National Aeronautics and Space Administration

Tracking and Data Relay Satellite Flyout: Information for NASA Partners

SCaN Space Communications and Navigation

Science & Exploration, enabled.

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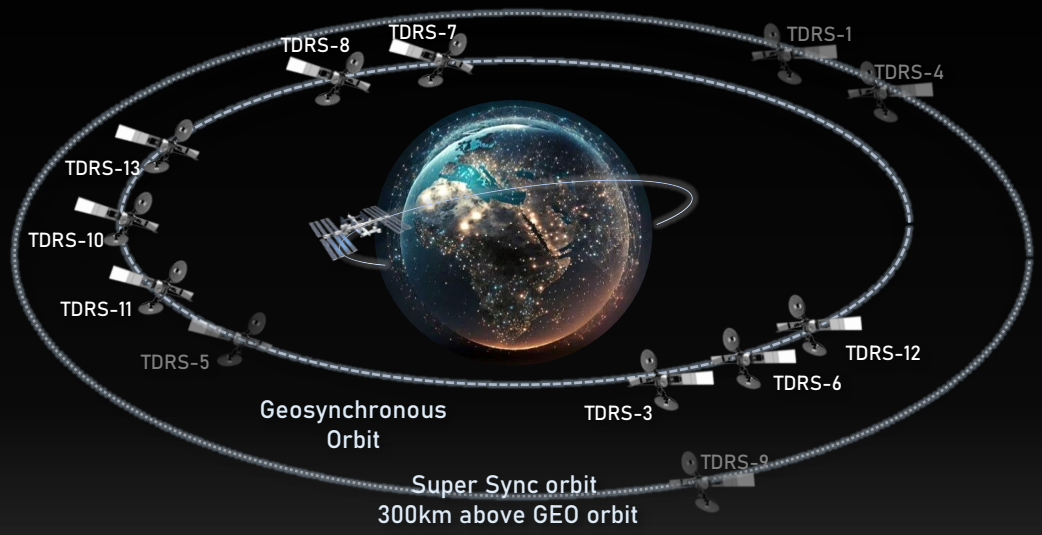
Purpose

- The NASA Tracking and Data Relay Satellite (TDRS) system is in decline and will not be replenished
- TDRS is used today by NASA missions, international and commercial partners
- To preserve capacity for existing users and avoid introducing new risks, NASA has decided to stop accepting *new users* on the TDRS network
- This informational overview is intended to provide partners with an understanding of:
  - The challenge
  - Implications and impacts
  - NASA's forward path
  - Who to communicate concerns to and engage with for support moving forward

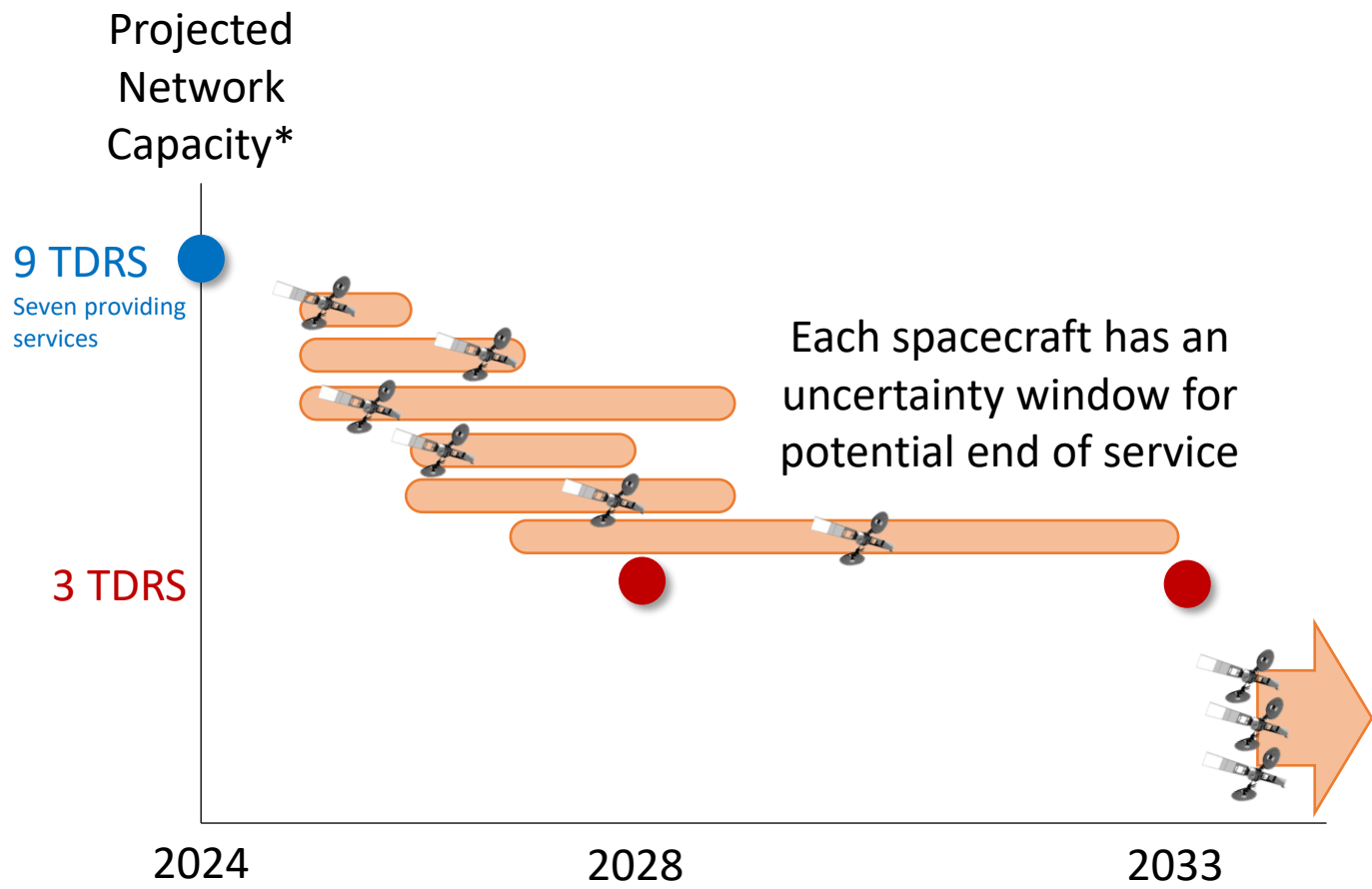
NASA Decision

- 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.



The Challenge

- 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 spacecraft are providing services currently
- Several spacecraft are predicted to fail in the next 1-5 years
- Projected decline indicates a reduction from 7 to 3 satellites by 2033, and potentially as early as 2028
- With a ~60% decline in capacity, NASA must actively manage utilization of the resource

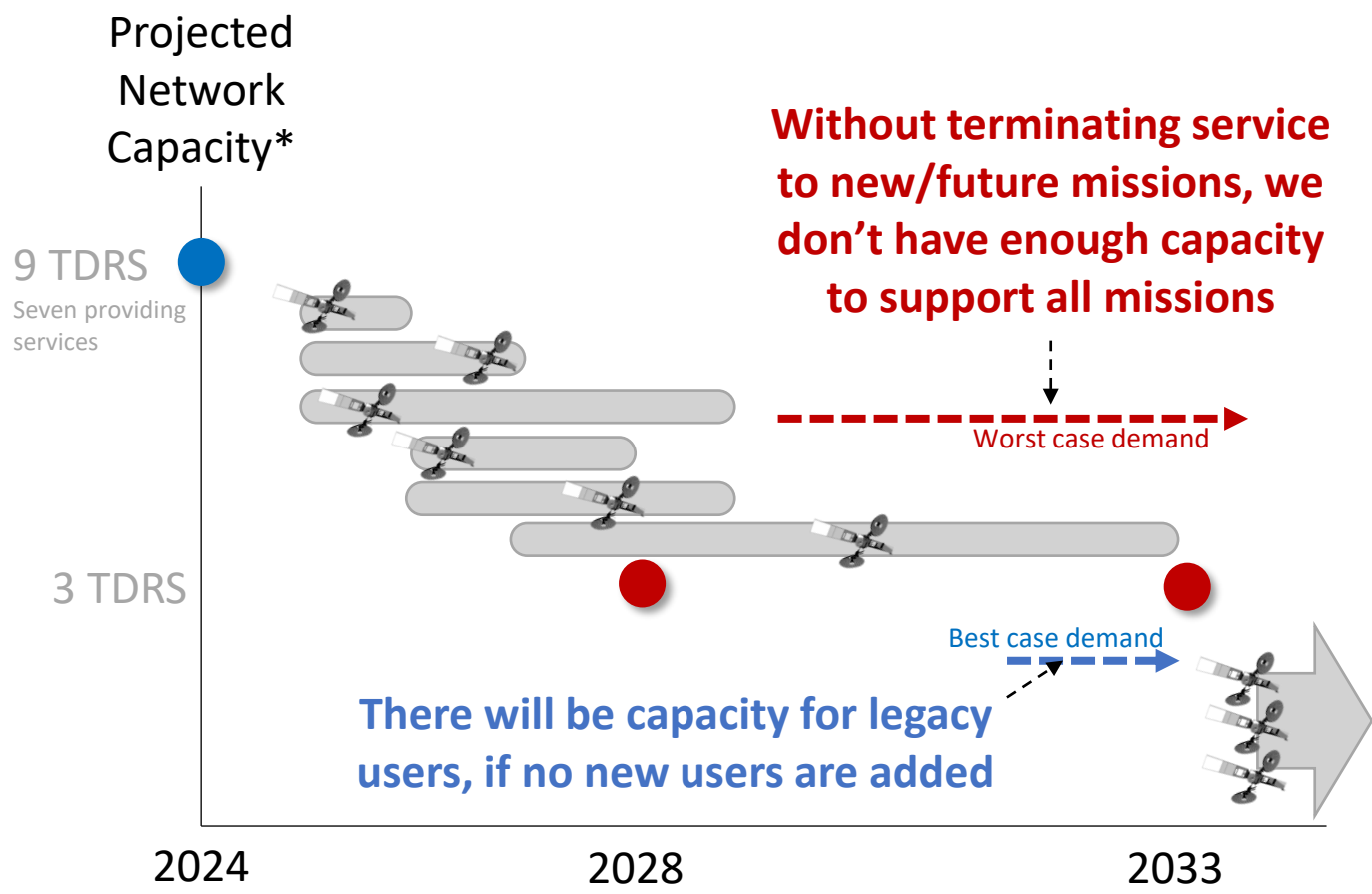


*Representative

Network capacity is anticipated to be less than half of today's value as early as 2028

Implications and Impacts

- NASA and non-NASA communities will be impacted
- Human space flight will continue to be prioritized
- As a result, the science community will feel the most significant impacts
  - If demand is left unchecked; the science community will receive less than 50% of required support into the 2030s, including missions like GPM and Hubble
- Launch support, although periodic, represents a unique challenge
  - Single access antenna use during a launch typically occupies two antennas (1 for the launch vehicle, 1 for the payload)
  - TDRS antennas available for other users in the region are limited for the duration

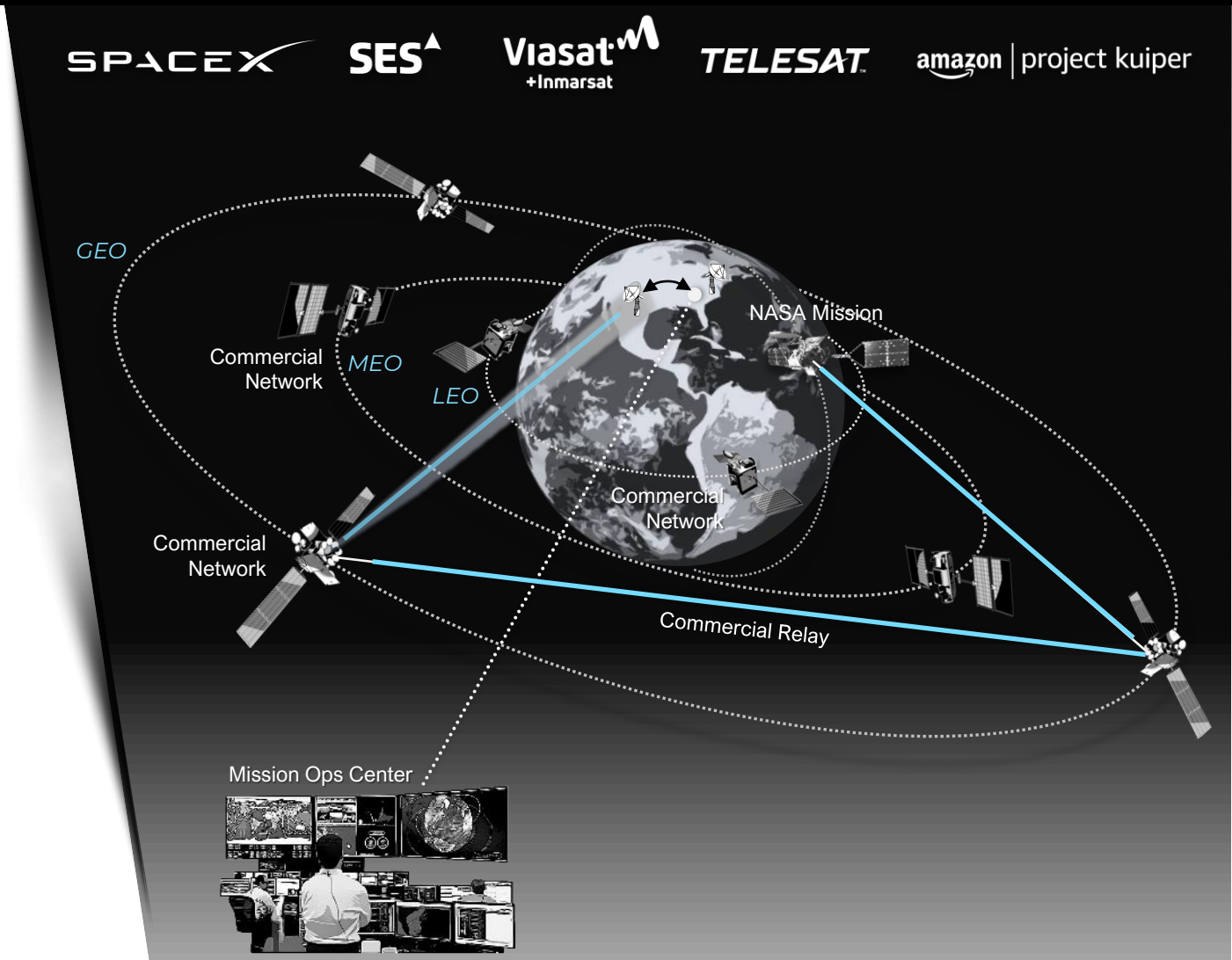


*Representative

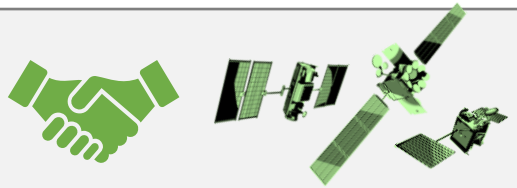
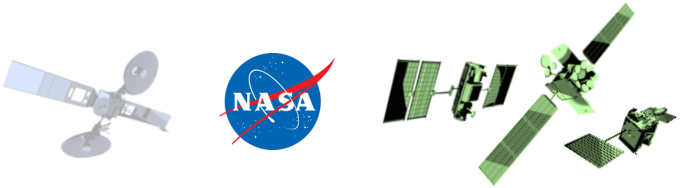
The decision to terminate services for future / new users is key to mitigating long-term risk for existing users

Path Forward: Pivoting to Commercial Space Relay

- In 2020, SCaN defined a strategy to transition NASA's Low Earth Orbit missions to commercial SR services
  - SCaN will maintain critical space relay capabilities including global coverage for TT&C
  - Commercial Space Relay (SR) will provide transformative new capabilities to science missions
  - Communications Services Project (CSP) is targeting operational commercial SR service by 2031



NASA Has Established a Framework for Future Earth Relay Services

	TODAY	OBJECTIVE FUTURE STATE
Commercial LEO Destinations (CLD) + Supporting Vehicles	--	 Business-to-Business Relationships Commercial Space Relay and Ground Services NASA Facilitates as Applicable
Commercial Launch Vehicles		
Artemis Human Spaceflight*	 NASA SCaN Provides TDRS Services	 NASA acquires Commercial Services on Behalf of Mission Community Maintains Continuity for Legacy Missions on TDRS
Science Missions		
International Space Station & Supporting Vehicles		 TDRS support through flyout of ISS

**Some Artemis Vehicles Planning to Leverage Commercial Communications*

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
amazon | project kuiper	File Delivery	Science data	Optical	LEO
SPACEX	File Delivery	Mission data	Optical	LEO
Viasat +Inmarsat	File Delivery	Science data	Ka-Band	GEO
	Direct Access	LEOP and TT&C	L-Band	GEO
SES	File Delivery	Science data	Ka-Band	MEO
	Direct Access	LEOP and TT&C	C-Band	GEO
TELESAT	File Delivery	Science data	Ka-Band	LEO
	Direct Access	LEOP and TT&C	C-Band	GEO

Space Relay Continuity: Momentum is Building

- 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 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

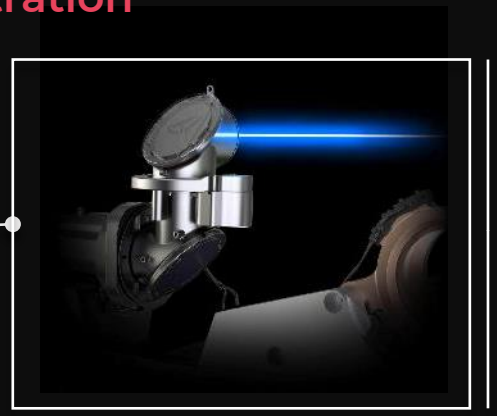


Image Credit: Space X

Polaris Dawn and Starlink Plug and Plaser

Image Credit: JHU APL

Image Credit: Amazon

CSP will Deliver Services by 2031

1 Demonstrations Continue

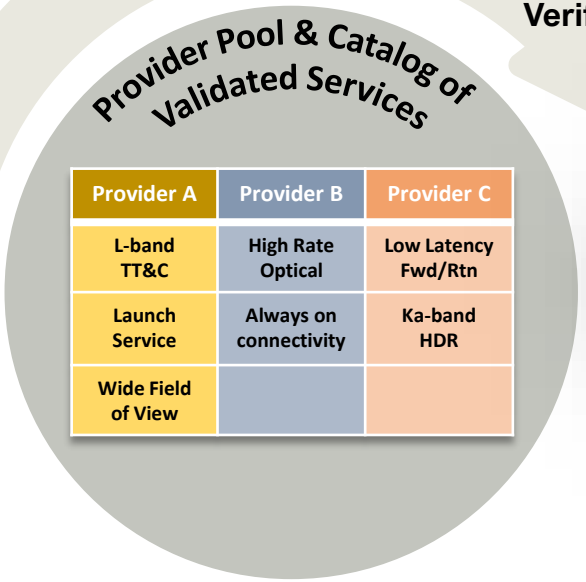
- Flight demos between 2024 - 2027
- Current partners expected to have operational services as early as 2025

2 Requirements Development

- Continue to collaborate with the mission community to finalize Service Requirements
- Identify need for backward compatible services and cost to deliver

3

- Pursue acquisition and prepare for transition



All services are verified & validated before being added to the Catalog and made available to Missions

4 Verification & Validation

- Validate capabilities before transitioning to operations

5 Target: Portfolio of Services

- Managed by the Near Space Network
- Portfolio approach provides diversity
- NASA as one of many users / buyers

Join Us as We Take This Opportunity to Enable New Missions

Fly out of TDRS is an opportunity not a set-back; there will be real opportunities for break-through

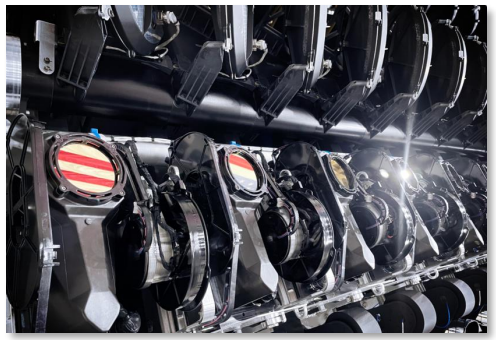
Legacy Architecture and Services (Switchboard in the Sky)

- 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

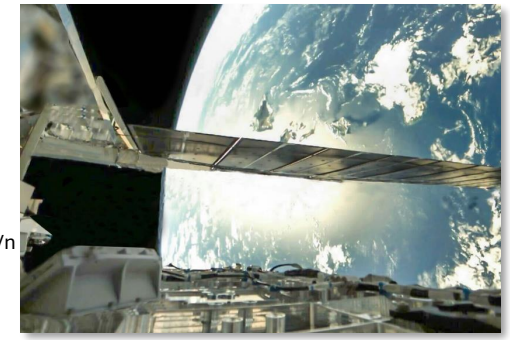
- High-throughput, demand-responsive networks can remove network constraints and unleash new modes of science



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

- Look for planned periodic updates from SCaN on the status of the flyout
- 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 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

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

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

Interested in support service requirements development? Contact the CSP Service Infusion Sub-Project Manger – Jennifer Rock at jennifer.l.rock@nasa.gov

SCaN

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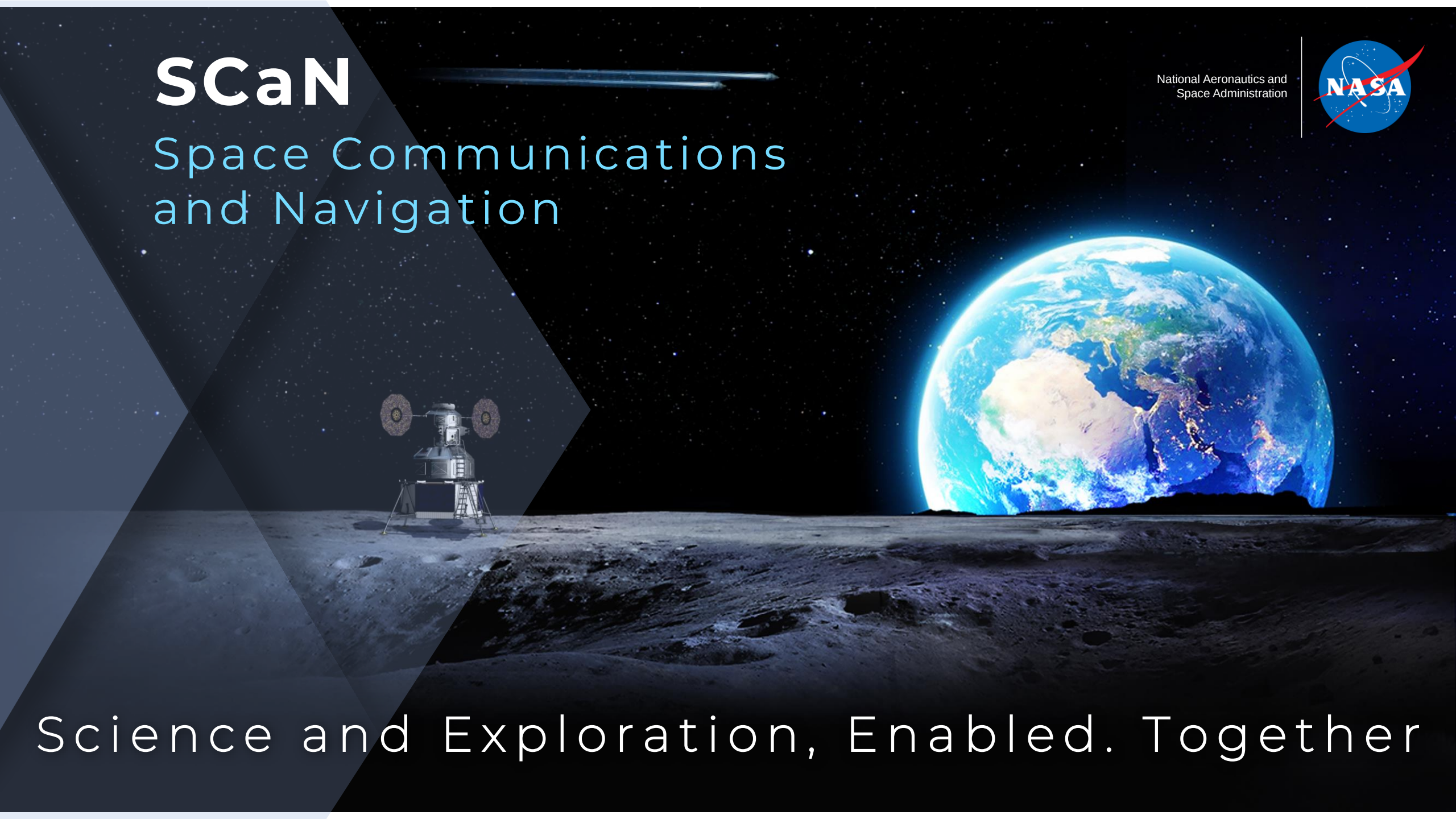


Science and Exploration, Enabled. Together

Kuiper is demonstrating optical space-to-space capabilities for science data transmission

Kuiper uses a phased approach to develop its space-to-space services.

Service Type	File Delivery
Demo. Mission	3rd party satellite representing LEO science mission.
Use Case	Transmitting Earth science data to mission operators and scientists through cloud-based systems.
Terminal	Amazon Kuiper proprietary terminal and integration kit.
Network	3,000+ LEO satellites provide Ka-Band services to terrestrial users and optical intersatellite links to space-users.

KuiperSat-1 and KuiperSat-2 completed initial testing in early 2024.

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

SpaceX is demonstrating always-on optical space-to-space capability extension of Starlink targeting mission data use cases

Starlink optical intersatellite links provide high-rate data with always–on services to space-users.

Service Type	File Delivery
Demo. Mission	Crewed SpaceX asset.
Use Case	Always-on mission data between crewed asset and representative Mission Operations Center (MOC).
Terminal	Plug and Plaser proprietary terminal and avionics bridge
Network	5500+ Starlink LEO satellites

Starlink satellites connect via optical links and transmit tens-of-petabytes of data per day.

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

Viasat is demonstrating integrated, on-demand space-relay and DTE data services

Viasat’s Real-Time Space Relay (RTSR) offers on-demand services for LEO operators.

Service Type	File Delivery
Demo. Mission	Rocket Lab and Loft Orbital missions representing LEO science users.
Use Case	Transmitting high-resolution Earth science data to mission operators and providing real-time access to spacecraft.
Terminal	Viasat proprietary terminals for space relay. Additional options available for DTE links.
Network	Integrated Space Access Network (ISAN) consisting of Viasat-3 GEOs and DTE stations.

Viasat's VS3 F-1 recently entered service, providing users with data rates exceeding 100 Mbps.

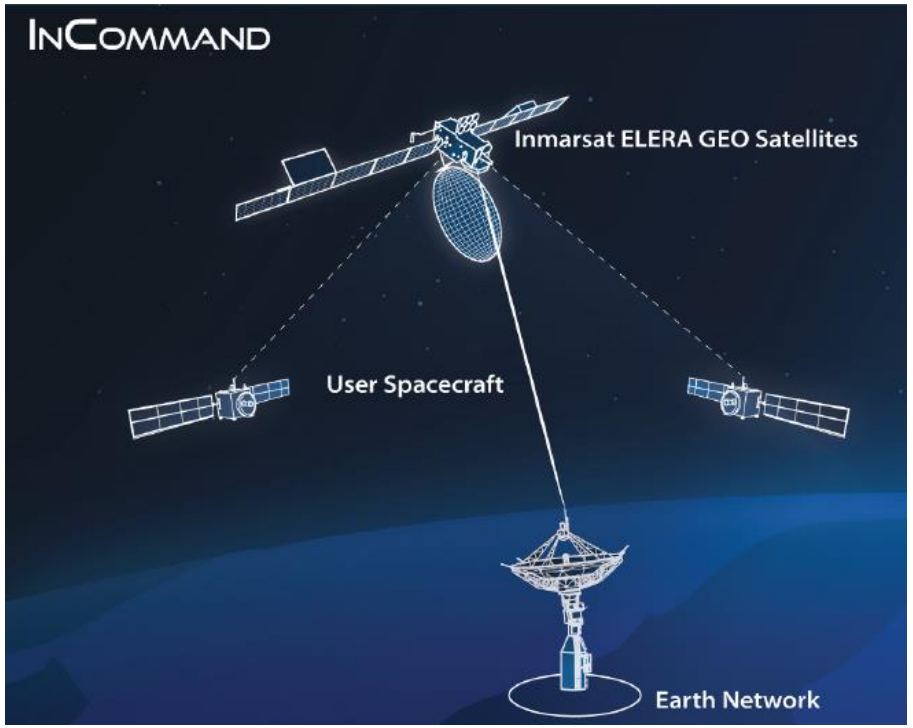
https://www.satellitetoday.com/manufacturing/2023/03/20/boeing-delivers-first-viasat-3-satellite-ahead-of-launch/

Legacy Inmarsat is demonstrating L-Band space-to-space capabilities for TT&C

InCommand is extending the capability of the deployed ELERA constellation.

Service Type	Direct Access
Demo. Mission	Rocket Labs spacecraft
Use Case	Telemetry, Tracking, and Command (TT&C), Launch and Early Operations Phase (LEOP), contingency cases.
Terminal	Rocket Labs Frontier user terminal.
Network	Inmarsat's ELERA constellation in GEO is fully deployed and providing mobile data and safety services.

InCommand offers a two-way, on-demand communication link worldwide.



https://www.nasa.gov/wp-content/uploads/2024/05/inmarsat-csp.pdf?emrc=8add3e

Legacy Inmarsat is demonstrating L-Band space-to-space capabilities for launch services

InRange gives users additional insight into network status during the pre-launch phase.

Service Type	Direct Access for Launch
Demo. Mission	Blue Origin New Glenn launch vehicle, with a second demonstration announcement forthcoming.
Use Case	Launch support and telemetry
Terminal	Safran Data Systems terminal
Network	Inmarsat's ELERA constellation in GEO is fully deployed and current providing mobile data and safety services

InRange offers flexible worldwide launch telemetry.

https://www.inmarsat.com/en/news/latest-news/government/2023/launch-vehicle-telemetry-available-faster-InRange.html

SES Space and Defense is demonstrating a combined MEO-GEO strategy that meets a wide variety of mission needs

SES uses existing GEO satellites to provide C-Band capabilities for real-time tasking.

Service Type	File Delivery Direct Access
Demo. Mission	Planet Labs spacecraft
Use Case	Earth science data transmission Real-time spacecraft tasking
Terminal	Planet Labs developed terminal
Network	03b mPOWER constellation in MEO, and established SES-GEO C-Band network.

Boeing O3b mPower MEO satellites, launched April 2023, provide Ka-Band capabilities.

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

Telesat is demonstrating Ka-Band capabilities for science data and C-Band capabilities for LEOP and TT&C

Telesat's optically-linked Lightspeed constellation delivers high-rate Ka-Band relay services.

Service Type	File Delivery Direct Access
Demo. Mission	Planet Labs spacecraft
Use Case	Earth science data transmission Real-time spacecraft tasking
Terminal	Planet Labs developed terminal
Network	Telesat is leveraging Aalyria's Spacetime for orchestration of its Lightspeed LEO constellation of approximate 198 nodes.

Analog Devices and MDA provide electronic beam forming for Lightspeed.

https://www.businesswire.com/news/home/20210407005055/en/Analog-Devices-and-MDA-Collaborate-to-Provide-Electronic-Beam-Forming-Technology-for-the-Telesat-Lightspeed-Constellation-Enhancing-Global-Connectivity