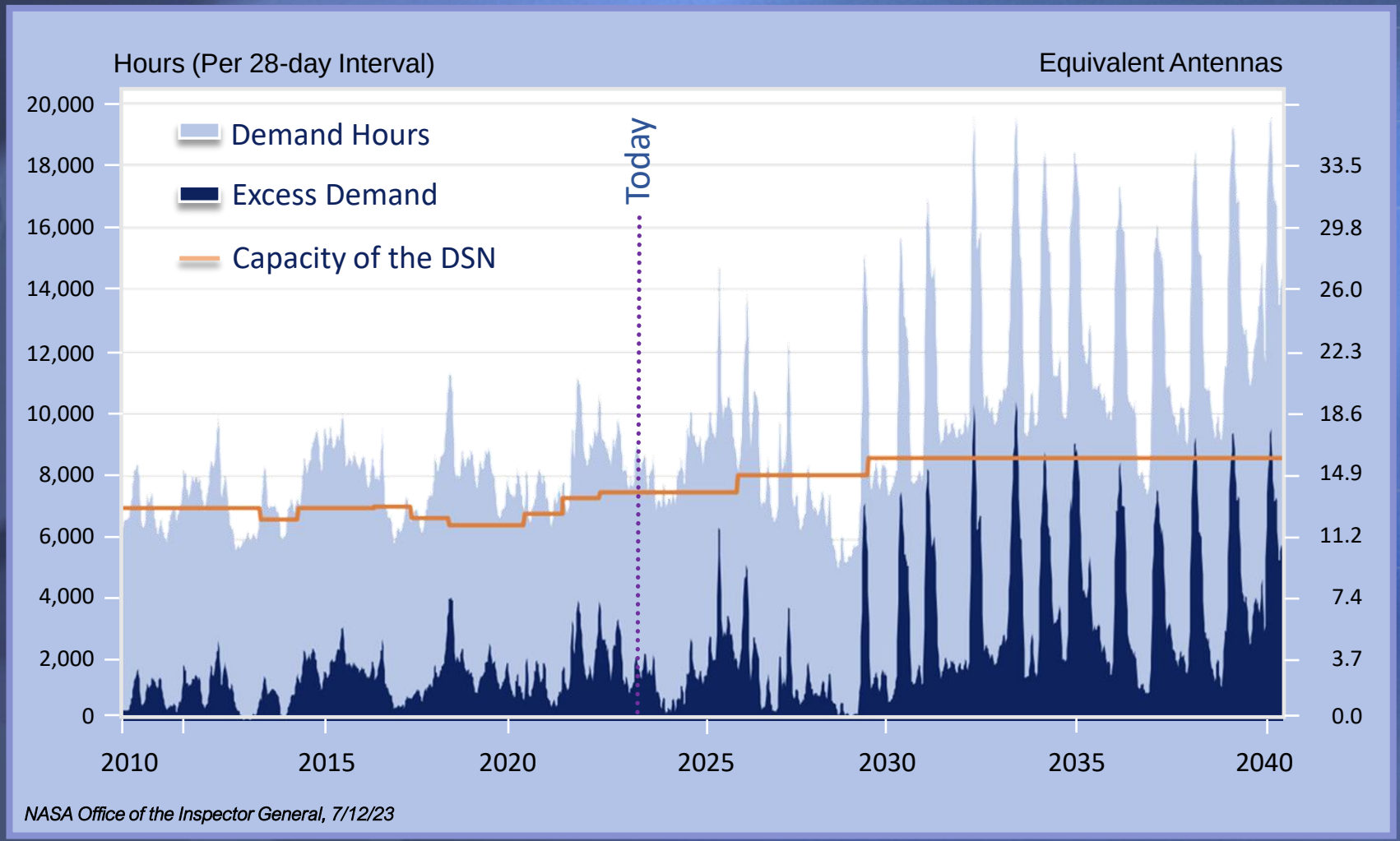
O3b mPOWER

- MEO Constellation
- Thousands of beams per satellite
- 11 satellites

Telesat Blackjack

- LEO Constellation
- 2 steerable antennas per satellite
- 2 satellites in DARPA mission

DSN Challenge: Growing User Needs



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

DSN Supply and Demand

- There is a significant demand baseline for aging DSN infrastructure
- Projected requirements from Artemis, alongside high-throughput science missions like JWST, are pushing DSN beyond its capacity
- SCaN's mitigation plan includes DSN upgrades, alongside new apertures and commercial providers

Solution: DSN Aperture Enhancement Project (DAEP)

- DAEP is building six 34m Beam Wave Guide (BWG) antennas across all three DSN complexes to provide additional capacity
- FY2024 DAEP STATUS SNAPSHOT:
  - Four 34m BWG deliveries completed (Two in Canberra and two in Madrid)
  - One 34m BWG in process in Goldstone; Delivery to service April 2026
  - One 34m BWG in the future at Canberra; Delivery to service expected October 2029
- Further expansion after FY30 will be based on a *DSN Futures Study* and Agency requirements
  - May include higher power transmitters, HEF antenna refurbishments, and site diversity measures
  - Post-FY30 development work is funding dependent

Solution: DSN Lunar Exploration Upgrades (DLEU)

DLEU is upgrading six antennas (two at each of the three DSN complexes), including:

- Increasing data rate downlinks, uplinks and data delivery – including 100Mbps downlink in Ka-band
- Providing simultaneous operations across multiple frequencies, including simultaneous Ka-band, S+Ka-band and X+Ka-band
- Adding capability for near Earth K-band uplink and uplink encoding

FY2024 DLEU STATUS SNAPSHOT:

- Two upgrades completed (one in Goldstone and one in Canberra)
- Estimated completion dates for additional upgrades:
  - Goldstone: December 2023
  - Canberra: July 2024
  - Spain (DSS-56): April 2025
  - Spain (DSS-54): March 2028

Expanded capabilities provided through DLEU will benefit the astrophysics community – particularly missions at L1 / L2

Solution: Lunar Exploration Ground Segment (LEGS)

LEGS will be a network of DTE antennas and services that reduce contention for DSN resources by absorbing new Artemis demands

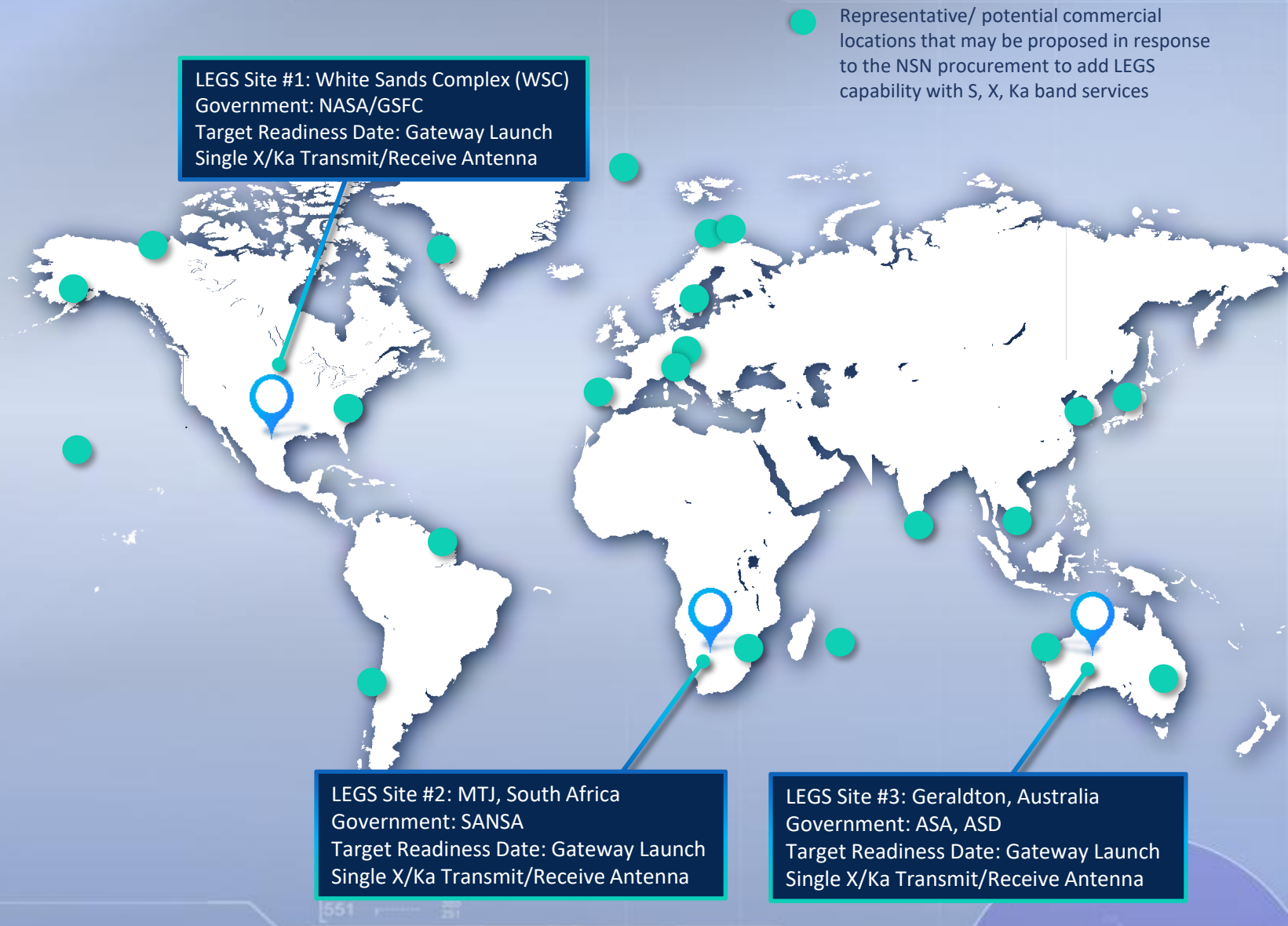
LEGS 1 to 3:

- Cover three geographically diverse sites, offering continuous lunar coverage
- 18-meter class performance in X and Ka
- Government-owned / contractor operated

LEGS 4+:

- Locations TBD
- 18-meter class performance in X, Ka **and S**
- Being pursued under full commercial services procurement

<u>There will also be opportunities for the science mission community to utilize LEGS for Lagrange missions</u>



Summary

DSN and TDRSS are facing perfect storm of increased throughput demand and aging infrastructure

SCaN is evolving network capability, inclusive of DSN improvements and incorporating emergent commercial services in Near Space

We need the NASA APAC community to engage with SCaN and let us know what you want to see from service providers—and to consider how commercial relay, LEGS, and other new options may fit with future mission profiles

NASA's Communications Services Project (CSP) hosts periodic Commercial Services User Group (CSUG) forums that provide more detailed information – contact me for info on the next one!

SCaN

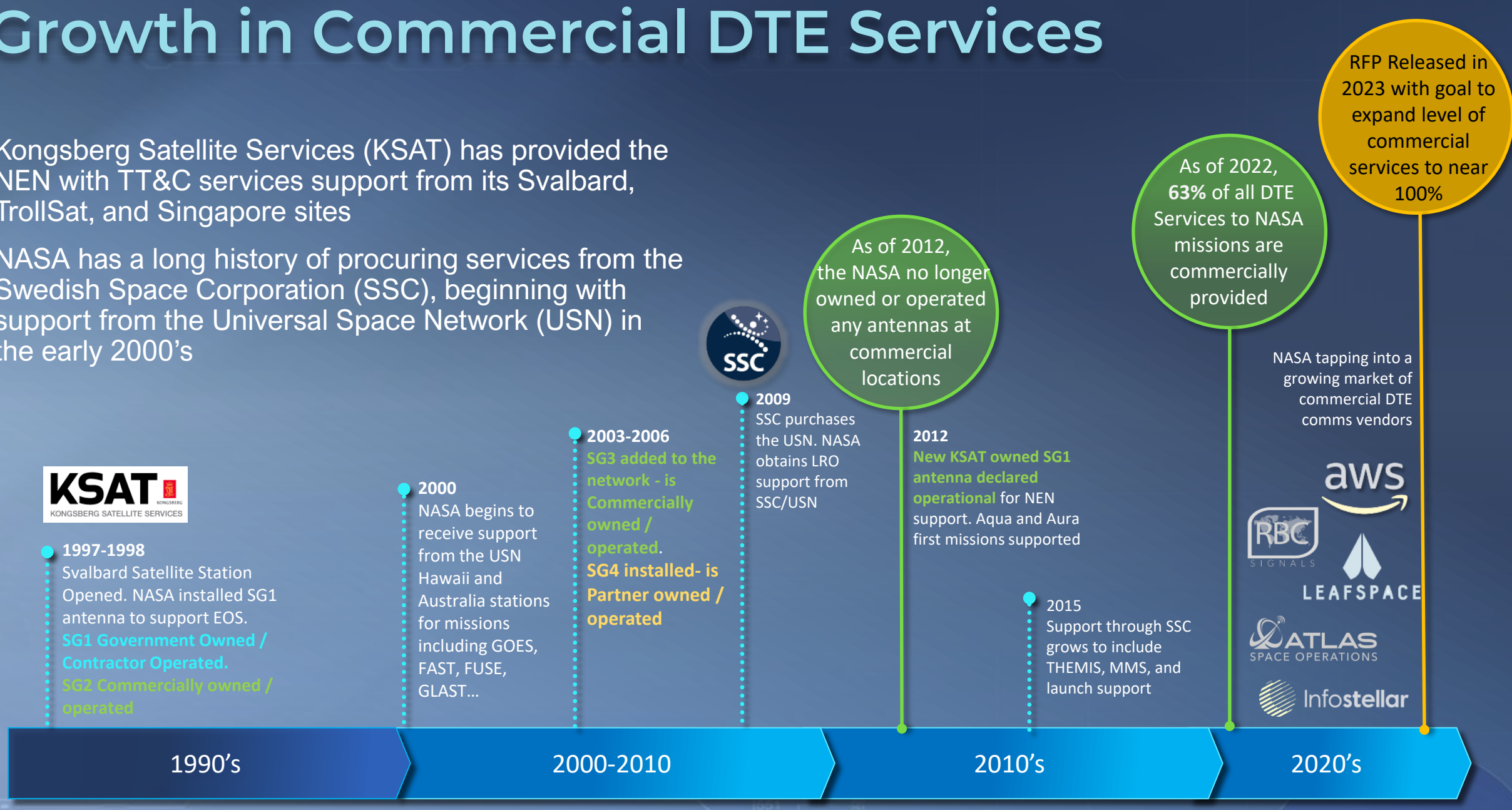
Space Communications and Navigation

National Aeronautics and Space Administration

Exploration, Enabled.

Growth in Commercial DTE Services

- Kongsberg Satellite Services (KSAT) has provided the NEN with TT&C services support from its Svalbard, TrollSat, and Singapore sites
- NASA has a long history of procuring services from the Swedish Space Corporation (SSC), beginning with support from the Universal Space Network (USN) in the early 2000's



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

Artemis 1 and Cubesat Experience

Artemis-I + Deep Space CubeSat Support: DSN Impacts