NASA Facts

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Three Newly DesignedTracking and Data Relay Satellites To Help Replenish Existing On-Orbit Fleet

NASA is poised to launch the second of three enhanced Tracking and Data Relay Satellites (TDRS), which will serve the Space Shuttle, International Space Station, Hubble Space Telescope and other Earth-orbiting satellites with improved communications and data relay services well into the 21st century.

The first Tracking and Data Relay Satellite, TDRS-H, launched in June 2000. TDRS-I is scheduled to launch in March 2002 from Cape Canaveral Air Force Station, Fla. aboard a Lockheed Martin Atlas IIA rocket, and TDRS-J is scheduled for a late 2002 launch. The new trio of satellites will help replenish the current TDRS constellation, which has provided communication services to the Space Shuttle and other orbiting spacecraft since 1983.

TDRS-H, -I and -J will increase commu-

Artist concept of TDRS-H spacecraft on orbit.

nications, and also maintain compatibility with the existing on-orbit TDRS fleet.

Similar to other communications satellites, TDRS-I will be placed into a 22,300 mile high geosynchronous orbit, which means it will maintain a fixed position above the Earth. TDRS is unique, however, in its ability to follow the motion of fast moving satellites, providing nearly continuous communication links with controllers and researchers back on the ground.

Satellite Capabilities

The new data and relay satellites retain and augment two large antennas that move smoothly to track satellites orbiting below, providing high data rate communications. An additional new feature is the higher radio-frequency communications band.

The Ka-band will enable higher data rates at a more favorable band and be less susceptible to interference from an increasingly busy radio environment. The new band has been coordinated with planned Japanese and European relay systems to permit a greater extent of mutual support and possible fallback operations.

TDRS-H, -I and -J also use an improved Multiple-Access system. This system operates in the 2.0 to 3.0 Gigahertz (Ghz) range, and is capable of supporting five additional users at higher rates than the original TDRS fleet.

The communications services offered by TDRS-H, -I and -J are:

S-Band Single Access - Full-time coverage (except for a 10-minute gap per orbit over the Indian Ocean) provided by two 15-foot diameter steerable antennas used at the 2.0 to 2.3 GHz band supplies robust communications to user satellites with a smaller antenna, and receives telemetry data from expendable launch vehicles during launch.

Ku-Band Single Access - The same two large antennas, operating between 13.7 to 15.0 GHz, provide high data-rate support to the International Space Station with high-resolution digital television.

The Ku-band can dump huge volumes of data at rates up to 300 megabits per second (Mbps), which is 5,000 times faster than the standard 56K home computer modem.

Ka-Band Single Access - This new higher-frequency (22.5 to 27.5 GHz) service increases data rate capabilities to 800 Mbps to provide communications with future missions requiring higher bandwidth communications such as multi-spectral instruments for Earth science applications.

Multiple Access - Using a phased array antenna and operating in the 2.0 to 2.3 GHz range, the system receives and relays data simultaneously from five lower data-rate users and transmits commands to a single user.

Satellite Navigation - In addition to equipment located at the White Sands Complex in New Mexico, the system continues to provide user navigational data required to locate the orbit and position of NASA user satellites.

New Antenna Design for Ka-band

A pair of 15-foot diameter reflectors, made of a flexible graphite mesh were developed to provide the large, accurate and steerable antennas needed at the Ka-band operating frequencies.

The reflectors' composite material permitted an economical fabrication that allows them to fold easily, conforming to limited space inside the launch vehicle.

TDRS-H, -I and -J are launched with antennas folded into a taco-like shape. Upon reaching orbit, stowage straps are released, unfurling the antennas and allowing them to spring back to their original shape. Each antenana then uses mechanical adjustments that tune them on orbit into a precise shape.

Acquisition Approach

NASA contracted with Boeing Satellite Systems (formally Hughes Space and Communications) of El Segundo, Calif. for the new trio of tracking and data relay satellites.

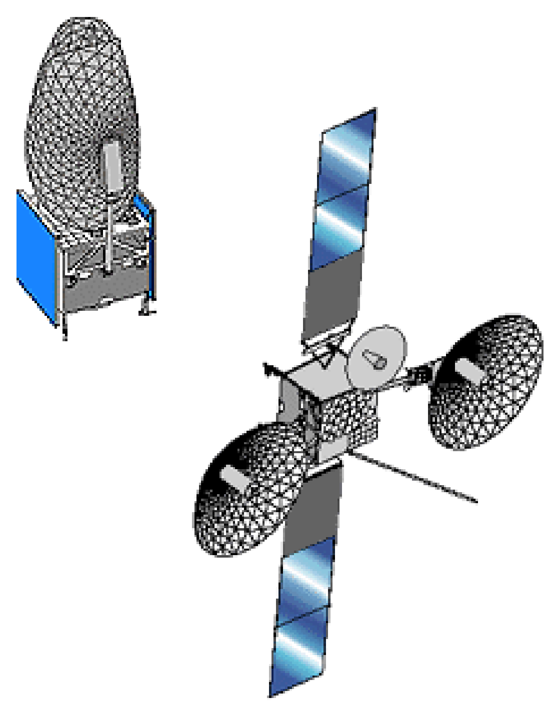
A new procurement approach, which substituted higher-level performance specifications in lieu of detailed technical specifications allowed Boeing to use commercial practices to build the satellites, thereby reducing the overall cost of the new trio.

With NASA's greater emphasis on contractor accountability, the contract includes a unique payback provision that protects the Agency's interests should a service failure occur during the first eight years of the spacecraftís 11-year design lifetime.

System Background

The current Tracking and Data Relay Satellite System, or TDRSS, is made up of the six original tracking and data relay satellites, built by TRW of Redondo Beach, CA, TDRS-H, which launched in June 2000, the White Sands Complex, a ground terminal extension on the island of Guam in the South Pacific, and various customer scheduling and data handling facilities.

The Space Operations Project Office at Goddard Space Flight Center, Greenbelt, Md., manages operations of the TDRS satellites (located at 41, 47, 49, 150, 171, 174, and 275 degrees West longitude) in



TDRS-I (upper left) shown in a stowed configuration for launch. TDRS-I (lower right) on-orbit with antennas fully deployed.

(Artist concept courtesy of Boeing Satellite Systems.)

accordance with the terms of NASA's Consolidated Space Operations contract.

(NASA relocated TDRS-1 to 49 degrees West longitude where it provides part-time coverage of the Antarctic region, supporting National Science Foundation research efforts.)

From this high altitude perch, the TDRSS can maintain near continuous contact with lower orbiting satellites, replacing the many ground stations which used to be required to maintain minimal contact with the Space Shuttle and other Earth orbiting satellites.

The outstanding success of TDRSS in improving space flight communications has, in some respects, overshawdowed other far-reaching achievements of the system, such as communications needed for state-of-the-art commercial applications, launch vehicle telemetry and government system acquisition.

Some of these achievements include:

Flight Operations**:** An extensive and costly ground-based tracking system (which relied on foreign sites, numerous personnel, tracking vessels and aircraft that provided users less than 15 percent contact per orbit) was replaced with NASA's TDRSS.

Multiple Users: The TDRSS pioneered simultaneous support to multiple space users by shared space and ground assets, and by employing advanced communications technologies and scheduling operations.

Innovative acquisition: The TDRSS was a trailblazer of commercial/government dual use of spacecraft, of lease and purchase procurement and of hosting a commercial communications package.

Launch Operations: With its unique capability to view and track a launch from anywhere on Earth, the TDRSS provides increased support for new classes of launch vehicles. The additional support provides superior coverage at a lower cost.

Communications Research: The TDRSS has been a test platform for a multitude of research efforts, such as radio-frequency propagation, very-long-base interferometry, digital radio broadcasting, telemedicine and aircraft satellite communications, which serve to advance civilian mobile and military communications.

Ancillary Applications: Residual TDRSS assets (e.g., TDRS-1) have provided terrestrial communications for researchers located at remote areas such as the South Pole.

Working in conjunction with the TDRSS, NASA's trio of replenishment satellites will provide vital communication links to a rapidly growing fleet of research aircraft, satellites and government and commercial launch vehicles during the next decade and possibly longer.

Websites

For detailed information about the TDRS-H, -I and -J spacecraft, as well as the TDRSS go to:

http://tdrs.gsfc.nasa.gov/Tdrsproject/

http://nmsp.gsfc.nasa.gov/tdrss/