

# Time Domain and Multi-Messenger Communications Science Analysis Group

AKA: TDAMMCommSAG

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# TDAMMCommSAG

## Motivation for study

- NASA's communications solutions are evolving with the transition to commercial services
- TDAMM Missions have some of the strictest requirements (latency, capacity, flexibility)
- Use experience from current TDAMM missions and those in development to establish what works and what doesn't
- Influence agency-wide decision making efforts to make sure the needs of future TDAMM missions are met
- Specifically timely given the upcoming demise of TDRSS and the current NASA Glenn Study into commercial replacements.

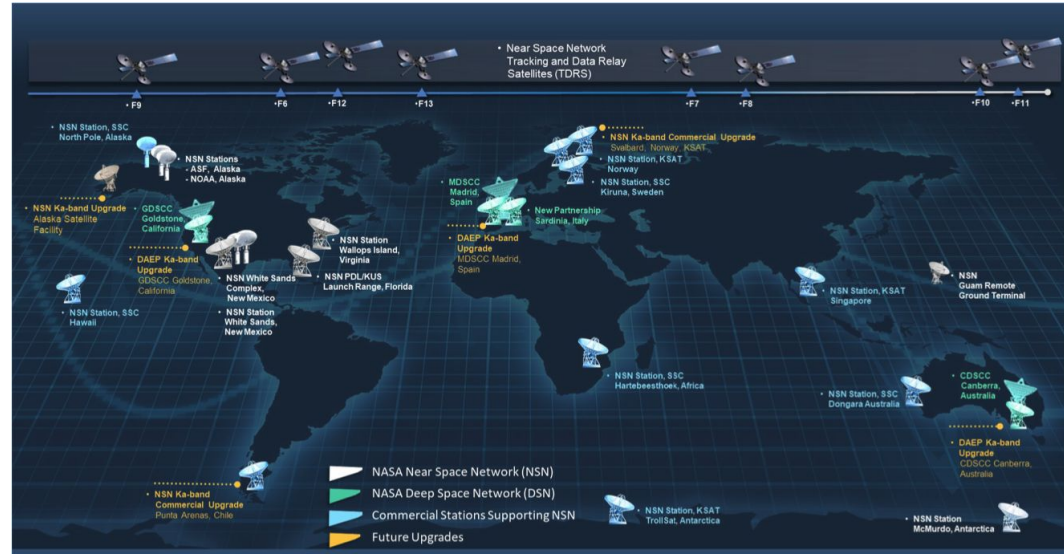
# TDAMMCommSAG

## SAG Process

- Terms of Reference for TDAMMCommSAG recommended by APAC in March 2023, ratified in June 2023 by HQ
- Started monthly meetings July 2023
- Membership:
  - ~35 regular members of SAG
  - Invited participation from active and in-development TDAMM missions
  - Members of Commercial Services Program (Glenn Study) participating, along with representatives from DSN and NSN
  - Membership open to anyone interested in the community
- Final report will be submitted to NASA with a list of findings in ~April 2024.

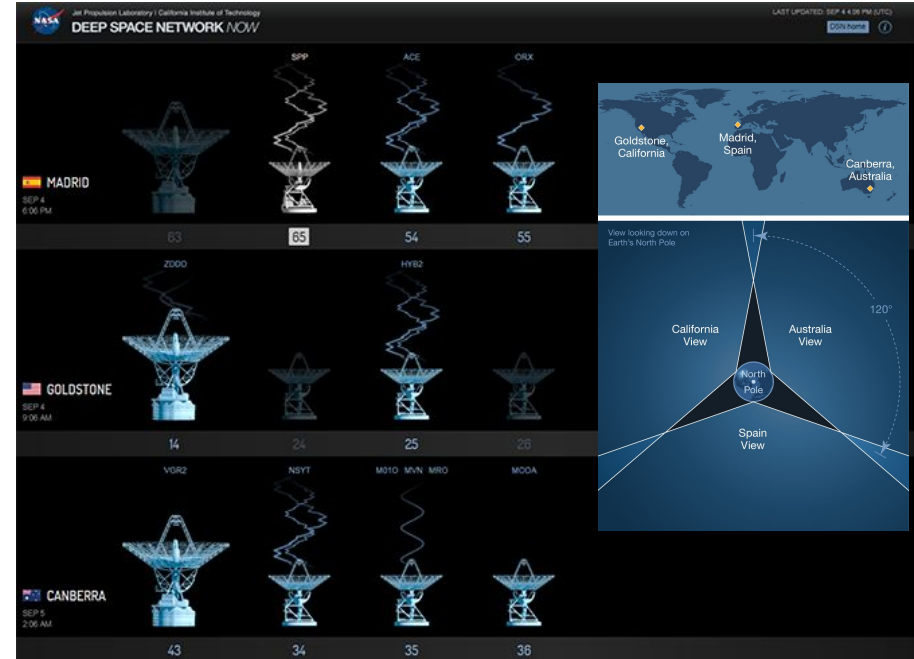
# Current Comms Capabilities: Near Space Network

- Direct to Earth (DTE)
  - NASA + commercial stations under contract
  - Return: S-band (2.2 Mbps), X-band SRS (13.1 Mbps), X-band (220 Mbps), K-band (3.5 Gbps)
- Space Relay (SR) - Tracking Data Relay Satellite System (TDRSS)
  - Single Access (SA) - Hubble, Fermi, ISS download bulk data
  - Multi Access (MA) - Swift/Fermi telemetry (return) & commanding (forward)
  - Demand Access Service (DAS) - Alerts on demand (Swift, Fermi, BurstCube)
  - S-band (MA:1 Mbps, SA:14.1 Mbps), Ku-band (600 Mbps), Ka-band (600/1200 Mbps)



# Current Comms Capabilities: Deep Space Network (DSN)

- 3 complexes located ~120 degrees apart (Canberra, Australia; Madrid, Spain; Goldstone, California)
  - Supports [NASA and non-NASA missions](#) (e.g. Chandra, Webb, Voyager)
  - S-band, X-band, Ka-band
- More details at <https://deepspace.jpl.nasa.gov/about/commitments-office/mission-documents/>



# Current Comms Capabilities: Commercial Examples

- Space to Ground
  - KSAT lite (22+ stations) - UHF, S-band, X-band, Ka-band (not at all stations)
  - AWS (global) - S-band, X-band
- Space to Space
  - Globalstar
  - Iridium
  - Inmarsat / AddValue Inter-satellite Data Relay System (IDRS)
  - Many more in development



[https://gsaw.org/wp-content/uploads/2019/03/2019s11a\\_monson.pdf](https://gsaw.org/wp-content/uploads/2019/03/2019s11a_monson.pdf)

# TDRSS Future

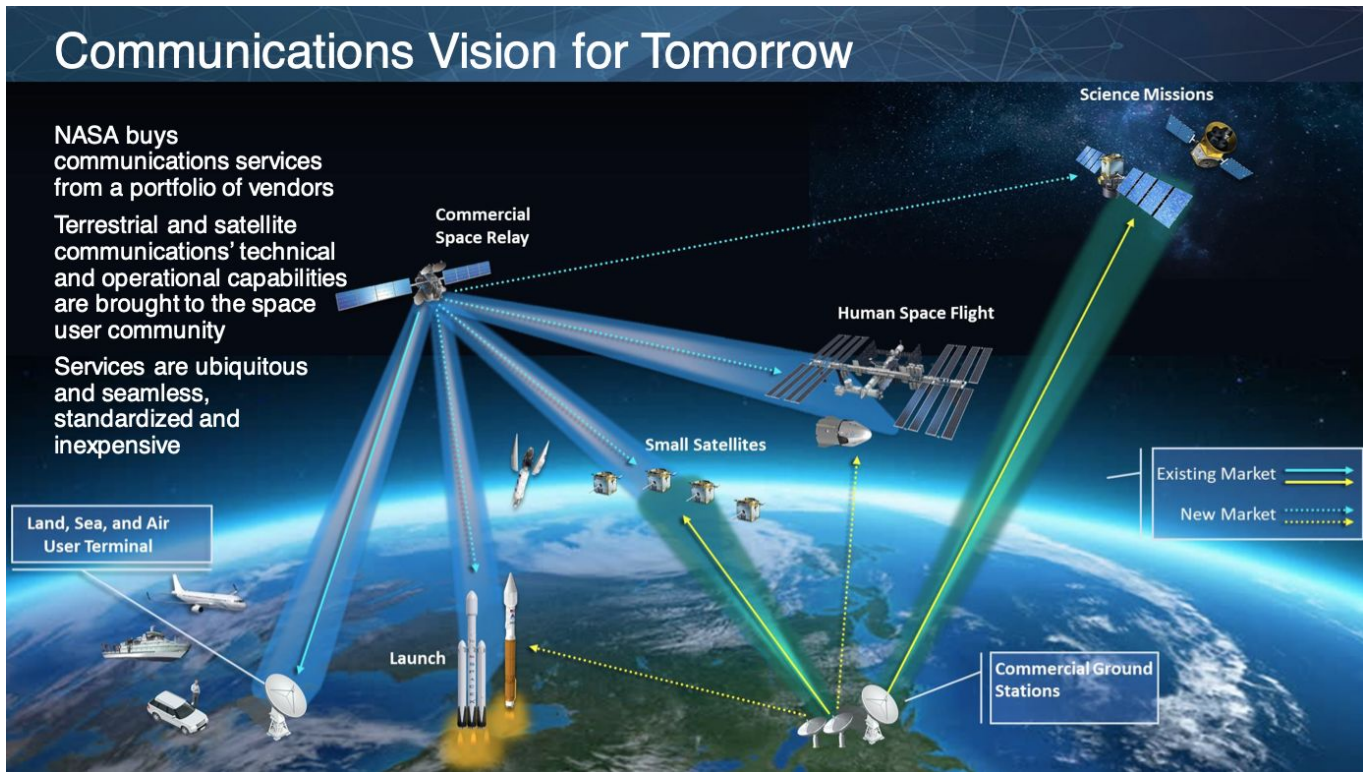
- Last TDRS launch in 2017 (TDRS-M), NASA passed on the option to fly another (TDRS-N: <https://spacenews.com/tdrs-launch-marks-end-of-an-era/>)
- NASA no longer plans to replenish the TDRS fleet
- Plan to continue to operate for existing missions into the 2030's
  - Degradation may lead to gaps in coverage, additional demand for services
  - No new missions are being allowed to use TDRS, except short missions already in development (BurstCube, StarBurst, COSI)
  - “Astrophysics Probe investigations shall meet all science requirements without the use of TDRS.” ([https://explorers.larc.nasa.gov/2023APPROBE/pdf\\_files/2023%20Astro%20Probe%20QandA%20Rev14.pdf](https://explorers.larc.nasa.gov/2023APPROBE/pdf_files/2023%20Astro%20Probe%20QandA%20Rev14.pdf))
- Ground station at Guam damaged due to recent [Typhoon Mawar](#)
  - Has lead to gaps in TDRS coverage which will remain until repairs completed
- Plan to replace capabilities with commercial providers
  - <https://www.nasa.gov/press-release/nasa-industry-to-collaborate-on-space-communications-by-2025>



# NASA's Commercial Communications Future

Following NASA cargo and crew commercialization programs, future communications is going commercial

CSP is looking for potential early adopter missions launching in 2028+





# NASA has 6 Space Act Agreements with Vendors to Develop New Space Communications Solutions

“Each company has proposed a technical approach to lower costs, increase flexibility, and improve performance for a broad range of missions. The agreements create opportunities to develop innovative solutions that could potentially meet NASA’s future mission requirements while supporting each company’s business model, future customers, and a growing domestic commercial SATCOM market.”

<https://www.nasa.gov/press-release/nasa-industry-to-collaborate-on-space-communications-by-2025>

  
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SOLUTIONS

**SPACEX**  
**TELESAT**

**Viasat**<sup>^</sup>  


# TDAMMCommSAG

## Website

- Details of TDAMMCommSAG on PhysCOS website:
  - <https://pcos.gsfc.nasa.gov/sags/tdammcomm-sag.php>
  - Terms of Reference
  - Recordings of prior meetings

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Exploring fundamental questions regarding the physical forces of the universe

TDAMMComm SAG Home SAG Events SAG Leadership

### Time-Domain And Multi-Messenger Astrophysics Communications Science Analysis Group (TDAMMComm SAG)

#### Introduction

Space-based astrophysics requires that missions be able to downlink data to the ground. In the burgeoning field of time domain and multi-messenger astrophysics (TDAMM), the science drives the frequency of this communication both for downlinking data and uplinking commands. In the last few decades, NASA has provided a wide array of options for communications, including Near Space Network (NSN), which is composed of Direct-to-Earth (DTE) ground stations for communicating with missions in near-Earth orbits; the Space Relay (SR), which operates a fleet of geostationary satellites known as the Tracking and Data Relay Satellite System (TDRSS); and finally the Deep Space Network (DSN) for communicating with missions at larger distances (e.g., Planetary Distances, Lagrange points).

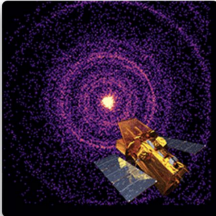


Image: 1-in-10,000-Year Gamma-ray Burst. Images captured over 12 days by the X-ray Telescope aboard NASA's Neil Gehrels Swift Observatory combined. Credit: NASA/Swift/A. Beardmore (University of Leicester)

The current fleet of rapidly-communicating TDAMM missions (e.g., Fermi, Swift, NICER) have utilized TDRSS assets to perform low-latency alerts and commanding that have enabled transformational TDAMM science. However, in the future it has been communicated that TDRSS will be decommissioned and replaced by a commercial service by 2030, with some period of overlap. The goal of this SAG is to, based on the science drivers, define requirements for comms systems to enable rapid commanding and downlinking of data for future NASA TDAMM missions.

The SAG will consider various questions relating to how future communications solutions can be developed to better support TDAMM missions. These questions include looking at the science drivers that will define future comms needs; the needs for missions in a variety of orbits; looking into bandwidth and latency requirements for future TDAMM missions; the issue of cost of comms for TDAMM missions; the need for high availability and flexible scheduling of comms; and how the future of communications can be better advertised to proposers.

#### Related Documents

- APAC approval letter [PDF]
- Terms of Reference (TOR) [PDF]

#### How to Join the TDAMMComm SAG

The TDAMMComm SAG welcomes input from community stakeholders, including those involved in mission concepts currently in development.

If you are interested in joining the TDAMMComm SAG, please fill out [this form](#) by **June 19th, 2023**.

9 November 2023  
PhysPAG Executive Committee  
— Nominations due 16 November 2023  
» Details

Submit Questions for Astrophysics Division Director at AAS Joint-PAG Session  
» Details

Soliciting Community Input on Precursor Science Gaps; Due 27 November 2023  
» Details

F.5 FINESST: SMD's Graduate Student Research Proposals due 6 February 2024  
» Details

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## What we are discussing?

- Science Drivers (July meeting)
  - Discuss how science cases (from TDAMM white paper) are driving requirements for Comms.
- Impacts of not meeting requirements (August meeting)
  - If requirements are not met, what science is lost?
- Non-LEO orbits (September Meeting)
  - Discussing topics specifically relating to spacecraft in distance orbits, e.g. cislunar, Earth/Sun Lagrange points.
- Bandwidth, Latency and Coverage (October Meeting)
  - Issues relating to available bandwidth, latency and geographic coverage of ground stations.

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## What we are discussing? (continued)

- Availability and Scheduling (November Meeting)
  - Availability of comms resources, and complexities of scheduling as related to TDAMM missions.
- Cost (December Meeting)
  - Cost drivers for TDAMM science
- AOs and Transition Planning (January)
  - How to handle better transition between comms systems in future, and in AOs.  
**Example of how not to do this: TDRS**

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## SAG Report Schedule

- Meetings on TOR topics to finish in January
- Plan:
  - February meeting to plan and start assigning topics to members for writing up of final report
  - March meeting: Continue with report
  - Submit final report to NASA end of April 2024
  - Present to APAC ~June 2024