



Space Communications and Navigation
Science & Exploration, enabled.

National Aeronautics and
Space Administration



Emerging Communications Options for NASA Science

Presented To:

National Academy of Sciences

Committee on Astronomy and Astrophysics (CAA)

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National Aeronautics and Space Administration

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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

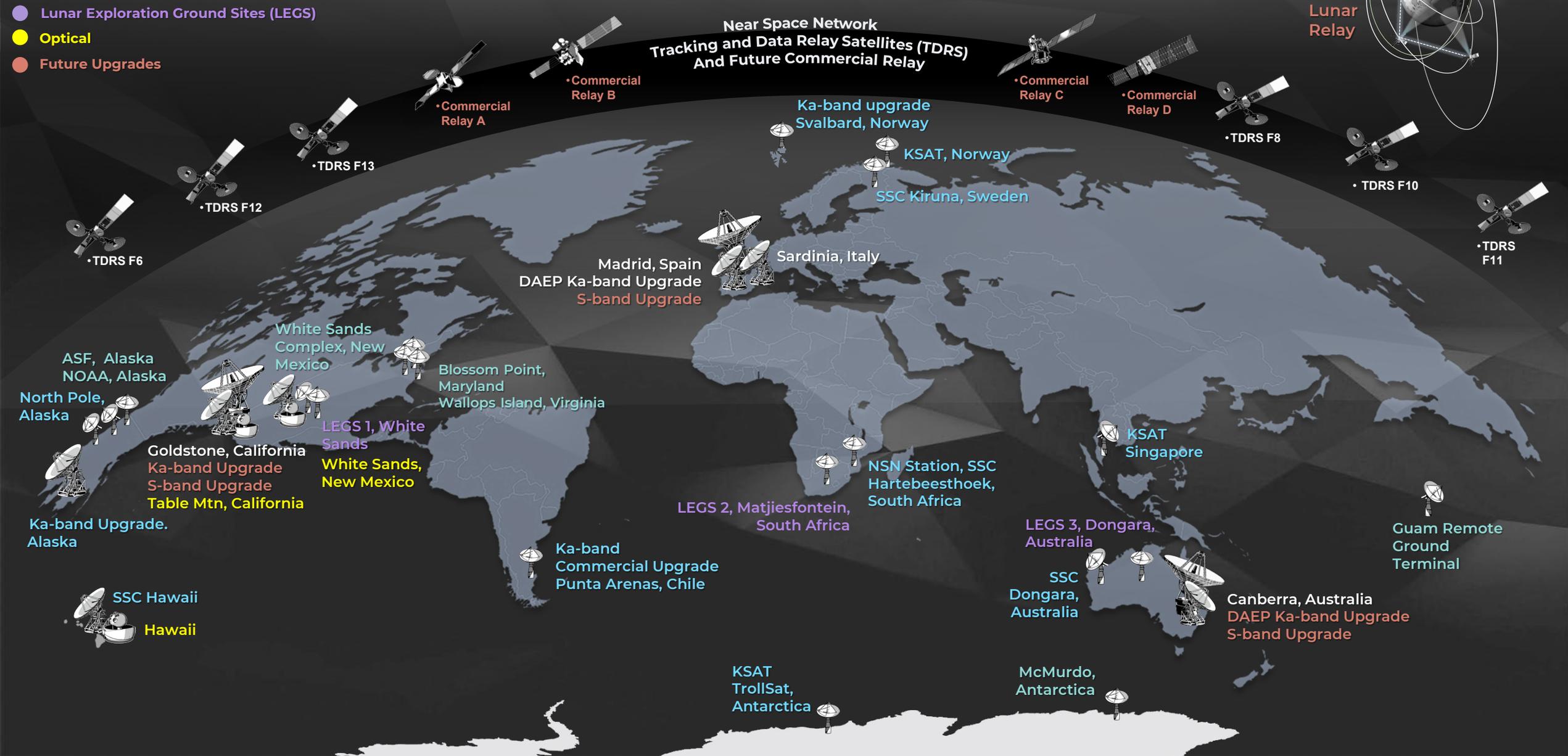
Execute
with Sound Technical
and Programmatic
Fundamentals

Evolve
the Network to
Satisfy Mission
Customer Needs of
the Future

Empower
Our Science and
Exploration
Partners

SCaN Network Architecture is Evolving to Meet Stakeholder Needs

- 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 – Direct to Earth

The Near Space Network (NS) provides NASA missions with communications and navigation services from LEO out to two million kilometers

The network serves missions throughout their entire lifecycle, providing requirements analysis, spectrum management, communications analysis, service agreements, mission design, mission planning, launch, operations, and post-mission support activities

When missions use the NSN for Direct-to-Earth (DTE), SCaN acts as the intermediary with industry partners (e.g., SSC, KSAT) whose networks carry most of the data

[SCaN Services and Scheduling - NASA](#)

The NSN provides four main services to mission customers:

- 1** Mission Integration: development of service agreements, interfaces, documentation, support of reviews, etc.
- 2** Mission Planning and Scheduling: performing link and loading analyses, supporting service requests, and generating and implementing operational schedules
- 3** Position, Navigation, and Timing (PNT): navigation information, tracking data measurements, and messages
- 4** User Mission Data Transfer: spacecraft forward command and return telemetry data

[NSN Services Brochure 1.2 DIG \(nasa.gov\)](#)

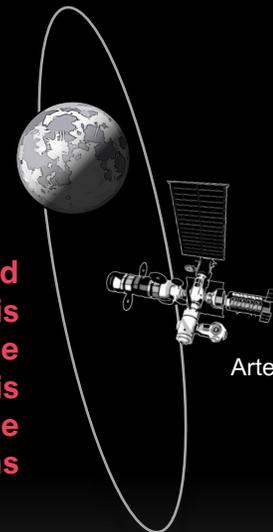
A new NSN Capability Lunar Exploration Ground Segment

Lunar Exploration Ground Segment (LEGS) will provide NSN capacity for users out to L1/L2, alleviating DSN demand

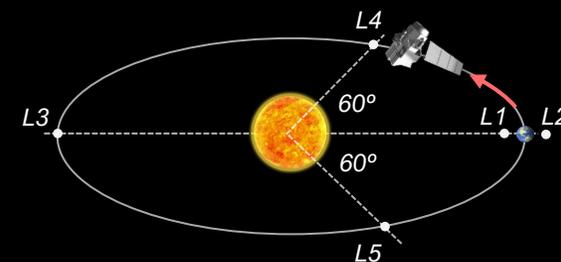
NASA is building “18-m class” LEGS antennas at sites #1-3 in the US, Australia and South Africa to be government owned and commercially operated

- LEGS 1-3 will be operational in time for the Artemis IV launch
- LEGS 1 is in White Sands, NM
- Agreement with SANSA for LEGS 2 site in Matjiesfontein, South Africa signed in September 2024
- LEGS 3 site finalized for Dongara, Australia in October 2024

Additional ground station capacity is critical to support the demands of Artemis and SMD Lagrange Missions



Artemis Gateway



SMD Lagrange Missions



DTE: Investments in Capacity and Commercial Opportunity

- Lunar Exploration Ground Segment (LEGS) sites 1-3 are GOCO but will be augmented by commercial services
- Providers, including KSAT, are already investing to offer interoperable services using LEGS service architecture
- LEGS is NASA's long-term vision for DTE support out to L1/L2

1

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

2

LEGS Site 2:
South Africa

3

LEGS Site 3:
Australia

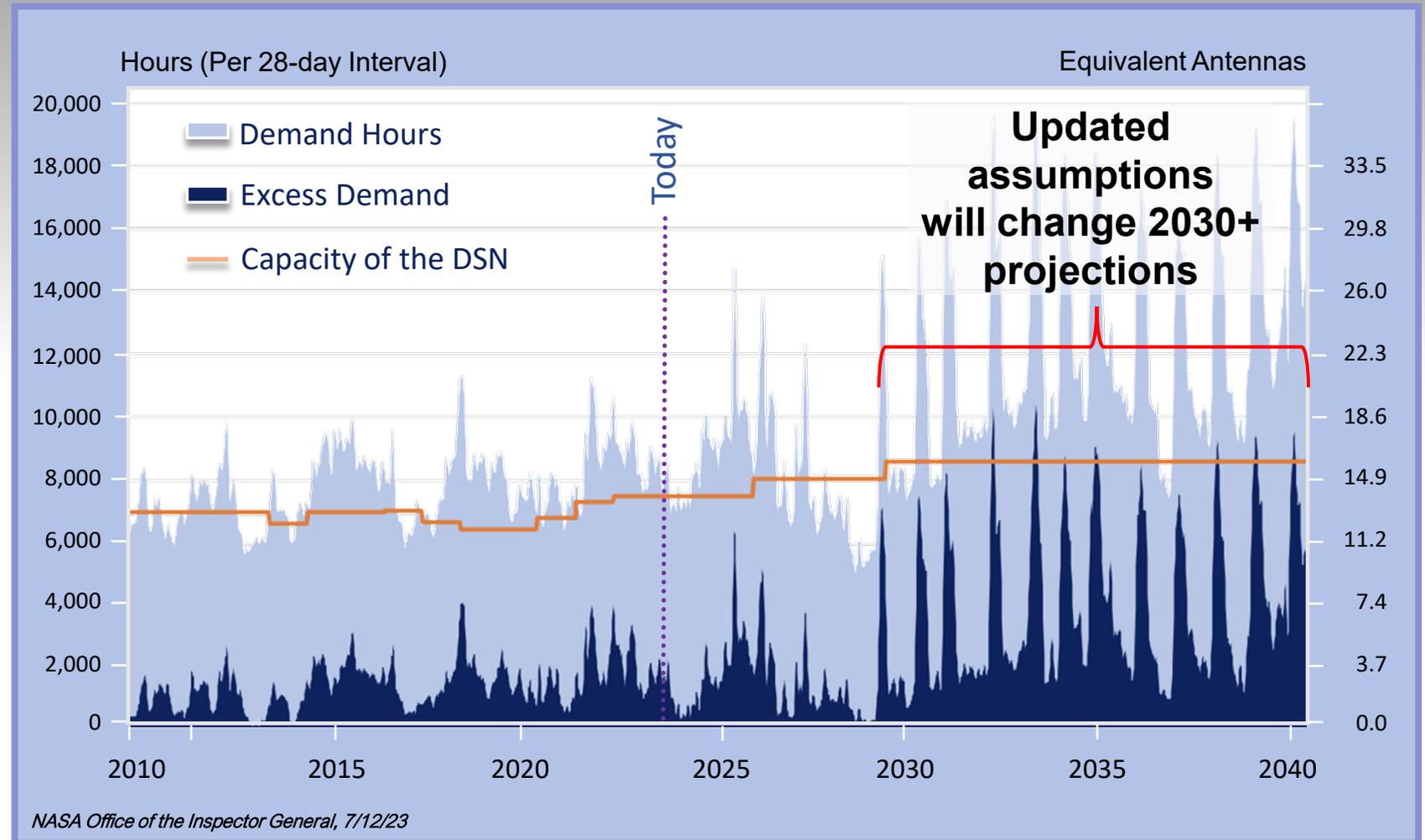


Representative/Potential Commercial Locations



Near Earth Users Should Opt for Non-DSN Services

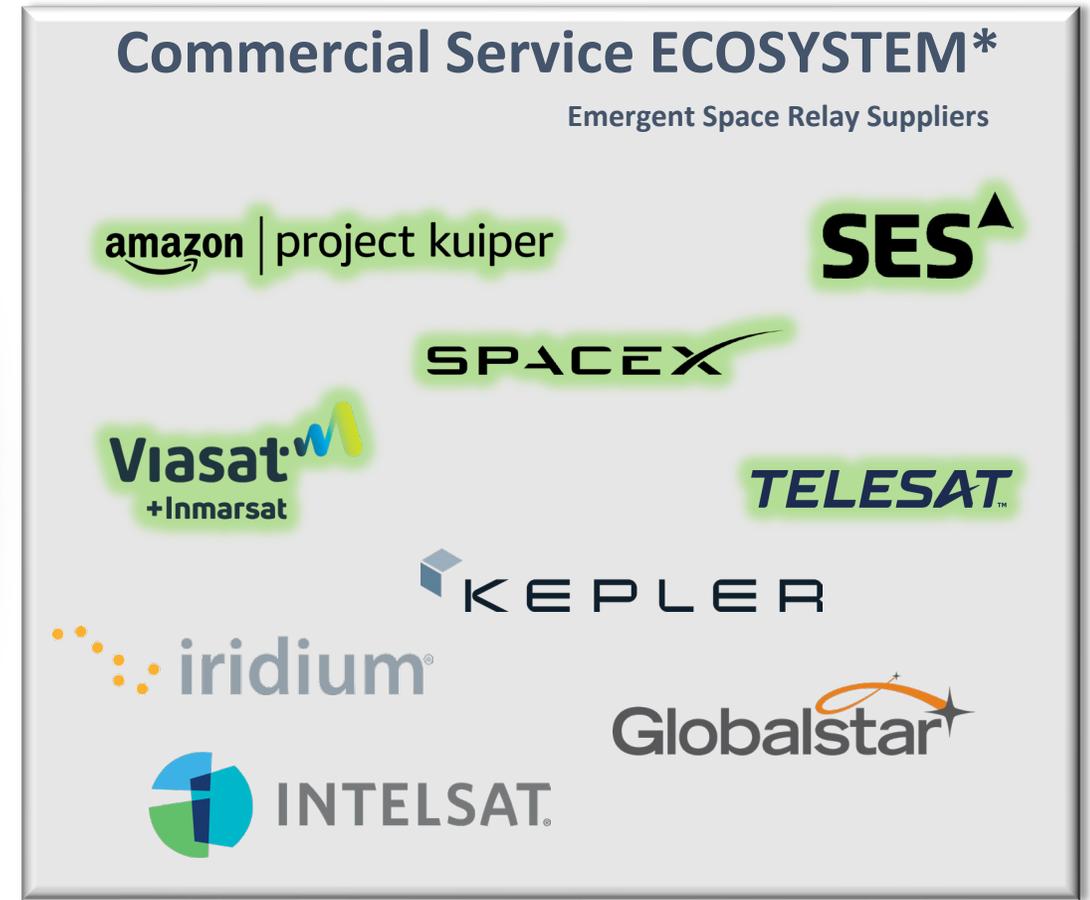
- JWST is a “top ten” user of DSN capacity
- Each Artemis launch leads to a short demand spike
- Assumptions regarding Artemis utilization of DSN continue to be updated and analyzed through a formal loading study process
- ESDMD defining new operational approaches to reduce operational churn on DSN community
- SOMD, SMD, and ESDMD are all engaged and working together



SCaN discourages missions proposing inside the 2m km bubble from seeking DSN services

Space Relay Continuity: Today to 2031

- There are multiple emergent vendors of near-Earth proximity relay services
- Many already work with commercial customers and would be capable of supporting NASA missions today
- SCaN and CSP will work with missions that require SR support to help them contract directly with these providers; some missions already do this for commercial DTE
- SCaN can provide expertise and support



**Representative, not all inclusive*

 *Current Space Relay CSP
FSAA Partners*

Space Relay Continuity: Momentum is Building

- 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 demo with Blue Origin New Glenn launch is on track for March 2025
- Polylingual Experimental Terminal (PEXT) set for 2025 launch and demo of services with multiple vendors

Optical Demonstration

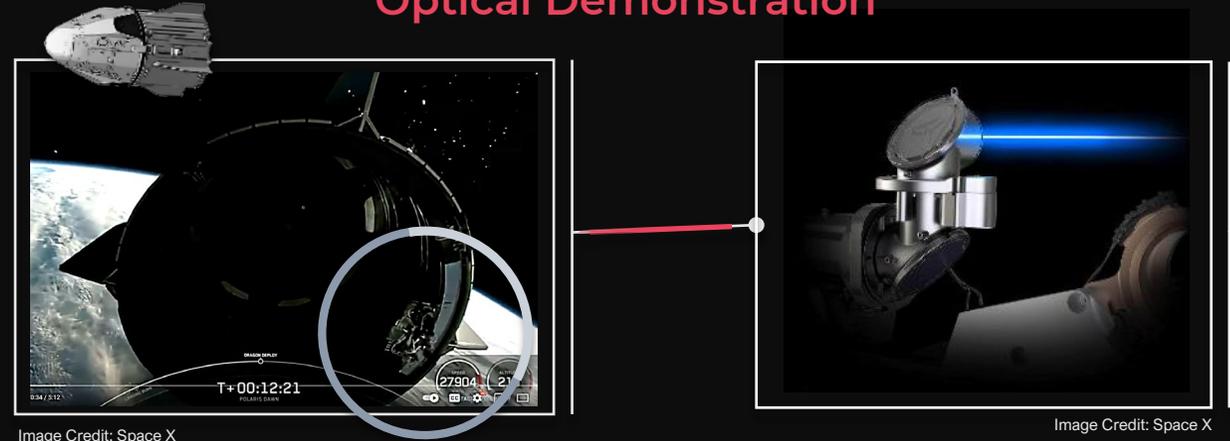


Image Credit: Space X

Image Credit: Space X

Polaris Dawn and Starlink Plug and Plaser

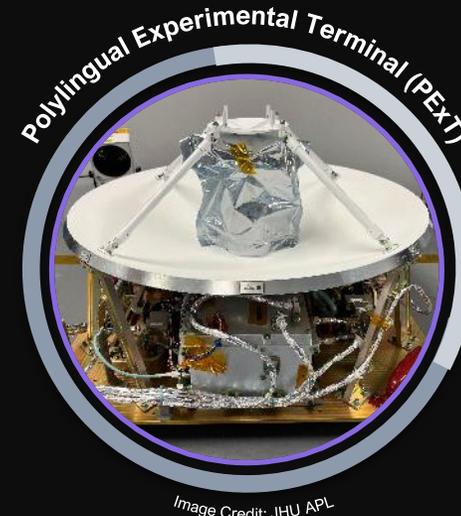


Image Credit: JHU APL

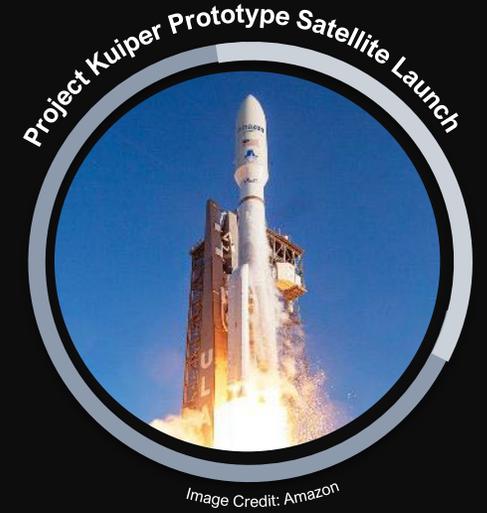
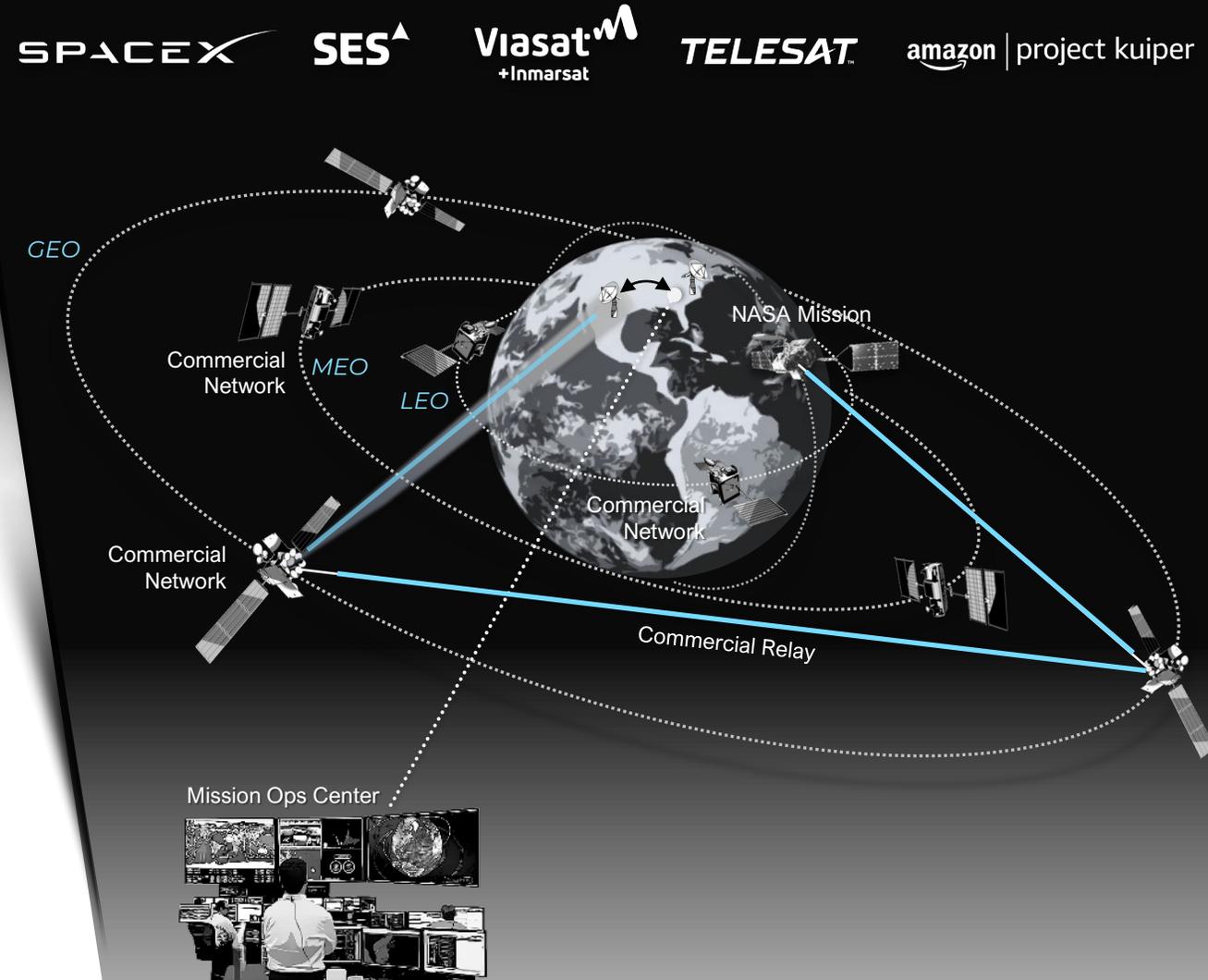


Image Credit: Amazon

Space Relay Continuity: 2031 and Beyond

- In 2020, SCaN defined a strategy to transition NASA's Low Earth Orbit missions seeking to use the NSN to commercial SR services
- The NSN will maintain critical space relay capabilities including global coverage for TT&C
- SCaN's Communications Services Project (CSP) awarded funded space act agreements (FSAAs) in 2022 to demonstrate how commercial satellites can support NASA missions
- **Validated SR services will be available through NSN in 2031**

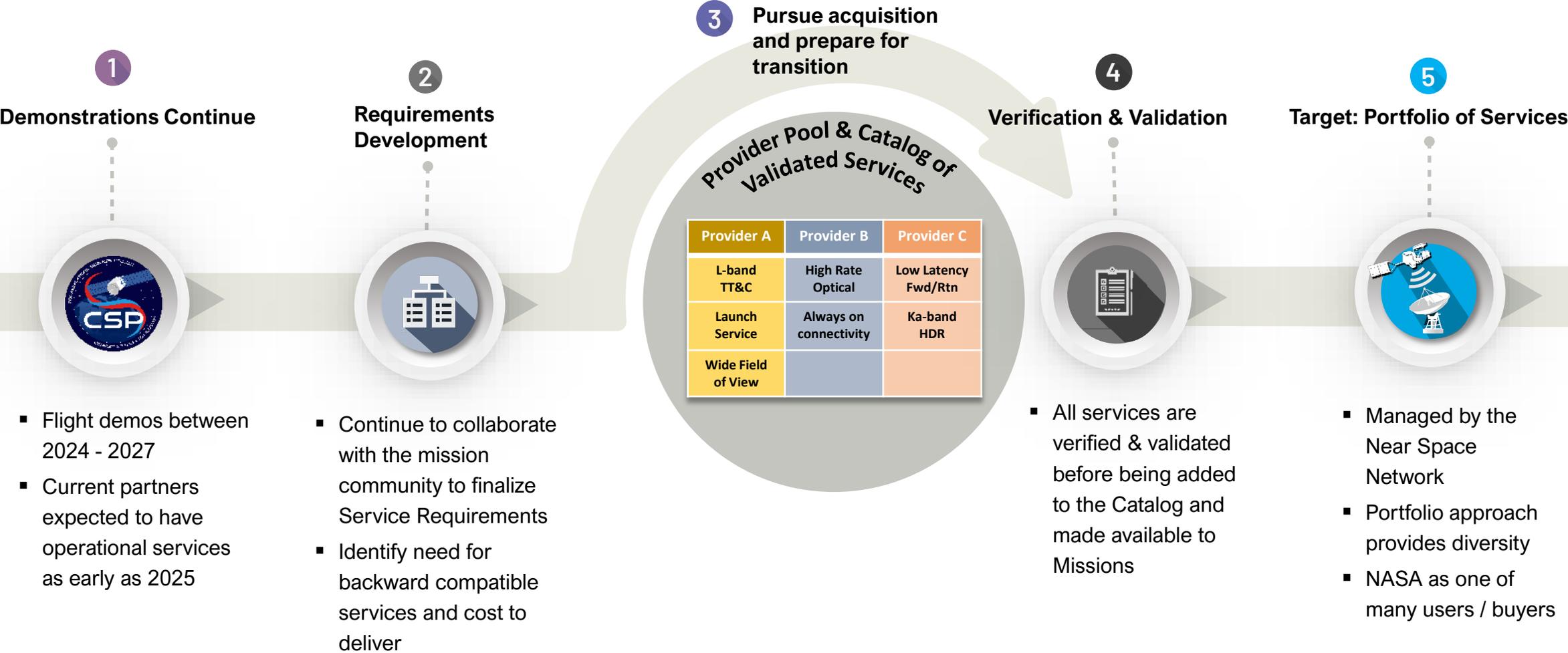


CSP's Six FSAA Partners are Demonstrating Services for Relevant NASA Use Cases

- NASA awarded six Funded Space Act Agreements in April 2022
- Total NASA investment: \$278.5M
- Commercial investment matching / exceeding the awards – totals ~\$1.5B over 5 years
- Vendors are progressing through their agreed milestones through mid-2027

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

Space Relay Continuity: CSP will Deliver Services by 2031

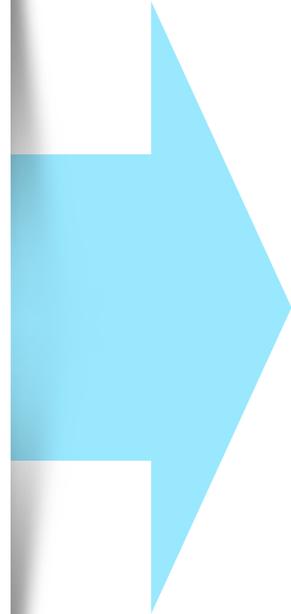


Join Us as We Take This Opportunity to Enable New Missions

TDRS retirement is an opportunity not a set-back; there are new enablers

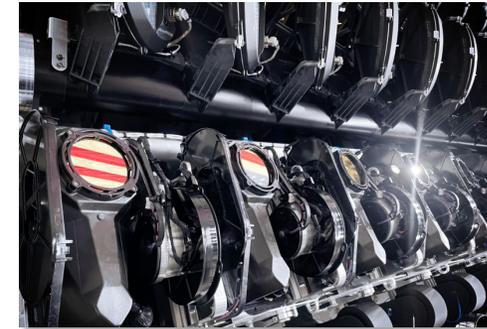
Legacy Architecture and Services (Switchboard in the Sky)

- Costly
- Limited capacity
- High effort to schedule
- Closed ecosystem
- Complex mission integration



Technology and Service Evolution

- Diverse service offerings
- Tens of thousands of users served simultaneously
- On-demand capabilities akin to cellular
- Large industrial base and market
- Promotes mission autonomy
- High-throughput, demand-responsive networks can remove network constraints and unleash new modes of science



Starlink optical connectivity

<https://x.com/Starlink/status/1706718537711337650/photo/1>

Kuiper prototype testing

<https://www.aboutamazon.com/news/innovation-at-amazon/amazon-project-kuiper-deorbit-satellites>



O3b mPower MEO satellite

<https://spacenews.com/boeing-preparing-to-ship-milestone-o3b-mpower-satellites-for-launch/>

NASA is Committed to Open Communication and Partnership

TDRS Flyout and LEGS Rollout

- Look for planned periodic updates from SCaN on the status of the flyout and progress on LEGS GOCO
- Please contact the DPM for Mission and Stakeholder Engagement, [Jena Garrahy](#), and the DPM for Capability Development, [Greg Heckler](#), at hq-tdrsflyout@mail.nasa.gov

Commercial Relay Path Forward

Learn more at:

<https://www.nasa.gov/communications-services-project/>

Questions regarding CSP's commercialization strategy and timeline? Contact the CSP Project Manager – [Dr. Peter Schemmel at peter.j.schemmel@nasa.gov](mailto:peter.j.schemmel@nasa.gov)

Want to understand how commercial services can meet your mission needs? Contact the CSP Mission Support Sub-Project Manager – [Ryan Richards at ryan.m.richards@nasa.gov](mailto:ryan.m.richards@nasa.gov)

Want to talk to a CSP FSAA partner? Contact the CSP Capability Development and Demonstration Sub-Project Manager – [Aaron Yingling at aaron.j.yingling@nasa.gov](mailto:aaron.j.yingling@nasa.gov)

Interested in support service requirements development? Contact the CSP Service Infusion Sub-Project Manager – [Jennifer Rock at jennifer.l.rock@nasa.gov](mailto:jennifer.l.rock@nasa.gov)

SCaN

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Science and Exploration, Enabled. Together