



Space-Based Range Safety Technical Interchange Meeting (TIM)



Space Network Overview



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Agenda

- Space Network (SN) Space & Ground Segment
- TDRS Constellation
- TDRSS Data Flow
- TDRSS Interfaces
- SN Evolution
- SN User List and Loading
- TDRSS Support for Expendable Launch Vehicles
- Current TDRSS Reimbursement Rates
- On-Line Resources





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Space and Ground Segment

- **The Space Network is Comprised of a Space Segment and a Ground Segment:**
 - **The Space Segment** consists of 6 TDRS's positioned in geosynchronous orbit. Five are activated and operational, one is denoted as stored Spare.
 - Each TDRS provides:
 - » Two S-Band Single Access (SSA) Forward (SSAF) and Return (SSAR) services
 - » Two Ku-Band Single Access (KSA) Forward (KSAF), and Return (KSAR) services
 - » One Multiple Access (MA) Forward (MAF)
 - » Five MA Return (MAR) services
 - » One-way Doppler and two-way Doppler & range
 - » Tracking modes
 - Of importance to the Range Community are the S-Band services and on-board redundant components. All components are redundant with the exception of the TDRS antenna systems.



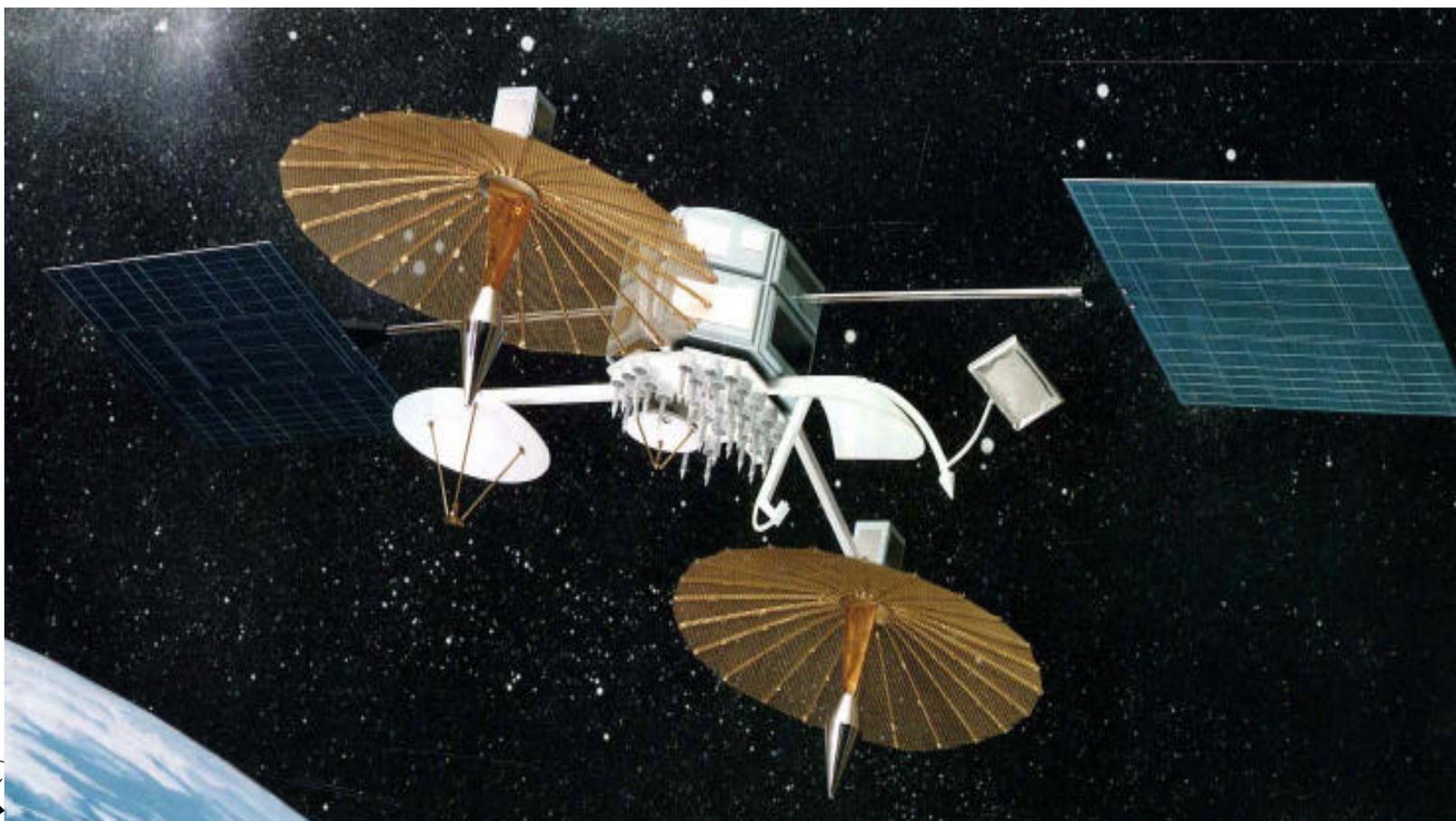


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Space and Ground Segment (cont'd)

Tracking and Data Relay Satellite (TDRS)



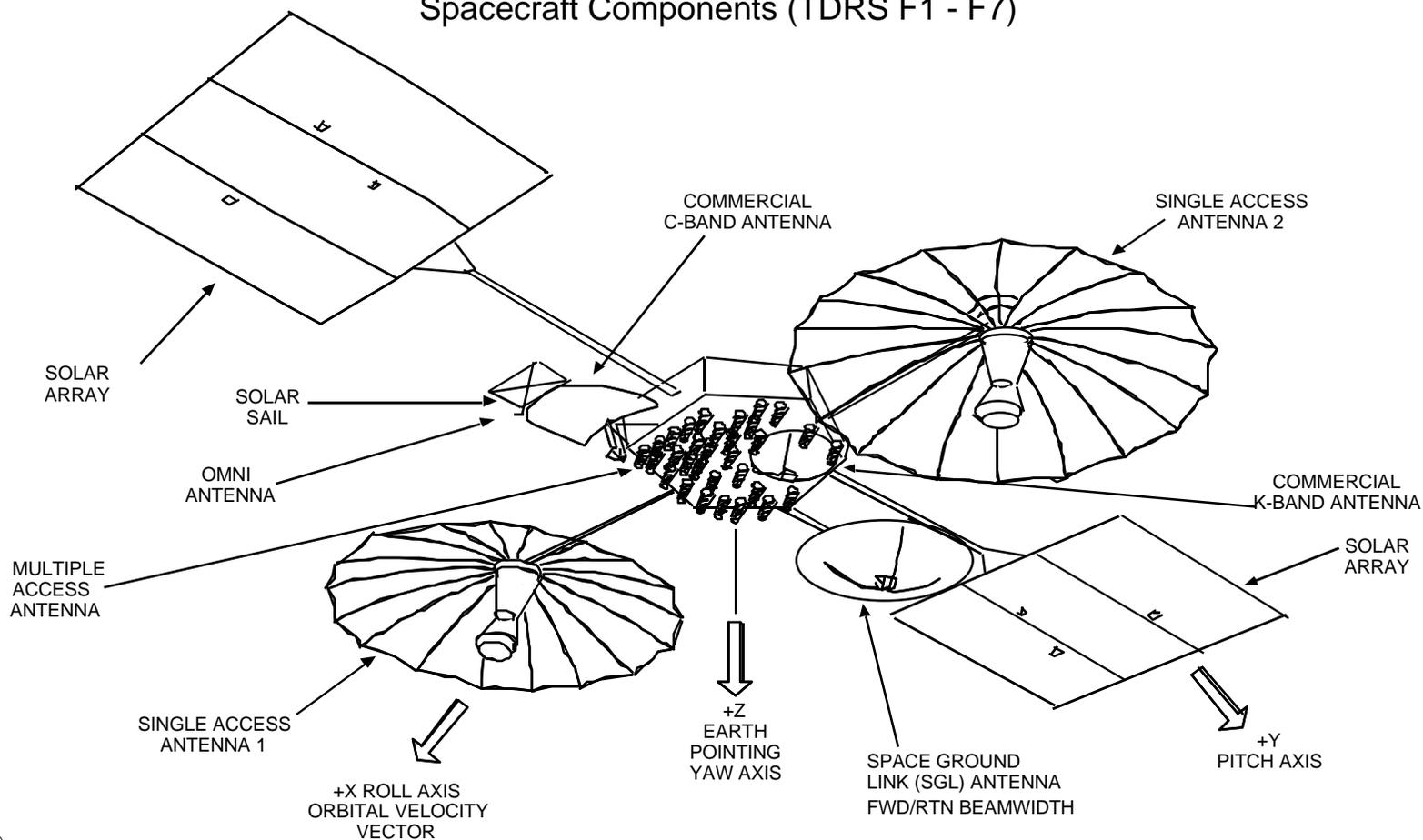


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Space and Ground Segment (cont'd)

Spacecraft Components (TDRS F1 - F7)





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Space and Ground Segment (cont'd)

- **The Ground Segment** includes White Sands Ground Terminal (WSGT), and Second TDRSS Ground Terminal (STGT), commonly referred to as the White Sands Complex (WSC), located near Las Cruces, New Mexico
 - The Two Ground Terminals are interconnected by the Inter-Facility Link (IFL).
 - WSGT has two (2) Space-to-Ground Link Terminals (SGLT's), and STGT has three (3) SGLT's. Each SGLT supports one TDRS, and the accompanying services. The Guam Remote Ground Terminal (GRGT) also consists of one (1) SGLT and operates as an extension of WSGT.
 - Ground Segment Support Elements Include:
 - » The NCC is located at GSFC. The NCC is the operations control facility for the SN and provides the operational management of the network. From a user's point of view the NCC is the one interface point for all services provided by the SN.
 - » The FDF is located at GSFC. The FDF generates state vectors for pointing that are provided to TDRSS via the NCC.
 - » The NISN is a global system of communications transmission, switching and terminal facilities that provide NASA communications services. NISN services include circuits between White Sands and various user sites for direct transmission of real-time and stored data; and SN control and status communications between NCC and WSC.





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Space and Ground Segment (cont'd)

White Sands Ground Terminal (WSGT)





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Space and Ground Segment (cont'd)

Second TDRSS Ground Terminal (STGT)

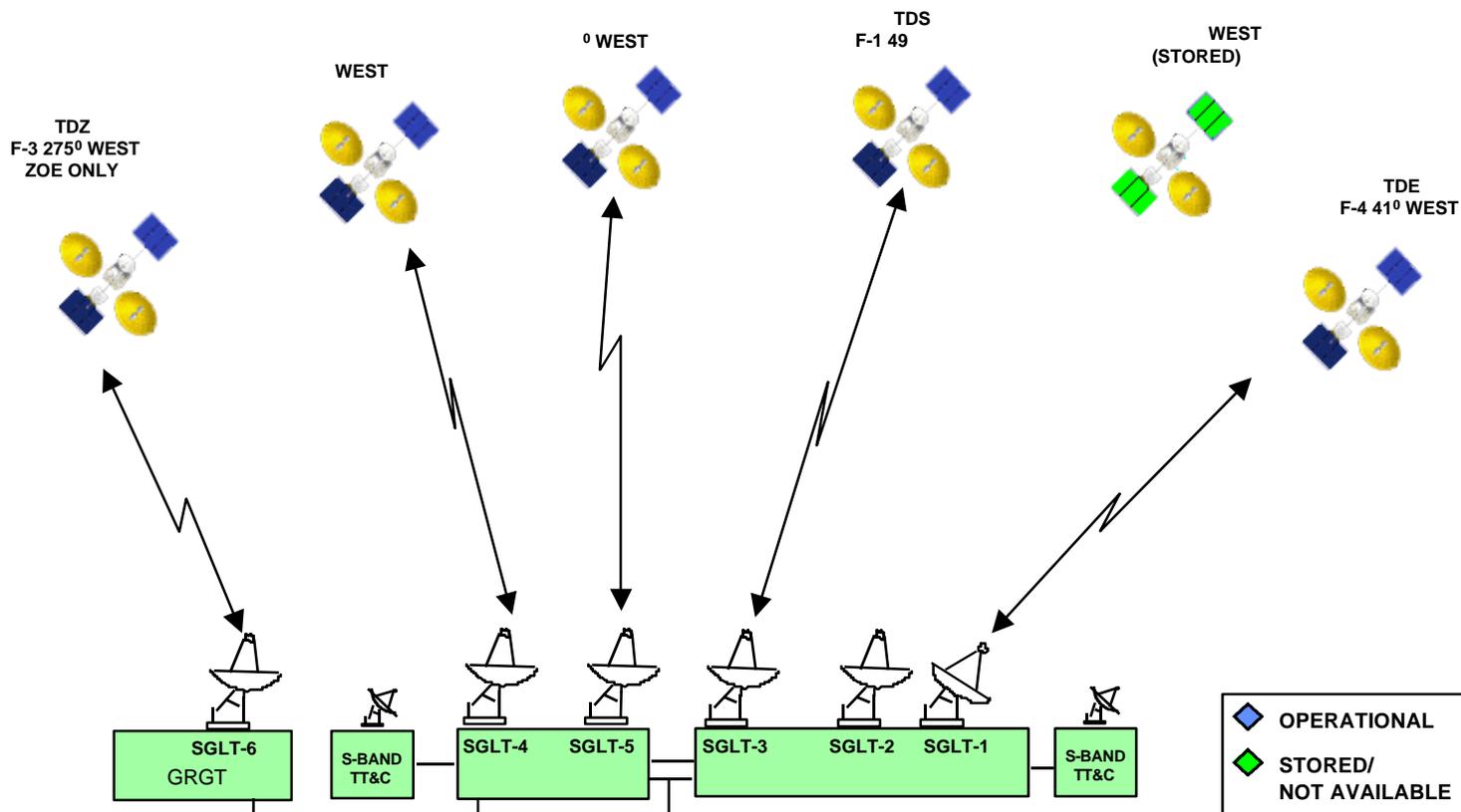




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Space and Ground Segment (cont'd)

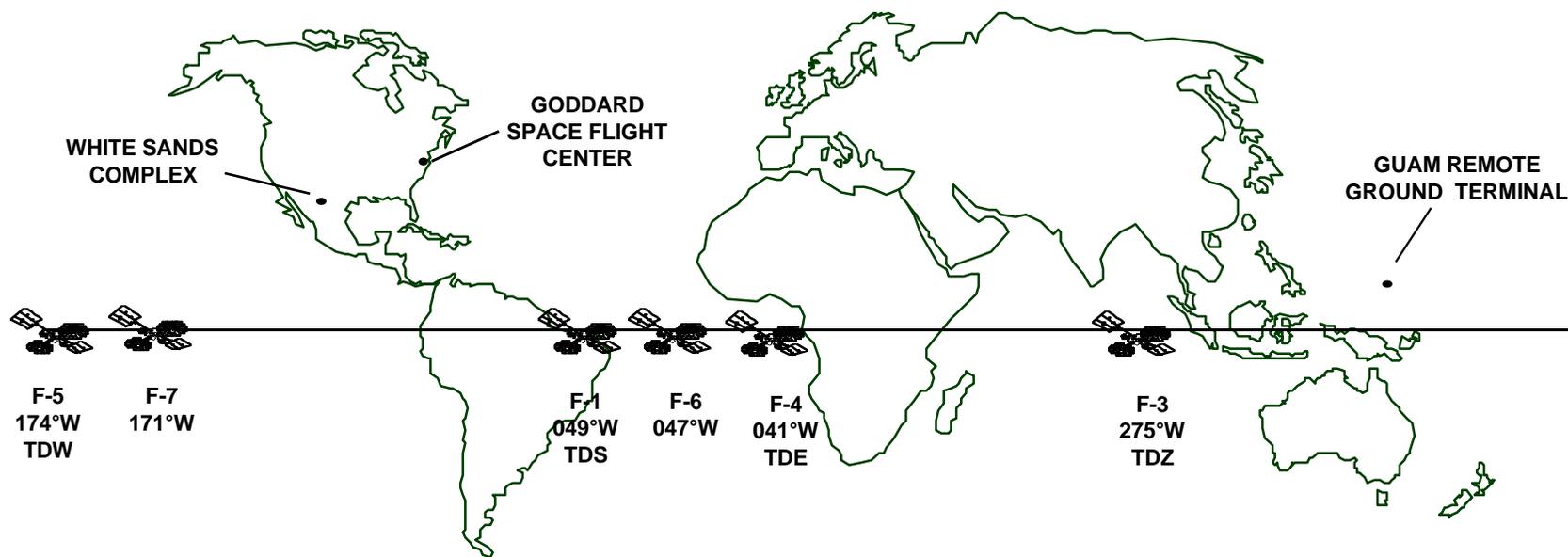




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TDRS Constellation





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TDRS Constellation (cont'd)

	Launched	Geosynchronous Orbit	In-Orbit Checkout	Utilization
TDRS-1	April 4, 1983 STS-6 (Challenger)	June 29, 1983	- December 28, 1983 - One Satellite System Acceptance April 1985	- Currently At 49° W - Designated TDS - Operational Support
TDRS-3	September 29, 1988 STS-26 (Discovery)	September 30, 1988	- January 15 1989 - Two Satellite System Acceptance July 1989	- Currently At 275° W - Designated As 275 - Operational Support ZOE Coverage
TDRS-4	March 13, 1989 STS-29 (Discovery)	March 14, 1989	June 9, 1989	- Currently At 41° W - Designated As TDE - Operational Support
TDRS-5	August 2, 1991 STS-43 (Atlantis)	August 3, 1991	October 7, 1989	- Currently At 174° W - Designated As TDW - Operational Support
TDRS-6	January 13, 1993 STS-54 (Endeavor)	January 14, 1993	March 4, 1993	- Currently At 4 ° W - Providing C-band Support
TDRS-7	July 13, 1995 STS-70 (Discovery)	July 14, 1995	August 22, 1995	- Currently At 171° - Designated As 171W - Operational Support

TDRS-2 Lost January 28, 1986 Aboard STS-51L (Challenger)

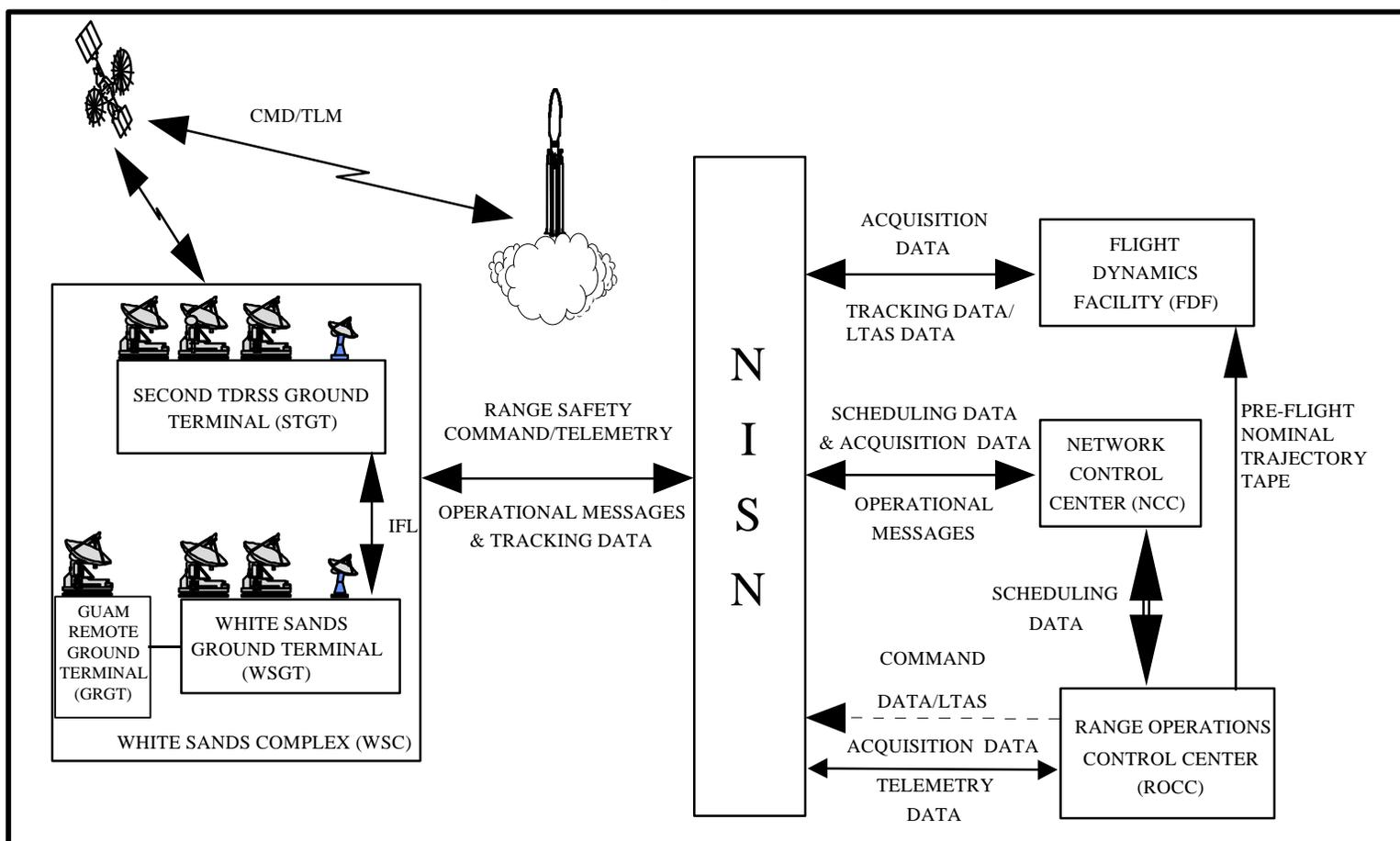




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TDRSS Data Flow Example for Range Safety Support

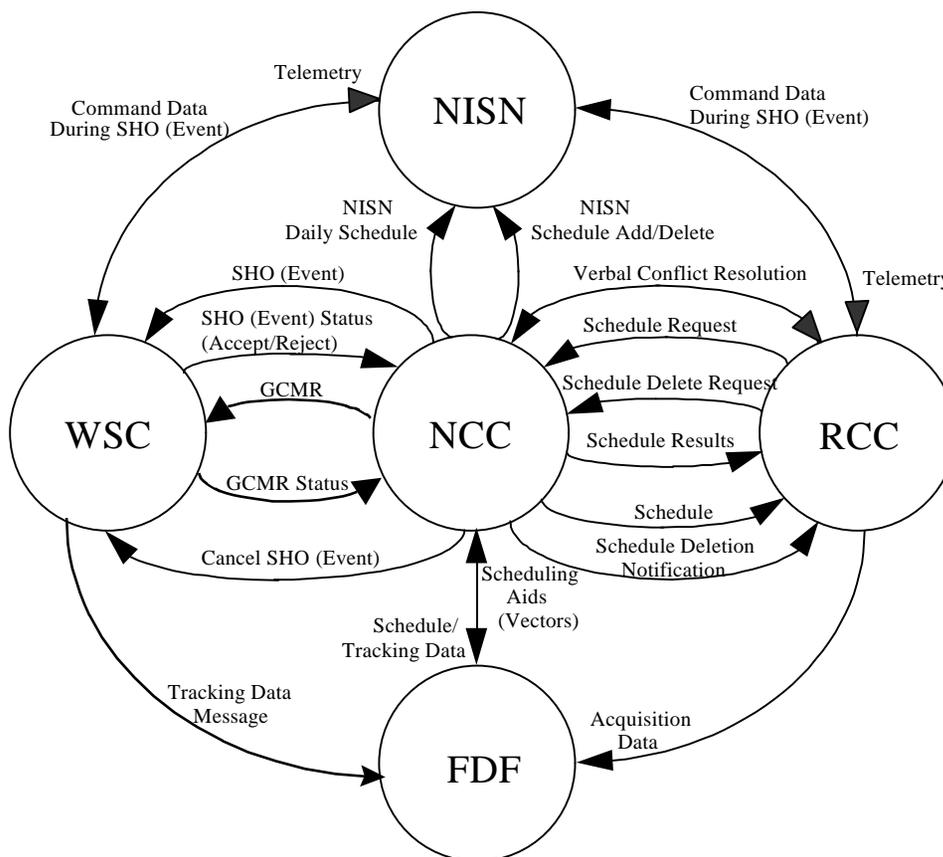




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TDRSS Interfaces





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Space Network Evolution

Guam Remote Ground Terminal

- **Guam Remote Ground Terminal (GRGT) is a fully functional, remotely operated ground terminal that closes the Zone of Exclusion (ZOE) over the Indian Ocean**
- **GRGT scheduling and data paths are such that it appears that customer support is coming from WSC**
- **GRGT declared operational July 1998**

GRGT Service Summary*

Forward	2 Mbps	25 Mbps (Uncoded)
Return	6 Mbps	300 Mbps (48 Mbps Shuttle Real-Time)

* Initial GRGT bandwidth available for customer services between Guam and WSC is 2 Mbps (Forward and Return)

* Time transfer and RDD are not presently from GRGT





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Space Network Evolution

NCC 98

- **Implementation of the new Service Planning Segment (SPS) of the Network Control Center Data System (NCCDS)**
 - SPS is the system used for planning and scheduling TDRSS services

- **NCC 98 functional improvements include:**
 - New NCC operator interface
 - Increased scheduling flexibility
 - Increased utilization of TDRSS interservice (unscheduled segments) time
 - Support for next generation TDRS Spacecraft (TDRS H, I, J)
 - Allows TCP/IP customer interface with backward compatibility for 4800-bit block customers
 - Support for Nascom IP transition

- **NCC 98 to be operational December 1998**





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Space Network Evolution

IP Transition

■ Objective

- Transition from the legacy 4800-bit block protocol to the established industry standard of IP
- Optimize costs associated with equipment, labor, and maintenance and thereby reduce the cost of communication network support
- Continue support to legacy customers by encapsulating 4800-bit blocks in an IP packet

■ Status

- Currently transitioning all NASA customers from Message Switching System (MSS) and Multiplexer/Demultiplexer (MDM) System to User Data Protocol (UDP)/IP data transport





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Space Network Evolution

TDRS H, I, J

- **Second Generation TDRS being designed and built by Hughes Spacecraft Corporation (HSC)**

- **Spacecraft provides:**
 - **Enhanced MA capability**
 - MA Beamforming onboard spacecraft
 - Return rates up to 3 Mbps
 - **Ka-band service**
 - Ka Forward 50 Mbps
 - Ka Return 300/800Mbps (Beyond 300 Mbps requires ground station modification)
 - **All currently available TDRSS services**

- **Launch Schedule**
 - TDRS H, July 1999
 - TDRS I, December 2001 *
 - TDRS J, July 2002*

* Launch moved to save Launch Vehicle Costs





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Space Network Evolution





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Space Network Evolution TDRSS/TDRS H, I, J Baseline Service Comparison

Service		TDRSS	TDRS H, I, J	Notes		
Single Access	S-band	FWD	300 kbps	No Change		
		RTN	6 Mbps			
	Ku-band	FWD	25 Mbps			
		RTN	300 Mbps			
	Ka-band	FWD	N/A		50 Mbps	23/25-27 GHz frequency band
		RTN	N/A		800 Mbps*	
Number of Links per Spacecraft		2 SSA 2 KuSA	2 SSA 2 KuSA 2 KaSA	For TDRS H, I, J simultaneous operation of S & Ku and S & Ka services via a single SA antenna are required		
Multiple Access	Number of Links per S/C	FWD	1 @ 10 kbps	Anticipated SSA users less than 3 Mbps offloaded to TDRS H, I, J MA		
		RTN	20 @ 150 kbps		6 @ 3 Mbps	
Customer Tracking		150 meters 3 sigma	150 meters 3 sigma	No Change		

* Beyond 300 Mbps requires Ground Station Modification



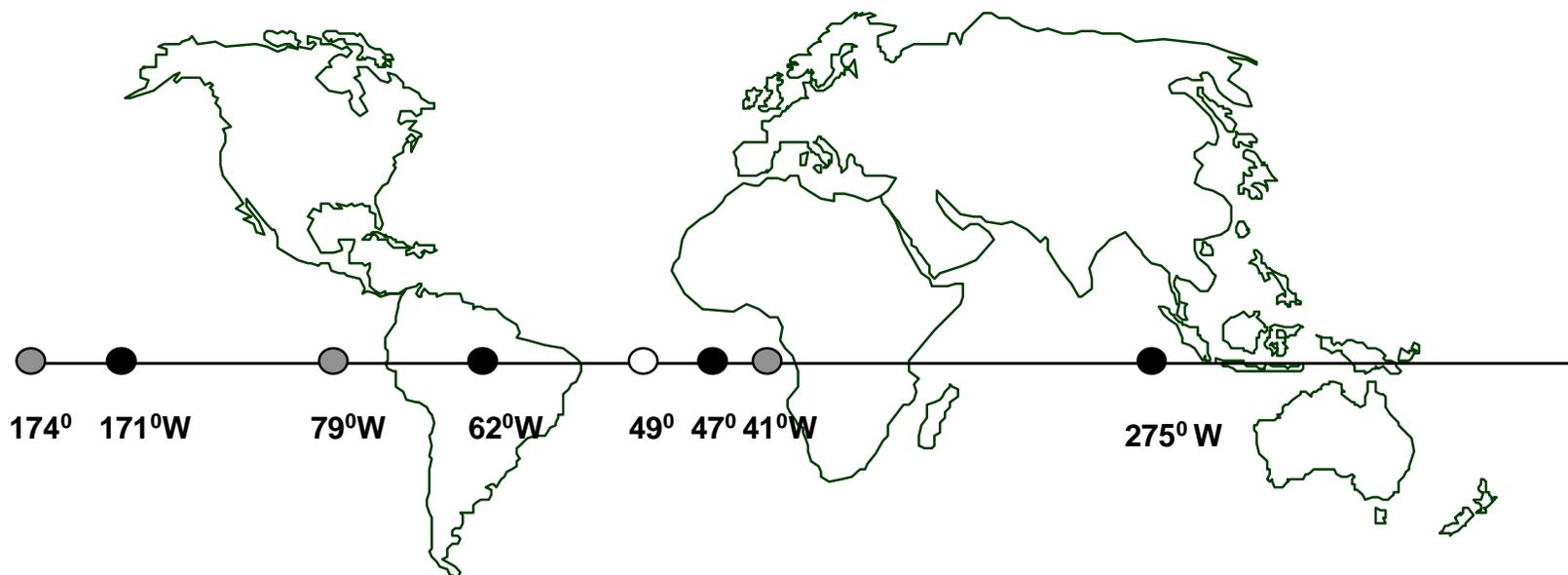


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Space Network Evolution

Constellation Including TDRS H, I, J (Year 2001 Timeframe)



- 1st Generation TDRS
- 2nd Generation TDRS
- Open Slot





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TDRSS Support for Expendable Launch Vehicles

- TDRSS provides Expendable Launch Vehicle (ELV) customers with telemetry support from liftoff through critical period(s) communications
- As of January 1998, TDRSS has successfully supported 20 ELV Launches
 - 9 Atlas/Centaur
 - 8 Titan/Centaur
 - 1 Titan/IUS
 - 1 Shuttle/IUS
 - 1 Delta (real-time relay via P-3 aircraft)
- Inexpensive and reliable alternative to telemetry relay via aircraft, ships, or temporary ground stations





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TDRSS Support for Expendable Launch Vehicles ELV Customer Support Configurations

Vehicle	Data Rate	Convolutional Encoding	Modulation	Transmitter	Antenna	Operational Link Margin
Titan/Centaur	128 kbps	Rate 1/2	BPSK	15.5 Watts	6 dB RCP	+7.2 dB
Atlas/Centaur	256 kbps	Rate 1/2	BPSK	30 Watts	4 dB RCP	+10.7 dB
Atlas/Centaur	I 256 kbps Q 200 kbps	Rate 1/2	QPSK	30 Watts	4 dB RCP	+ 7.5 dB
Sea Launch	I 256 kbps Q 256 kbps	Rate 1/2	QPSK	30 Watts	2 dB RCP	In Design



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Current TDRSS Reimbursement Rates

- There are substantial price discounts for preferred modes of operations
 - Customers that do not require specific time or position constraints (flexible schedules) in their schedules can save 50% for single access service and 33% for multiple access service

Service	U.S. Government Customers	Non-U.S. Government Customers
Single Access (Constrained)	\$128.00/minute	\$184.00/minute
Single Access (Flexible)	\$64.00/minute	\$92.00/minute
Multiple Access Return	\$9.00/minute	\$13.00/minute
Multiple Access Forward (Constrained)	\$27.00/minute	\$42.00/minute
Multiple Access Forward (Flexible)	\$18.00/minute	\$28.00/minute



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On-line Resources

■ TDRSS On-line Information Center

- A comprehensive on-line resource with current and detailed information on all aspects of TDRSS and the SN including the Space Network User's Guide
- <http://nmssp.gsfc.nasa.gov/tdrss/>

■ TDRSS User Base Expansion

- A compendium of information regarding the use of TDRSS services including customer interaction and future products
- <http://nmssp.gsfc.nasa.gov/TUBE/>

■ Technical Information Program

- A website that provides easy access to MO&DSD project and technical documentation
- <http://tip.gsfc.nasa.gov>

