ROLE OF TDRSS IN TRACKING AND DATA ACQUISITION

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ABSTRACT

In 1976, NASA committed to development and implementation of the TDRSS as a means of providing improved T&DA services to user satellites. This commitment completes a transition in T&DA operations planning initiated in early 1970’s to provide a more efficient network with a broad range of telecommunications capabilities. The integration and operation of the TDRSS within the NASA network is described. Current status and plans for system implementation will conclude the presentation.

INTRODUCTION

NASA’s near earth Tracking and Data Acquisition (T&DA) network has been undergoing change since the early 1970’s. This change has served to satisfy several important objectives. The first of these, consolidation, resulted in formation of the Spaceflight Tracking and Data Network (STDN) out of the Satellite Tracking and Data Acquisition Network (STADAN) and the Manned Space Flight Network (MSFN). The single integrated network that resulted consisted of fewer stations but with a more flexible capability to support the total community of earth orbital missions. The second objective, standardization, was driven by the need for more efficient network operations and the higher data rate, near real time control requirements of the developing flight missions.

Before this initial effort was complete, the need to continue the process was apparent. Forcasts of operating costs for the world-wide STDN indicated a steady rate of increase. In addition, as mission planning for the Shuttle era continued to mature, the range of data rates, the complexity of data transmission formats, and the sophistication of orbital operations expanded.

THE TDRSS CONCEPT

The Tracking Data Relay Satellite System (TDRSS) represents NASA’s next step in persuit of the consolidation and standardization objectives. The system concept employs spacecraft in geosynchronous orbit operating as communications front-ends and a single ground terminal to provide primary T&DA services for earth orbiting user satellites and the Shuttle. Figure 1 illustrates the basic system configration. The system is characterized further by the concept of real time thruput of user data and a high degree of automation.

Positioning two satellites 65 degrees east and west of White Sands, New Mexico provides continuous visibility to the ground terminal and provides a minimum of 85 percent coverage to earth orbiting users. Figures 2a and 2b illustrate the coverage capability. Current ground network coverage is a maximum of 15 percent.

CONTRACTING FOR SERVICES

A contract was awarded in December 1976 to Western Union Space Communications, Inc. (WU) for implementation of this concept. Two major subcontractors are supporting WU in this effort. TRW Inc. will build the spacecraft, act as systems engineer for the entire system, supply all systems control software, and integrate the overall system. Harris Corp. will provide most of the ground terminal RF subsystems and data detection equipment.

The TDRSS will not be delivered to NASA when complete. Under this contract NASA will lease services from WU. These services are provided by two basic system capabilities referred to as multiple access (MA) and single access (SA). A further breakdown is made into forward link, return link, tracking, and simulation/verification services.

Frequency allocations at S-band and K-band provide for additional discrimination of services. These classifications result in service designations such as S-band single access forward (SSAF) service and K-band single access return (KSAR) service. In total the following services are provided:

Forward Service	Return Service
3 MA	20 MA
6 SSA	6 SSA
6 KSA	6 KSA

Tracking Service	Simulation Service
9 Range	1 MA
19 Doppler	2 SSA
	2 KSA

INTEGRATION OF TDRSS

Procurement was initiated and detailed design for integration of TDRSS into the STDN began concurrent with the award of a contract to WU. Three new major network elements were involved. A new Network Control Center (NCC) was needed to manage the highly automated, real-time TDRSS service. New NASA Communications Network (NASCOM) equipment and services were required to accommodate the high volume of user data and operational traffic flowing in and out of the TDRSS ground terminal. And, new equipment was needed to accommodate the system interface at White Sands. The functional arrangement is shown in Figure 3.

The NASA equipment and facility at White Sands is colocated with WU's ground terminal and is designated the White Sands NASA Wing Facility (WSNWF). This element functions as the direct physical and electrical interface with the leased services system. It contains signal distribution components, signal monitoring and fault isolation components and NASCOM equipment. Automation capabilities are incorporated to allow for remote control by the NCC.

The NCC is comprised of operations processors, communications processors, and an array of operator consoles with interactive displays. Communications with user facilities and the TDRSS are through NASCOM which provides circuit and message switched channels. There are also data interfaces with the Operations Support Computing Facility (OSCF) for user orbit prediction data and with users for scheduling.

Interconnection of these elements by NASCOM will involve a new subsystem called a Multiplexer/Demultiplexer (MDM) and leased commercial communications via domestic satellite as shown in Figure 4. The MDM provides the mechanism to time share the leased channels. The initial service will provide 1.544 megabit channels. However, as data volume increases higher capacity channels can be accommodated.

NETWORK OPERATIONS

STDN operations and management of the TDRSS resource will be accomplished from the NCC located at Goddard Space Flight Center (GSFC). This center will provide the interface for user operational transactions and will maintain a data base of network and user information. Scheduling of operations will be highly automated.

Users will interact directly with the NCC scheduling data base and processors. An initial schedule will be generated by the NCC based on generic and/or specific requirements input by the user. The NCC will perform conflict analyses and resolve schedule conflicts among users. Real time reconfiguration of service links will be possible from user satellite operations control facilities through the NCC.

A typical service operation will entail NCC processor-to-TDRSS processor transmission of a schedule order and a compatible user ephemeris predict. The TDRSS processor will automatically configure the necessary equipment and initiate the ordered services at the specified time. The other network elements will respond in similar fashion. Acquisition of user signals will be performed automatically and data will be forwarded when received without processing or delay in accordance with the real-time thruput concept.

In addition to the scheudling function, STDN operations must perform the important management tasks of service accountability and fault isolation. The quality of services will be continually monitored through evaluation of qualitative service performance checks and review of outage reports. Fault isolation and service restoral will be performed by operations control personnel utilizing the status information available at the NCC from the network elements it supervises.

IMPLEMENTATION STATUS

At the current time, most system design for the STDN with TDRSS is complete. Construction of facilities is complete. All major hardware and software procurements have been placed and deliveries are underway. NASA is looking forward to a period of integration and compatibility testing of its newly acquired systems and services. Figure 5 puts the current activities in perspective. This integration and test activity will occur over an extended time interval. Simple message protocol checks between automatic control elements will start the process. The culmination will involve operational scenarios to fully exercise the STDN/TDRSS complex, its personnel and the telecommunications services. Service acceptance by NASA will occur when the system is operational with two TDR satellites on station.

SUMMARY

The TDRSS dominated STDN of the 1980’s represents a significant improvement in Tracking and Data Acquisition (T&DA) support to earth orbiting spaceflight projects. Increased operational flexibility is afforded through near continuous communications coverage. Telecommunications characteristics are provided to meet the varied transmission modes and data rates of the known and anticiapted user community. As a result, NASA’s goal of providing a standardized cost effective services will be achieved.

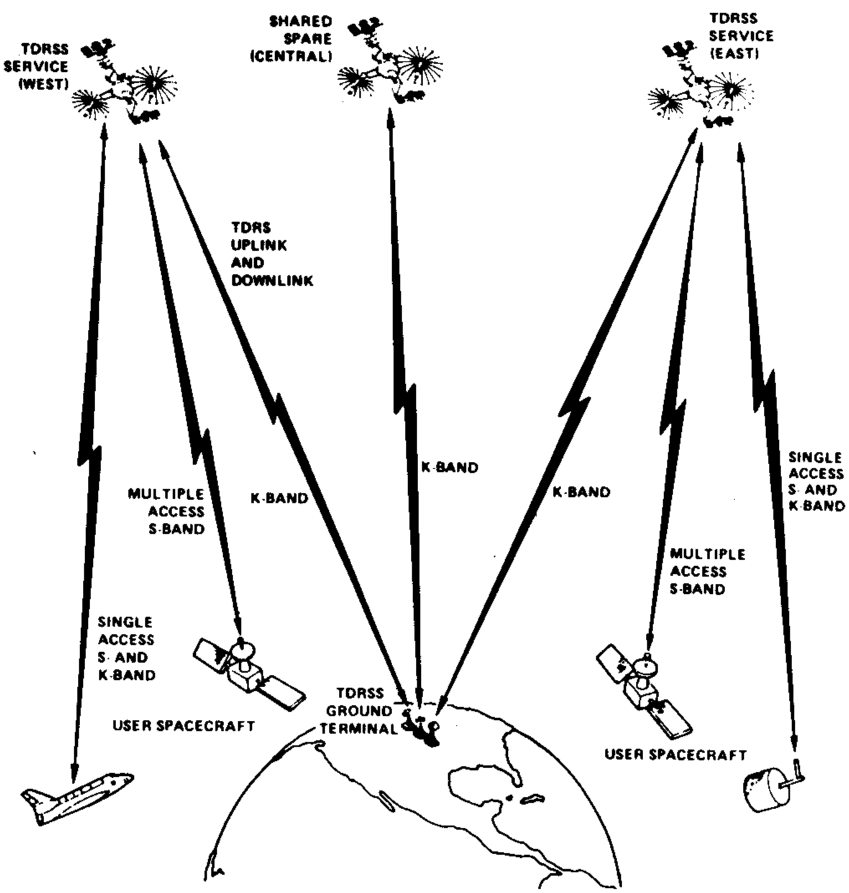

FIGURE 1. TDRSS CONFIGURATION

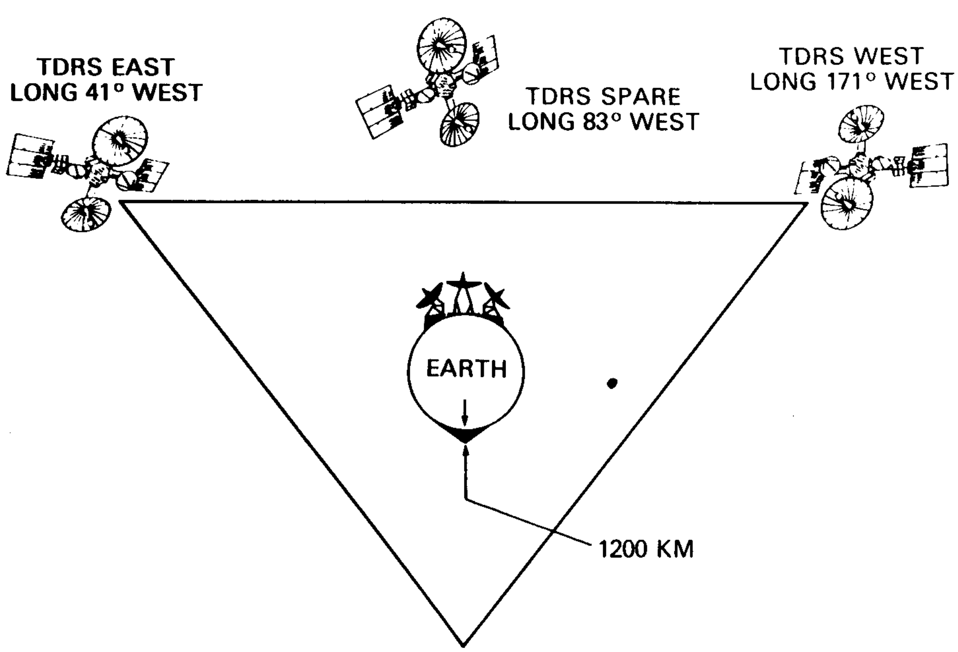

FIGURE 2a. TDRSS FIELD OF VIEW

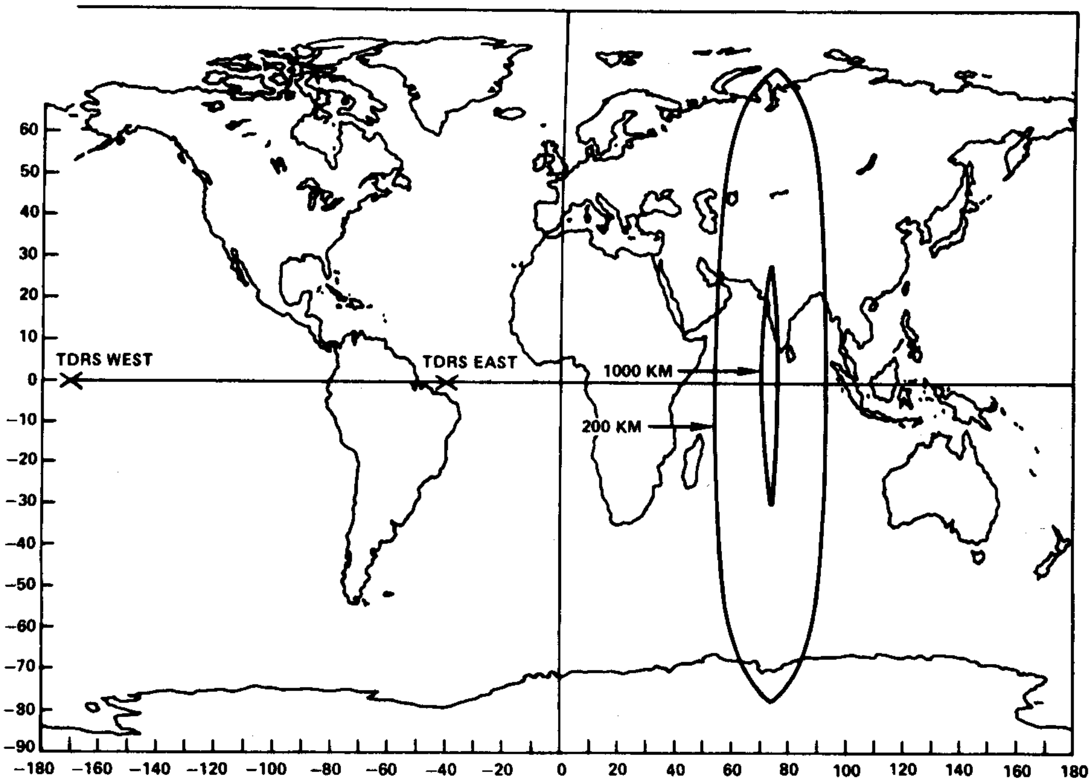

FIGURE 2b. TDRSS ZONES OF EXCLUSION

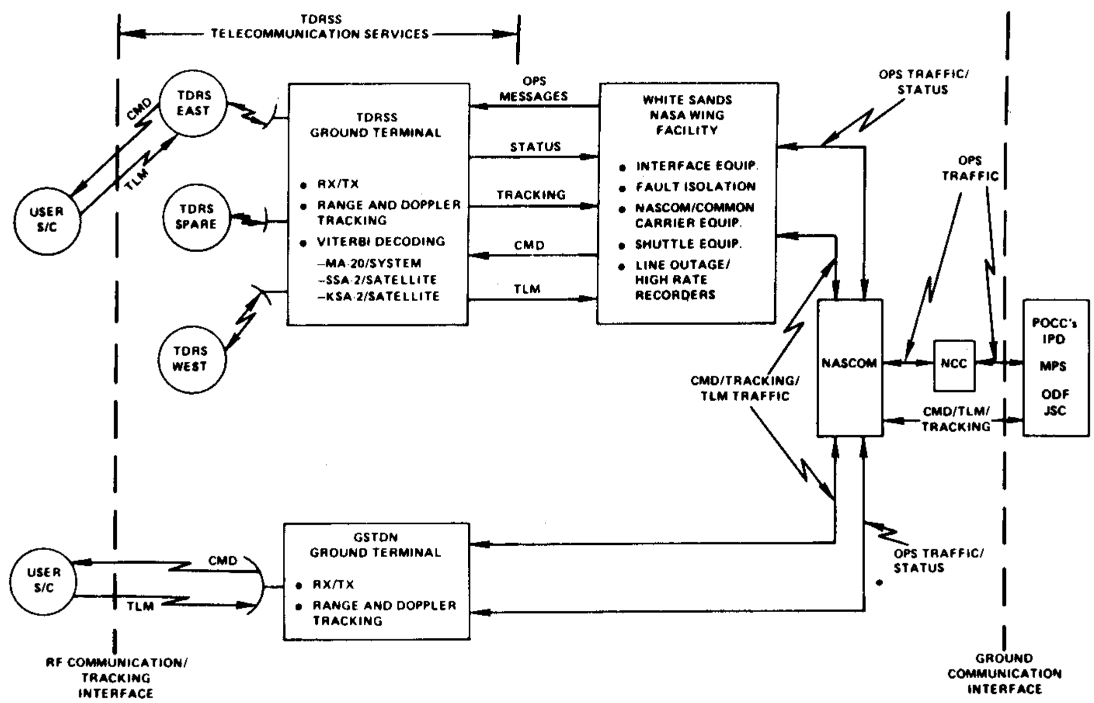

FIGURE 3. STDN/TDRSS CONFIGURATION

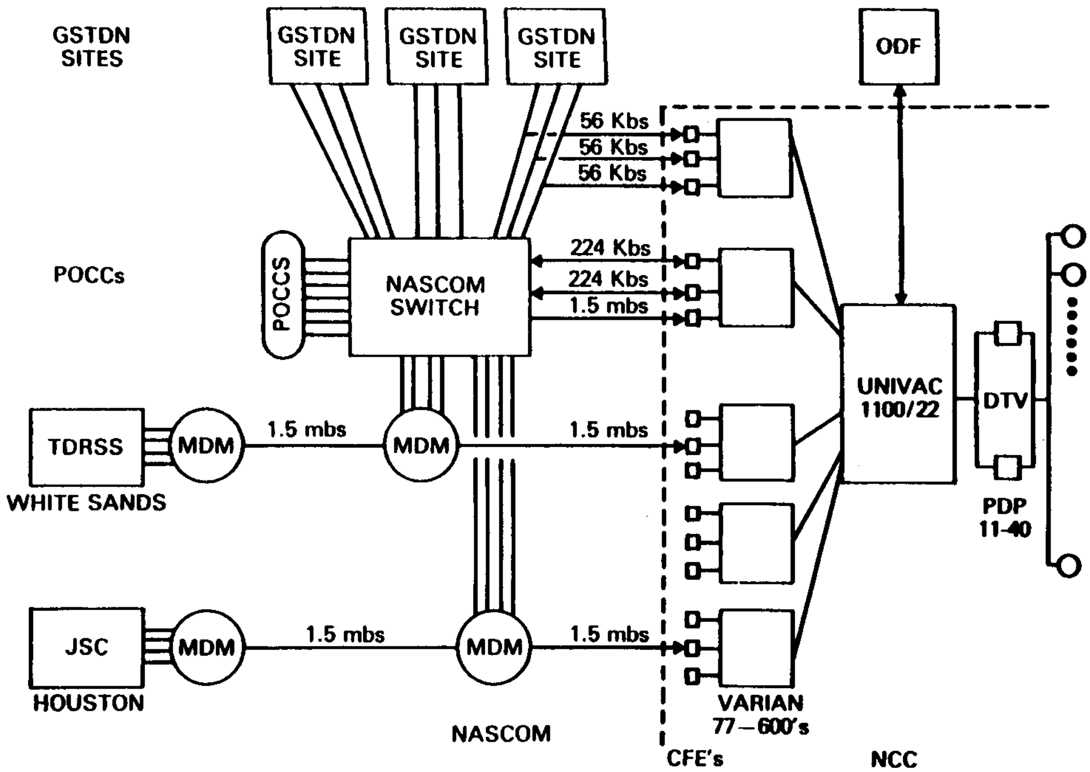

FIGURE 4. NASCOM INTERCONNECTION

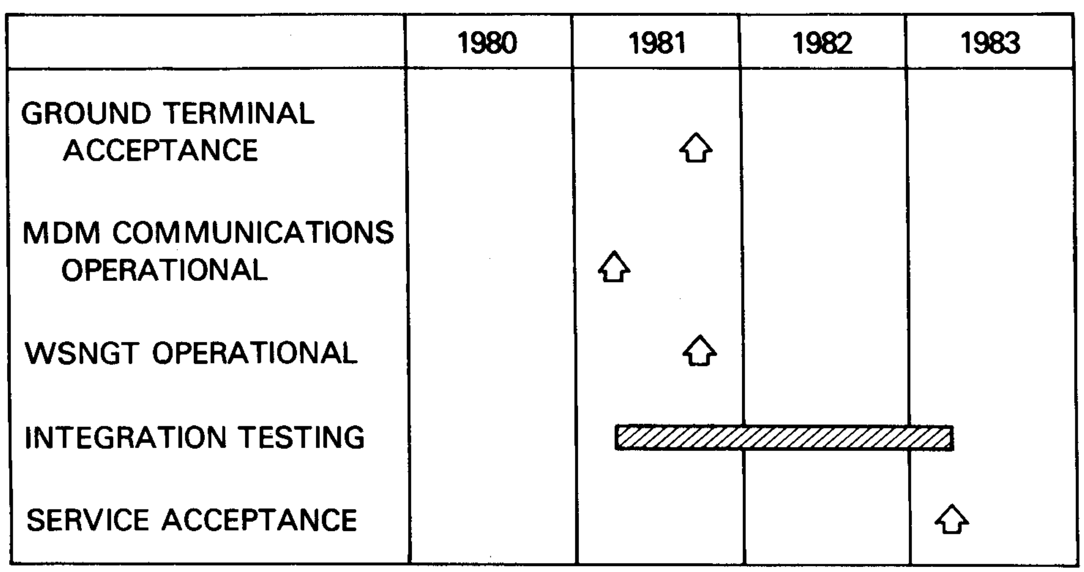

FIGURE 5. TDRSS INTEGRATION SCHEDULE