National Aeronautics and Space Administration

The Future of Satellite Communications Infrastructure for Astrophysics Missions

SCaN

SPACE COMMUNICATIONS AND NAVIGATION

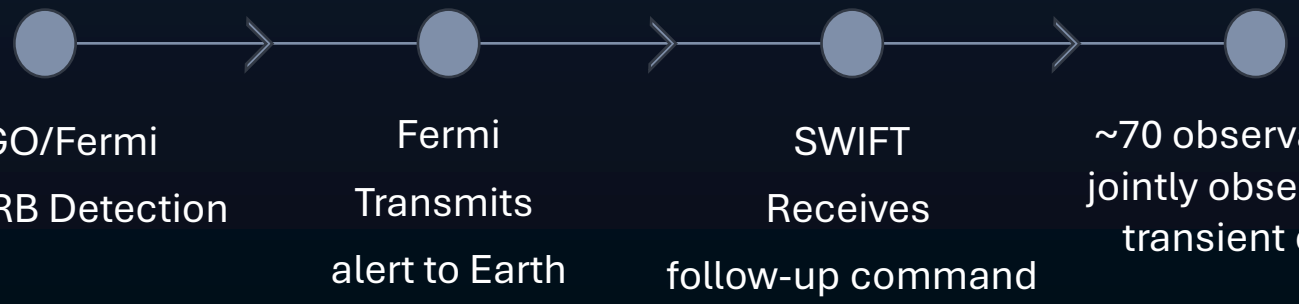
Dr. Aaron Smith, Deputy Lead Engineer
Communications Services Project
NASA Glenn Research Center

2 Sep 2026

www.nasa.gov

Communications is a science-enabling capability

***Science 2017 Breakthrough of the Year**: the first multi-messenger observation of a binary neutron star merger. NASA's Tracking and Data Relay Satellites (TDRS) enabled rapid coordination of space and ground observatories for this transient event.*



Every second matters: The time evolution of transient events informs our physics models. Maintaining and improving rapid alerts and tasking capabilities through space relay is essential for future science objectives.

Agenda

TDRS Capacity Timeline & Capabilities

- Identifying the NASA mission use cases

NASA SCaN's plans to validate and transition commercial space relay to operations

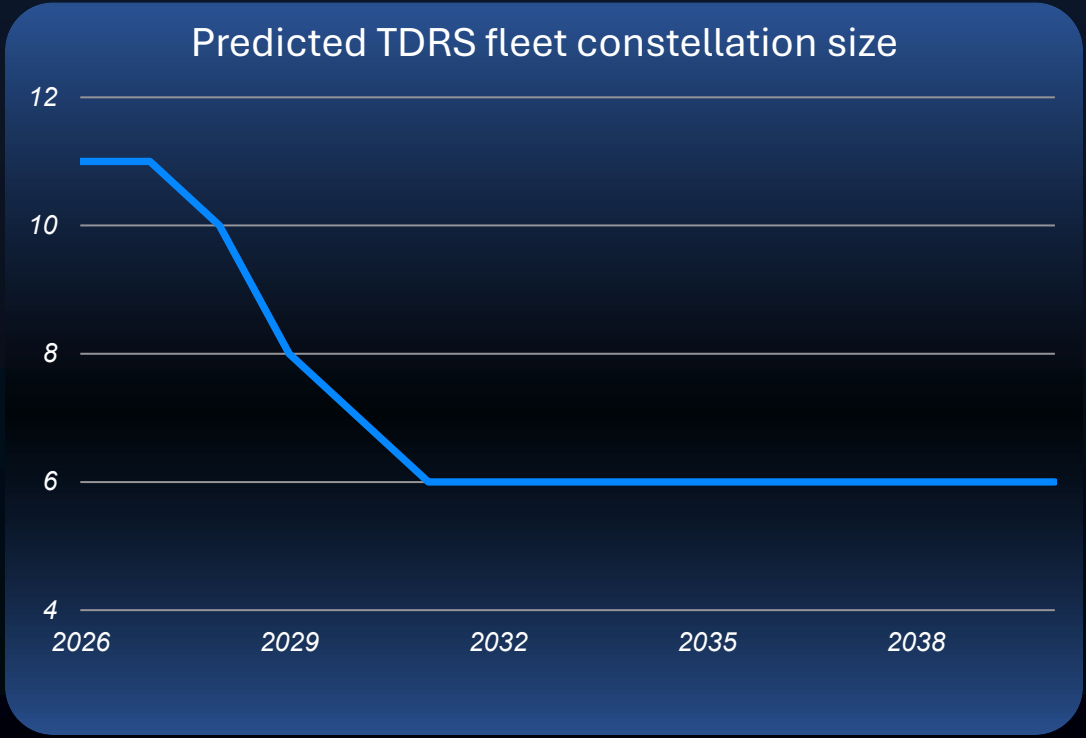
- CSP transition approach
- Funded Space Act Agreement (FSAA) providers and timelines
- Commercial service portfolio and capabilities

Mapping Astrophysics mission needs to capabilities

- Low-latency, high-availability, resilient communications

Future near-Earth astrophysics missions will transition from the TDRS fleet to commercial services as NASA has decided to not replenish the constellation and capacity is declining

The TDRS fleet constellation size will decline, limiting capacity, based on individual spacecraft health.



Goal: Transition to commercial systems, while preserving the capabilities for near-Earth missions.

Early Orbit Phase
Initialization, checkout, orbit raising

Emergency and Critical Events
Subsystem anomalies and off-nominal events

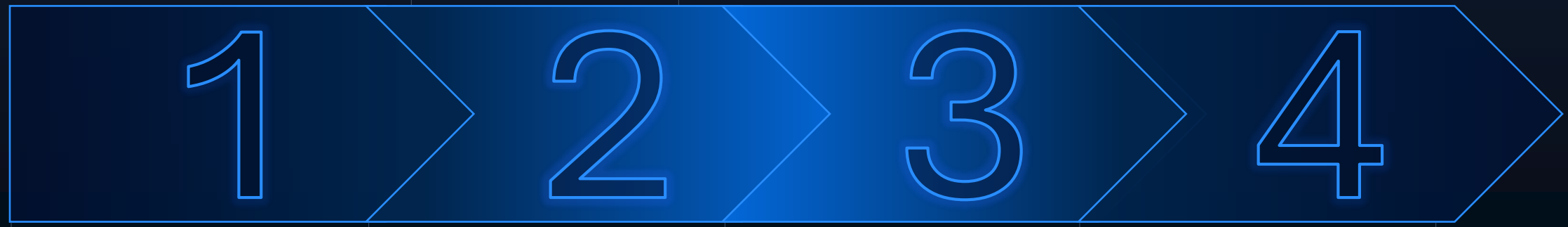
Telemetry & Commanding
Monitoring and control

Routine Science
Bulk science data transfers

Science Alert (Demand Access)
Low-latency alerts and tasking

The Communications Service Project (CSP) is leading this transition for near-Earth relay with a four phased approach to transition validated commercial space relay services to the Near Space Network (NSN) for operations

Service Requirements Development



PHASE 1

Initial commercialization studies

PHASE 2

Capability development and demonstrations via Funded Space Act Agreements (FSAAs)

PHASE 3

Commercial service acquisition, validation, and transition to operations

PHASE 4

On-ramping additional commercial service capabilities to meet future mission needs

CSP is partnering with five commercial providers to demonstrate space relay through Funded Space Act Agreements, with demonstrations continuing through 2027

SPACEX

SpaceX demonstrated high-rate data exchanges using optical links across their LEO Starlink network during the Fram2 human spaceflight mission.

Viasat

Viasat demonstrated launch tracking capabilities over L-band using their GEO HaloNet network during the Blue Origin NG-2 mission.

ses

SES Space & Defense demonstrated high-rate data exchanges between a Planet Labs satellite and their mPOWER MEO network over Ka-band, as well as TT&C exchanges with their GEO satellites over C-band.

amazon leo

Amazon Leo will demonstrate optical intersatellite links between their Amazon Leo satellites in LEO and Earth.

Viasat

Viasat will complete a second launch tracking demonstration using their GEO HaloNet Network during a future Blue Origin NG launch over L-band.

amazon leo

Amazon will demonstrate high-rate data exchanges using optical links between their Amazon Leo network and a third-party satellite.

ses

SES Space & Defense will complete a second demonstration between a third-party satellite and their mPOWER MEO network over Ka-band, as well as TT&C exchanges with their GEO satellites over C-band.

Viasat

Viasat will demonstrate high-rate data exchanges over Ka-band and TT&C services over L-band between their GEO HaloNet network and a third-party satellite.

TELESAT

Telesat will demonstrate high-rate data exchanges between their anticipated LEO Telesat Lightspeed network and a third-party satellite using optical links.

◀ COMPLETE

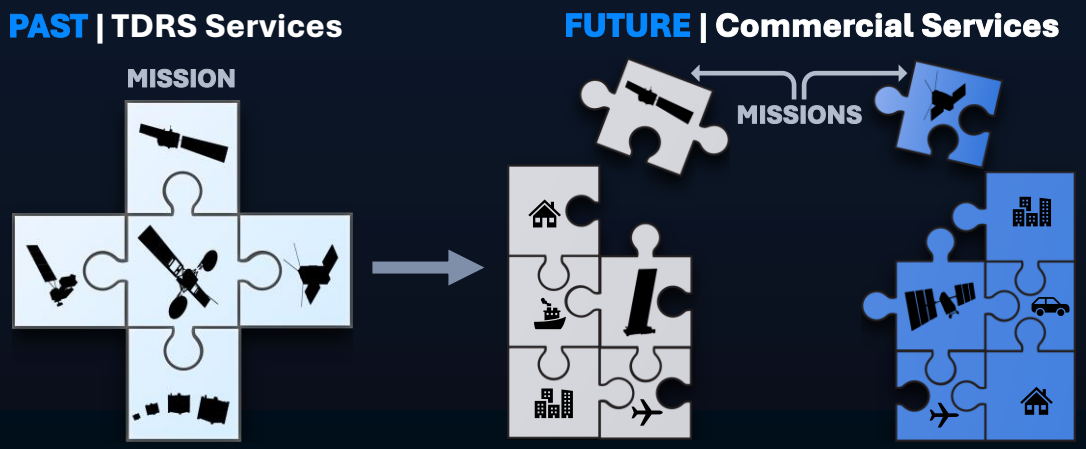
▶ UPCOMING

Future missions will use mature satellite relay services from industry; a paradigm shift from TDRS, when services were developed specifically for NASA missions

NASA will not prescribe the technical design or delivery methods used by commercial providers to develop services and will instead set performance and operational requirements.

Commercial providers will offer mature services to NASA missions as an extension of their existing services leveraged by millions of users on Earth.

NASA missions will adapt to a new normal, leveraging a range of unique commercial services that often offer increased capabilities compared to legacy TDRS services.



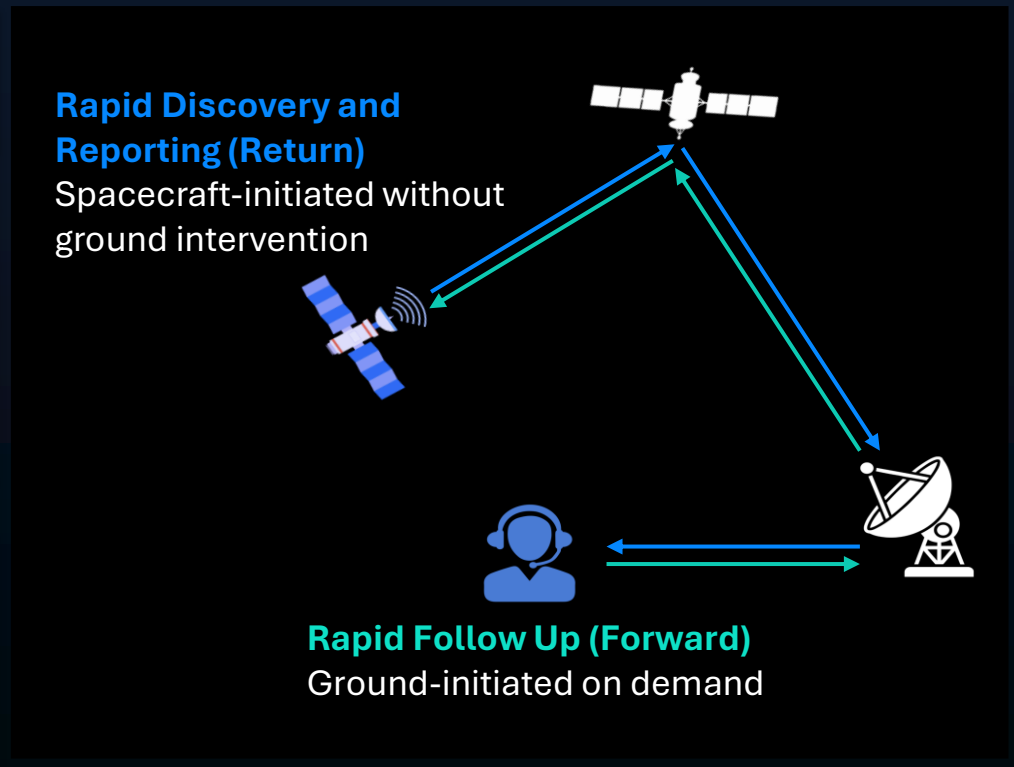
A portfolio of services will provide missions with the capabilities they require to conduct science, with some capabilities enabling new concepts of operations

MAX DATA RATES	KBPS TO GBPS-CLASS LINKS
DAILY THROUGHPUT CAPACITY	ALWAYS-ON OPTICAL, 50-1,000+ TB/DAY
MAX SIMULTANEOUS USERS	THOUSANDS OF CONCURRENT SPACE USERS
AVERAGE SCHEDULING TIME	AGILE API-BASED SCHEDULING (SECONDS TO HOURS)
LATENCY & RESILIENCE	INFRASTRUCTURE TO REDUCE LATENCY & IMPROVE RESILIENCY

CSP engaged with the Time-Domain and Multi-Messenger Astrophysics Communications Science Analysis Group (TDAMM Comm SAG) to capture future mission needs

Key service parameters include **low data volumes***, **low latencies**, and **high availability**.

Capability	Science Example	Alert Latency	Data Downlink Latency
Reporting - Return	Gamma-ray Burst Prompt Emission	Seconds	Minutes
	Soft Gamma-ray Repeater	Seconds	Hours
	Magnetar Giant Flares	Seconds	Hours
	Type 1 X-ray Burst	Seconds	Hours
	Supergiant Fast X-ray Transient	Seconds	Days
Follow up - Forward	Neutron Star Mergers	Seconds	Seconds
	Gamma-ray Burst Afterglow	Minutes	Minutes
	Nearby Core Collapse Supernovae	Minutes	Minutes
	Fast Optical Transients	Hours	Hours
	Kilonovae	Hours	Hours



Derived from Time-Domain And Multi Messenger Astrophysics Communications Science Analysis Group (TDAMM Com SAG) Report, Table 2

*Alerts only. The TDAMM Comm SAG Report highlights a need to process raw data on the ground, which requires larger data volumes.

Astrophysics transient science missions are prime examples of near-Earth space relay users requiring low-latency communications with near 100% availability, and commercial solutions can meet these needs

Action	Current Capability	Commercial Capabilities	
Fermi-GBM detected a signature and transmitted an alert to Earth within ~1.7 seconds	TDRSS Demand Access	Demand Access RF services	Always-on RF and optical
Target-of-opportunity task transmitted to SWIFT within minutes for follow-up observation and localization	TDRSS Multiple Access Forward	Ground-initiated API scheduling of RF service (allocation within seconds)	
Desire: Reduce/remove need for onboard filtering, which discards science data, to fit communication limitations	More frequent direct-to-Earth passes, TDRS Ku/Ka-band	Scheduled high-rate RF and optical relay	

Enabling new CONOPS: Always-on commercial services can provide “Wi-Fi” or “fiber internet” to future missions with sufficient SWaP-C. Low-rate, low-SWaP solutions also available for smaller missions.

Commercial systems, designed for terrestrial user base, are over-provisioned for space users; reducing/removing resource congestion and improving service resilience

Commercial capacity provisioned for **millions of users**

NASA missions
A marginal load on the system

A portfolio of commercial service would provide future missions with access to

10,000+
satellites on orbit
TDRS: a handful

100s
worldwide gateways
TDRS: a few

1,000s
RF spot beams
TDRS: a few steerable beams

1,000s
Optical links
TDRS: none

Within the SCaN Program, Mission Commitment, CSP and the NSN are working together to execute a seamless transition for the agency

SCaN vs. Mission Commitment vs. CSP vs. NSN

SCaN	Mission Commitment	CSP	NSN
Defining NASA & SCaN's future network operations.	**Connecting future missions with commercial services.**	**Partnering with the satellite communications industry.**	**Implementing SCaN's future network operations.**
Answering "big questions": TDRS flyout, network operations, and mission commitment.	SCaN's touchpoint with NASA missions. Matching mission needs with commercial providers.	Developing, demonstrating, validating, and transitioning commercial services into operations by 2031.	Jointly validating commercial services with CSP. Managing commercial services in operations.

Come meet the partners to learn more about their services at the

Commercial Services User Group Meeting (CSUG)

November 18-19, 2026

NASA's Glenn Research Center

Contact Kevin Burns, CSP Deputy Project Manager, to learn more:

kevin.j.burns@nasa.gov

For questions and further discussions, contact Aaron Smith, CSP Deputy Lead Engineer, at

aaron.smith@nasa.gov