

National Aeronautics and Space Administration



TDRS(S) Use of Space Weather Data



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(proxy for SN)

code 595

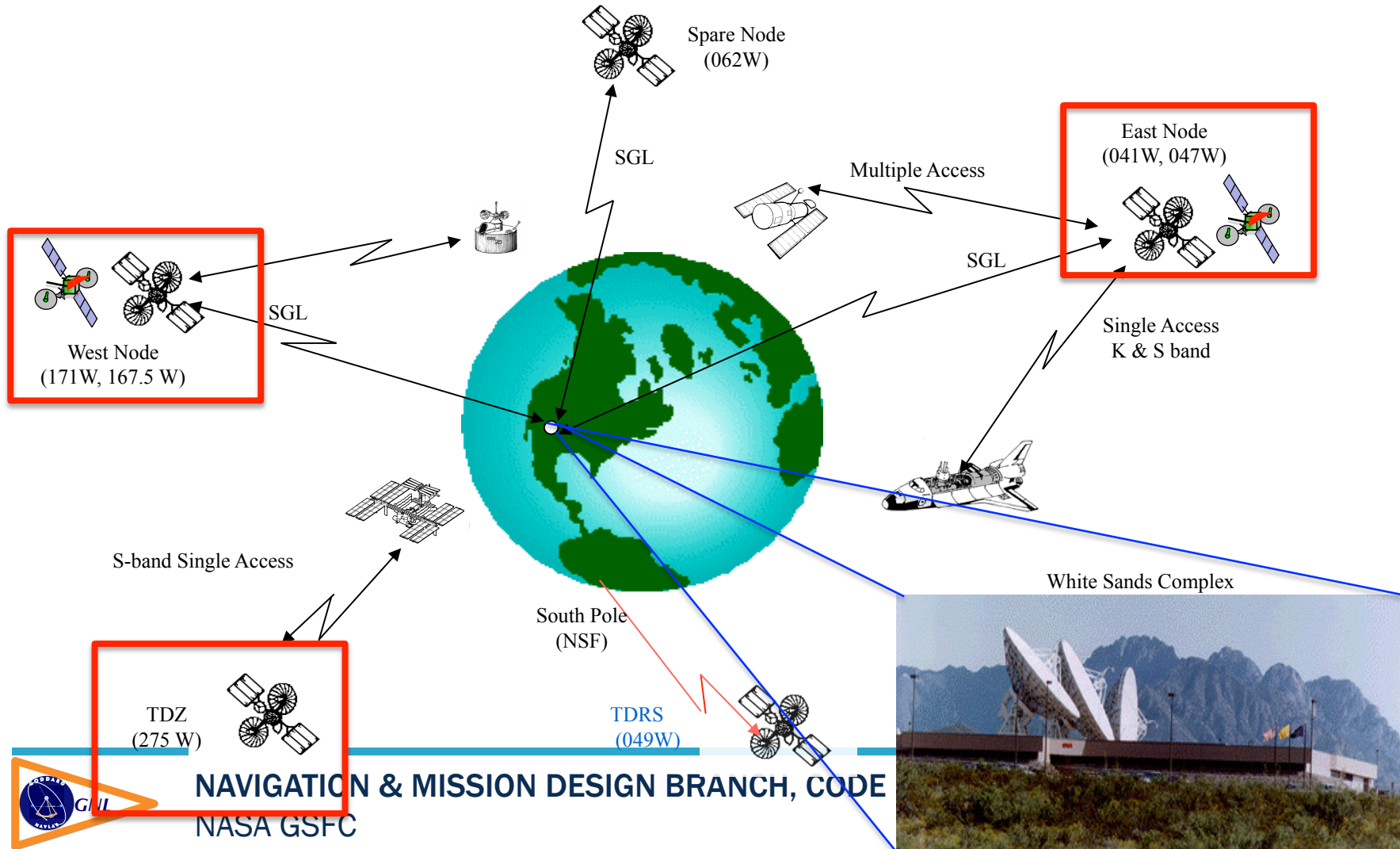
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Space Network - Tracking and Data Relay Satellite System (TDRSS) Overview



Space Network's Use of Space Weather Data

- SN receives alerts and weekly summaries from the NASA GSFC Space Weather Research Center (SWRC)
- Space weather not a big factor in managing the TDRS fleet
- No special activities performed on the TDRS satellites for anticipated space weather events
- SN uses Space Weather data after-the-fact when investigating communications or spacecraft anomalies, if deemed appropriate
 - E.g. unusual number of hits on the space-to-space user communications links
 - SEU-type anomaly investigation
- SN has no plans to do anything different in the future



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TDRSS Augmentation Service for Satellites (TASS)



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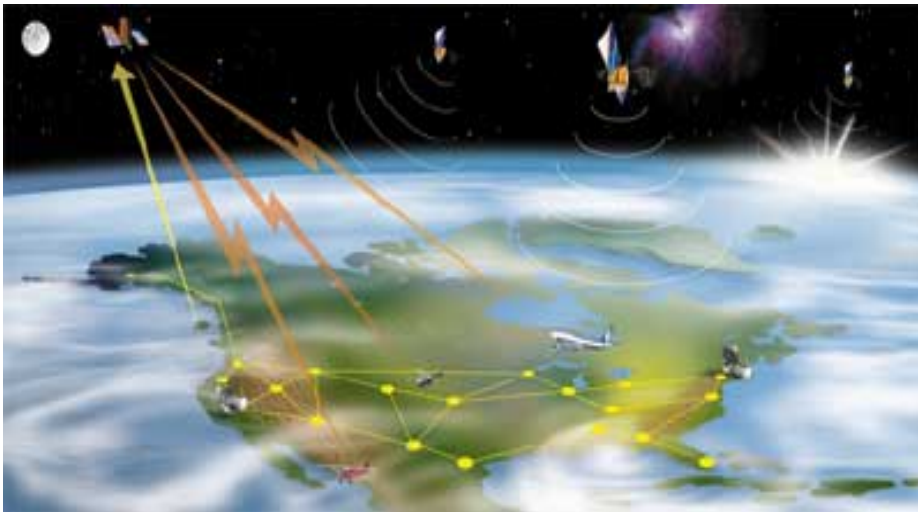


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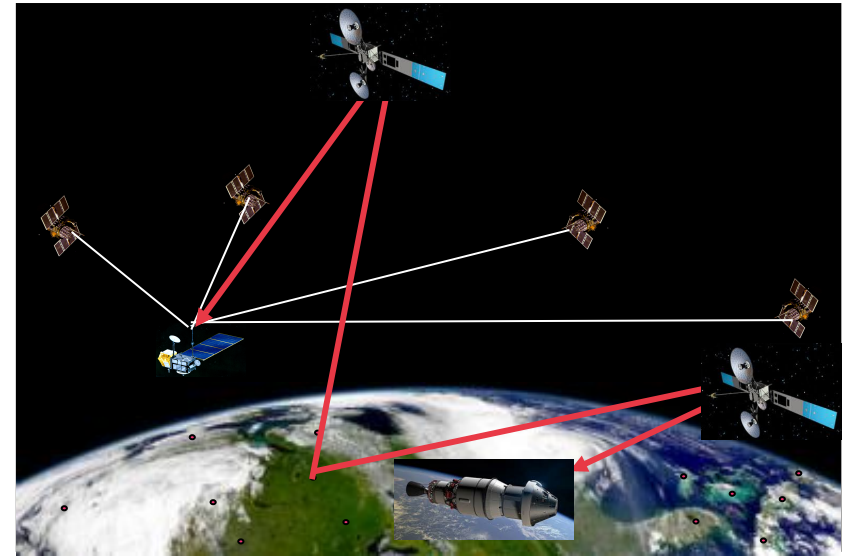


TASS: TDRSS Augmentation Service for Satellites

The Wide Area Augmentation System (WAAS), is a satellite-based augmentation system operated by the U.S. Federal Aviation Administration (FAA). WAAS provides information to augment the positioning accuracy and integrity necessary to enable GPS to be used for aircraft approach operations across the national airspace (North America).



WAAS



TDRSS Broadcast Beacon

A TDRSS broadcast beacon would provide unique signals and data commonly required to meet the needs of NASA users, globally.

TASS makes use of the Multiple Access (MA) system, using the second MA forward signal on second and third generation TDRS to broadcast across earth plus 1000 km altitude.



TASS (Multiple Access Broadcast Beacon) - Architecture Details

TASS Signal Consists of:

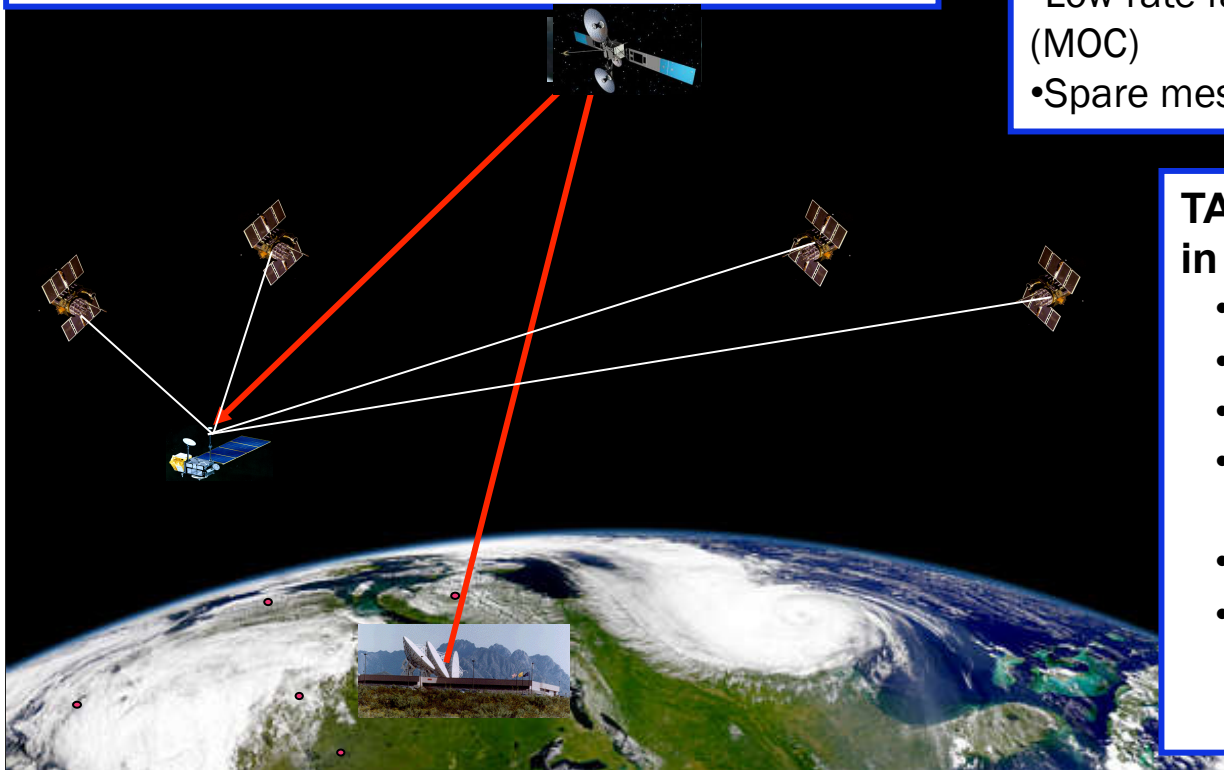
- Low-rate data message (1 kbps)
- PN ranging code synchronized with GPS time
- A wide “earth coverage” beam transmitted from three TDRS locations to provide global coverage to <1000 km altitude

TASS Message Includes:

- TDRS ephemeris and health/status information (FDF, WSC)
- 0.5 Hz GPS corrections (GDGPS)
- 5 sec GPS integrity alarms (GDGPS)
- Data authentication (GDGPS)
- Earth orientation (GDGPS)
- Space environment/weather data (GDGPS/NASA GSFC CCMC)
- Low-rate fast-forward user commands (MOC)
- Spare message bits for future content

TASS provides direct benefits in the following areas:

- Science/payload missions
- Human Space Flight missions
- SCaN/Network operations
- GPS and TDRSS onboard navigation users
- TDRSS performance
- New capabilities consistent with the modern GNSS architecture



Summary of TASS Beacon Benefits to Human and Robotic Missions

- GPS differential corrections, TDRSS radiometric tracking data, and standardized time correlation enable precision navigation and timing for a variety of applications including Earth Science Registration, Formation Flying, Atmospheric Sensing
- Enables routine and robust onboard navigation applications (improved autonomy and operational efficiencies)
- Enables significant improvements in the accuracy and automation of TDRS orbit determination and dissemination of TDRS ephemeris to users
- Provides GPS and TDRSS integrity monitoring information
- Distribution of space environment data alerts enables autonomous safing of robotics and quick knowledge for astronaut safety measures
- Enables or enhances science mission applications and operations through space environment data dissemination (e.g. autonomously trigger science observations) and transmission of low-rate user-specific commands (e.g. coordinated science target of opportunities)
- Provides for flexible operations and reduced demand for scheduled forward link services
- Reduces user operations costs
- TASS also a path-finder opportunity for navigation beacon architecture for lunar and Mars in-situ communications systems.



Summary of TASS Beacon Benefits to SCan and Network Operations

- Improved automation and accuracy of TDRS orbit determination
- Tracking the TASS signal on the ground in the GDGPS network provides a back-up to the current BRTS (e.g. in case of damage from natural events), possible consideration to replace BRTS
- Improved OD accuracy translates to reduced pointing errors and reduced data jitter
 - *Enabler for optical communication link*
- Transparent, automated dissemination of TDRS orbit knowledge and maneuver alerts to users
- Reduced demand for scheduled forward data services by providing commonly used/ updated parameters via broadcast beacon and low-rate commands
- Knowledge available to safe TDRS fleet from space environment events
- Near real time availability of Space Weather to the TDRS fleet operations at WSC, allows monitoring and safing action, if necessary

Overall, TASS offers GPS and TDRSS users services to improve autonomous operations for safety, navigation, and science while reducing the burden on the Network



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TASS: Current Status and Future

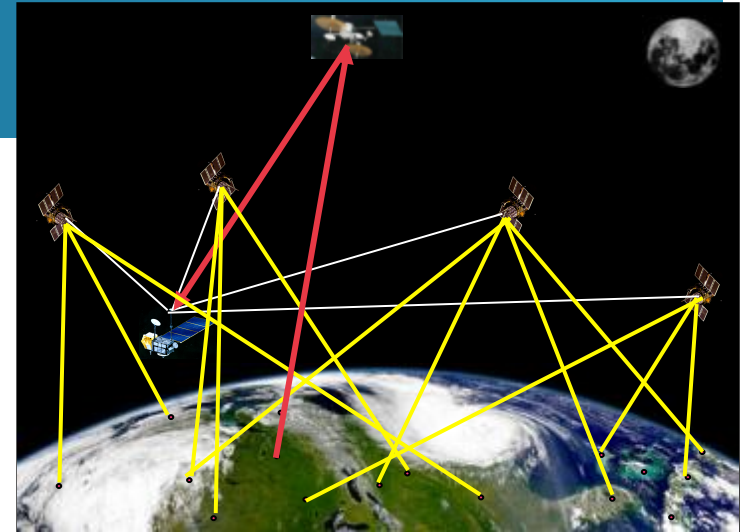
- An early format of TASS was demonstrated on TDRS-1 with 1 yr broadcast time
- TASS Use/Benefits study performed FY2009, identified implementation options and path forward
- GSFC's Communications and Standards Technology Lab (CSTL) developed an updated TASS signal and message structure to provide broader capabilities
- ICD established with GSFC Space Weather Research Center to identify data content within TASS stream
- In-orbit demonstration pursuits via scheduled directed service of updated TASS signal (prior to broadcast capability):
 - Receive and process by SCan Test Bed
 - Investigating potential to receive and process on ISS



Demonstration Expectation

Approach:

- Develop and demonstrate ground interfaces and operation to *generate the TASS message*
- *Develop data modulation* for uplinking the TASS signal to TDRSS then to directed user
- *Develop TASS receive capability* to assess and tune system performance



	State of the Art (unaugmented GPS)	GDGPS/TASS
Real-time orbit determination	1-5 meters	0.1 - 0.3 m
Real-time time-transfer	~10 nsec	<1 nsec
Integrity (GPS malfunction flags)	Not available	Included
Receive User command	Not available	Included
Demod & identify SpWx data	Not available	Included

