

The TDRS System (Space and Ground Segments)

By Don Hillger and Garry Toth

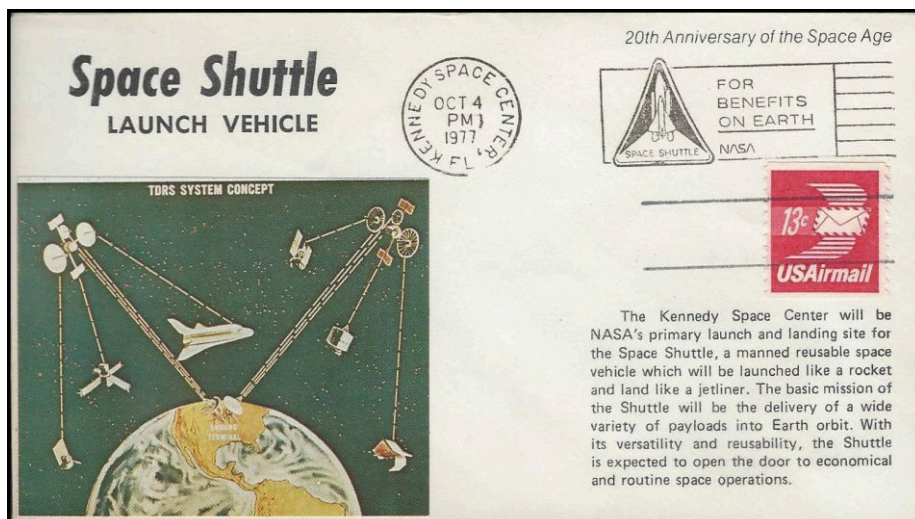
The NASA Tracking and Data Relay Satellites (TDRS) provide important communications for both un-manned spacecraft and NASA's manned missions. Like other satellite systems, TDRS consists of both a space segment and a ground segment. The space segment includes the spacecraft in orbit, which receive commands from the ground and transmit data back to Earth. The ground segment consists of the equipment to send station-keeping and data-acquisition commands to the spacecraft, telling them what to do. The ground segment also receives the data via ground stations, collects and stores those data, and distributes them to users, often in real time.

This article will first discuss the TDRS space segment, to provide the basis for further discussion of the TDRS ground segment, which is located at White Sands Test Facility (WSTF) near Las Cruces, New Mexico. Several postal items feature both

the TDRS spacecraft and the TDRS ground system. While the former will be covered in some detail, more emphasis will be on the ground segment, which is currently called the White Sands Complex, or the White Sands Ground Terminal (WSGT). Other related names for this ground station have also been found on postal items.

A short history of tracking spacecraft

The STADAN (Spacecraft Tracking And Data Acquisition Network) was developed by NASA in the early 1960s. It consisted of parabolic dish antennas and telephone lines and provided space-to-ground communications for Earth-orbiting satellites. A similar system for the manned space program was the MSFN (Manned Space Flight Network), which provided communications through the Apollo era. The two systems were eventually merged, resulting in the STDN (Spacecraft Tracking and Data Network), which was still limited to ground receiving stations. The Space Shuttle program, however, required a higher performance space-based communications system that utilized satellites in geostationary orbit to transmit commands to and receive data from satellites orbiting at lower levels. Thus began the TDRS System, which was designed at first to operate with a minimum of two TDRS spacecraft, but in fact required at least three TDRS to be within line-of-sight for most tracked satellites.



United States cover from 1977 showing the "TDRS System concept" and two 1st generation (TDRS-1/7 type) spacecraft.



Gabon Scott 937b Michel 1435 (1999) with a 1st generation (“TDRS”-1/7 type) spacecraft.

A US postal cover from 1977 has a printed cachet depicting the “TDRS System concept”, consisting of two TDRS of the 1st generation design (TDRS-1/7 type). Most postal items depicting TDRS have this 1st generation design. One of the best depictions is a stamp issued by Gabon in 1999 with “TDRS” in text as well. One of the few postal items with a later generation TDRS design is a souvenir sheet of one stamp, a known illegal issue, from Madagascar in 2017, with a 3rd generation TDRS (11/12/13 type) in the upper-right margin.

TDRS Space Segment

Thirteen TDRS spacecraft have been launched since 1983. The first generation TDRS (7 of them) were all deployed from the Space Shuttle and used a booster to attain geosynchronous orbit. The first one



Madagascar, known illegal issue, souvenir sheet of one stamp from 2017, with a 3rd generation TDRS (11/12/13 type) spacecraft in the upper-right margin.

was a partial deployment failure but still managed to reach geo orbit under its own power. The second one was destroyed in the ill-fated STS-51L/Challenger disaster, when the Shuttle exploded shortly after launch. The rest of the first generation TDRS were successful, ending with TDRS-7 in 1995. NASA then developed a second generation TDRS, three of which were rocket launched (TDRS-8 through 10), as well as a third generation consisting of three more, TDRS-11 through 13.

The table below summarizes the TDRS space segment, listing all the TDRS

| Spacecraft name | Launch date (dd-mm-yyyy) | Status | Generation |
|--|--------------------------|------------|----------------------------|
| TDRS-1 (TDRS-A) [STS-6/Challenger-deployed , partial failure] | 04-04-1983 | Retired | 1 st generation |
| TDRS-2 (TDRS-B) [STS-51L/Challenger , failed] | 28-01-1986 | Destroyed | |
| TDRS-3 (TDRS-C) [STS-26R/Discovery-deployed] | 29-09-1988 | In storage | |
| TDRS-4 (TDRS-D) [STS-29R/Discovery-deployed] | 13-03-1989 | Retired | |
| TDRS-5 (TDRS-E) [STS-43/Atlantis-deployed] | 02-08-1991 | In storage | |
| TDRS-6 (TDRS-F) [STS-54/Endeavour-deployed] | 13-01-1993 | Active | |
| TDRS-7 (TDRS-G) [STS-70/Discovery-deployed] | 13-07-1995 | Active | |
| TDRS-8 (TDRS-H) | 30-06-2000 | Active | 2 nd generation |
| TDRS-9 (TDRS-I) | 08-03-2002 | Retired | |
| TDRS-10 (TDRS-J) | 05-12-2002 | Active | |
| TDRS-11 (TDRS-K) | 30-01-2013 | Active | 3 rd generation |
| TDRS-12 (TDRS-L) | 24-01-2014 | Active | |
| TDRS-13 (TDRS-M) | 18-08-2017 | Active | |

spacecraft and their status at the time this information was researched (May 2024). It appears that 7 spacecraft are active, 2 are in storage, and 3 have been retired, aside from the one that was destroyed on launch.

Each succeeding generation of TDRS involved some improvement in capabilities such as an increased ability to capture and relay spacecraft data back to the ground. This was possible due to larger space-to-ground antennas and higher bandwidth connections for communications. The TDRS System now serves more than 35 low-

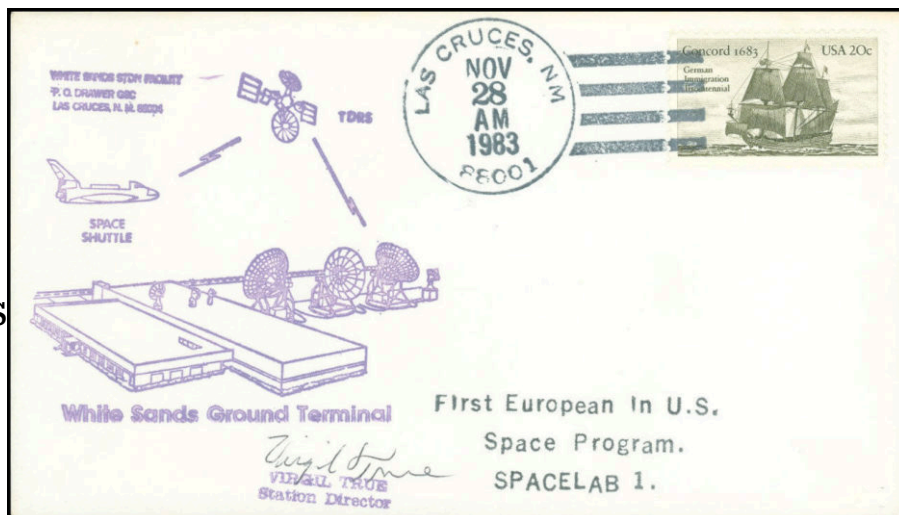
Earth-orbiting missions, including the Hubble Space Telescope and the Landsat series. Manned mission support included the Space Shuttle until its end in 2011.

TDRS supports the International Space Station, which depends on it for reliable communications with ground personnel. TDRS also supports some military spacecraft, such as the Lacrosse radar imaging reconnaissance satellites operated by the National Reconnaissance Office (NRO). TDRS uplinks and downlinks more than 99 percent of NASA's mission data and is the conduit for navigating those missions in low-Earth orbit. This is possible using three different frequencies of radio waves (S-band, Ku-band, and Ka-band). TDRS is able to connect to up to 20 spacecraft simultaneously.

TDRS Ground Segment

The TDRS ground terminals are primarily located at the NASA White Sands Complex, which consists of two functionally identical satellite ground facilities. The first one was built in 1983 at the start of the TDRS System, and the second one became operational in 1994. The two facilities, which are completely independent and redundant, are located 5 km apart at the White Sands Test Complex (WSTC), just to the west and outside of the much larger White Sands Missile Range (WSMR).

It turned out that a third ground terminal, in Guam, was needed to provide support for what was otherwise a gap in the TDRS System coverage. The Guam ground terminal, although separately located, is functionally part of the first White Sands Complex. Each



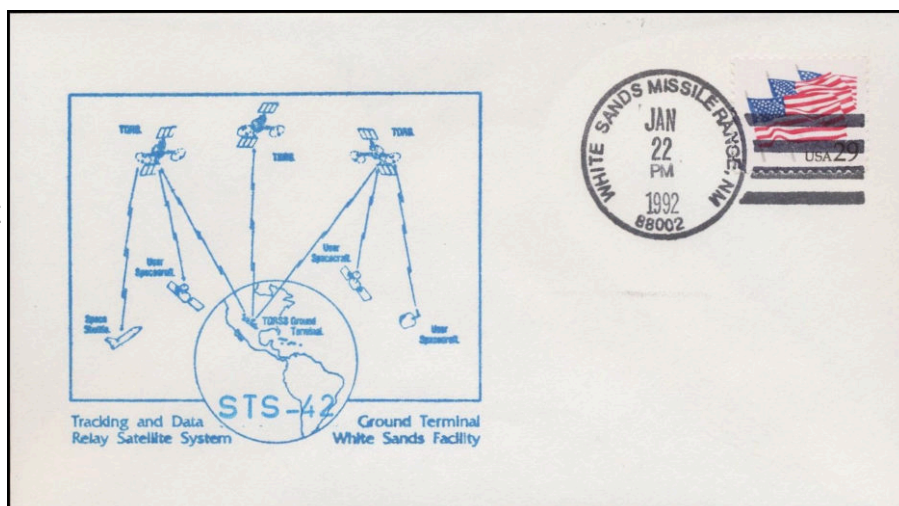
STS-9 launch cover from 1983 with a diagram of communications with the Space Shuttle via TDRS to the “White Sands Ground Terminal”.

complex consists of three 19 m dish antennas, also called ground terminals. As will be seen on postal items noting this facility, the White Sands Complex had different names over time.

Postal items with TDRS and other tracking systems

The earliest postal cover with specific mention of the use of the TDRS System is a launch cover for the STS-9 mission in 1983. The purple rubber-stamp cachet has a diagram of communications with the Space Shuttle via TDRS to the “White Sands Ground Terminal”, as it was called at that time. “White Sands STDN Facility” is found in the return address. Similar covers, all of which were canceled at Las Cruces NM, have been found for Space Shuttle missions through STS-52 in 1992.

A different design is found on a postal cover for the launch of STS-42 in 1992. The blue printed cachet has a diagram of the TDRS System providing communications between the Space Shuttle and three



STS-42 launch cover from 1992 with a diagram of a three-TDRS system providing communications for the Space Shuttle and three unmanned satellites to the “WSMR Ground Terminal” at the “White Sands Facility”.

unmanned satellites, via TDRS, to the “WSMR Ground Terminal” at “White Sands Facility”, which is marked on a map of the Western Hemisphere. This cover was canceled at the WSMR post office.

It appears that there was a name change of the White Sands Ground Terminal after 1992. A 1997 launch cover for STS-82 has “White Sands TDRSS Complex” in the return address position. Otherwise, the rubber-stamp design of the graphic as well as the cancel location (Las Cruces NM) are the same as on the STS-9 cover previously mentioned.

Finally, a recent cover depicting the “TDRS Control Center, White Sands Complex” has a picture of the ground station antennas as well as a TDRS mission patch or logo. This Artemis-1/Orion launch cover emphasizes the TDRS tracking support for that mission. The cover was canceled at the White Sands Post Office.

This article contains a few examples from the authors’ collection of postal items related to the TDRS System, both its space segment and its ground segment. Our online and more complete list of such postal items is available at <http://rammb.cira.colostate.edu/dev/hillger/TDRS.htm>.

Biographical notes

The authors have researched and written extensively on weather, climate, and unmanned spacecraft on stamps and covers, as well as other topics. Their Un-manned Satellite Philately website can be found at <http://rammb.cira.colostate.edu/dev/hillger/satellites.htm>. Email correspondence with the authors is welcome, using the addresses on the right.



STS-82 launch cover from 1997 with the same cachet diagram as found on the STS-9 cover already presented, but with a name change in the return address, to “White Sands TDRSS Complex”.



Artemis-1/Orion launch cover from 2022 featuring tracking support by the “TDRS Control Center, White Sands Complex” with a picture of the ground station antennas.

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Austria - UN Space Conference in Vienna

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On 17 November 1978, the UN General Assembly adopted Resolution 33/16 calling for a second UN Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE 82). In November 1980, the General Assembly accepted the invitation of the Government of Austria to host the Conference in Vienna from 9 to 21 August 1980. The first UN Conference on Outer Space was also held in Vienna in 1968, and by 1982 space technology had advanced considerably and opened up unprecedented prospects for the future. These new opportunities and their significance for humanity and future generations were among the topics discussed at this major conference, which was held at the Vienna Hofburg Conference Centre, while a space exhibition was held at the Vienna Messepalast, with demonstrations of satellite transmission. The public was informed about the state of the art in space technology and the success of its peaceful use for the benefit of mankind.