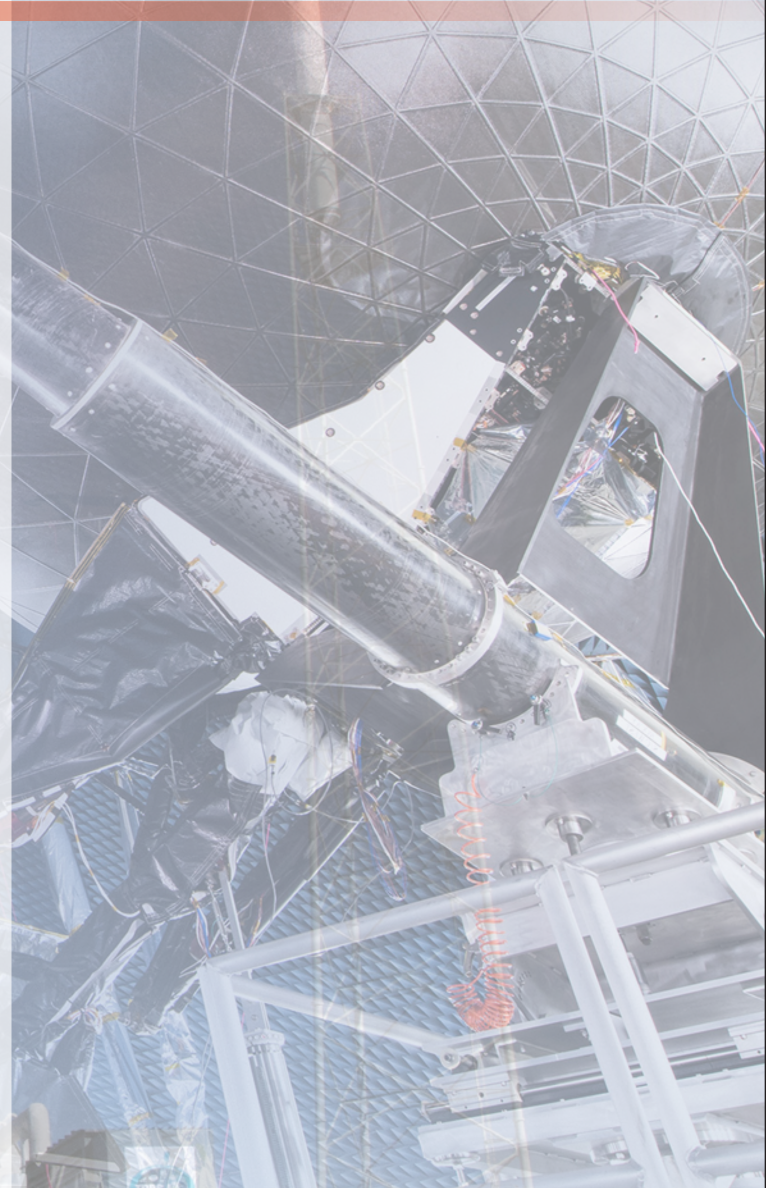
National Aeronautics and Space Administration

TDRS CONTINUING THE CRITICAL LIFELINE

TRACKING AND DATA RELAY SATELLITE



Data is essential to space exploration. Photos of foreign planets and faraway galaxies, satellite navigation, and even the health and safety of our astronauts rely on communications systems that move data to and from space. That's where the Tracking and Data Relay Satellite (TDRS) constellation comes in.

TDRS serves as a vital information pipeline for space-based research and exploration, fulfilling NASA's broadest communications demands. In geosynchronous orbit around Earth, the constellation ensures near-continuous global communications coverage of more than 35 low-Earth-orbiting (LEO) spacecraft.

In the early 1970s, more than 50 spacecraft required NASA's space communications support. The cost of maintaining ground stations was rising and ground-based networks only achieved coverage during about 15 percent of a spacecraft's orbit. NASA needed a more efficient network, and the agency theorized space-based satellites could mitigate these challenges. Thus, the TDRS project was established in 1973 to provide continuous, around-the-clock communications services to NASA's most critical LEO missions with higher data rates than before. Operations of the network began with the deployment of TDRS-A from the Space Shuttle Challenger in April of 1983.

TDRS serves as an intermediary for data between user spacecraft and the ground. As spacecraft orbit Earth, TDRS collects their data and sends it back down to NASA ground stations. In reverse, if user mission centers on Earth need to send commands to their spacecraft, they go through TDRS. The network allows spacecraft to transmit and receive data from almost any point in their orbit around Earth, not just when they are within the radius of ground antennas.

TDRS increased available coverage from 15 percent to more than 95 percent. The project also significantly reduced network operations costs and increased the number of spacecraft the network could connect with simultaneously from two to 20.

Generations of TDRS

TDRS-A to TDRS-G comprise the first generation of TDRS spacecraft, which have three modules: the spacecraft module, the communications payload and the antennas. The spacecraft module contains subsystems critical to everyday operations, such as power systems and components that stabilize and orient the spacecraft so the

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antennas point to Earth. The communications payload hosts components like receivers and transmitters that work with the antennas to connect to ground stations on Earth across several radio bands. Finally, four antennas enable communications relay between user spacecraft and TDRS, and then between TDRS and the ground.

Shortly after completing TDRS's first-generation constellation, the team commissioned a second generation of satellites to implement new technology and support evolving customer requirements. Spacecraft missions needed higher-bandwidth connections capable of delivering larger volumes of data per second. With new components and systems, the team increased data rates to more than 30 times the rate of the first-generation fleet and increased power transmission significantly. They also added Ka-band capability, enabling much larger transmissions and international compatibility with European and Japanese systems in case of emergencies. These spacecraft launched between 2000 and 2002, and all three continue to operate to this day.

While many of the spacecraft far outlived their 10-year operational lifespans and some are still in operation, replenishing the TDRS fleet remains vital; NASA commissioned a third generation of TDRS spacecraft just as the agency began to decommission the first generation shortly before 2010. The first third generation spacecraft, TDRS-K, launched in 2013, and the final one, TDRS-M, is scheduled to launch in 2017. This third TDRS generation uses ground-based beam-forming to create more flexible communications and enable tailored services for each customer, such as unscheduled access to their spacecraft.

A wide variety of American interests rely on dependable space-based communications. As a dedicated expert in operations above the atmosphere, NASA regards the TDRS-K, L and M missions as essential not only to the agency, but to the continued understanding of our planet and beyond.

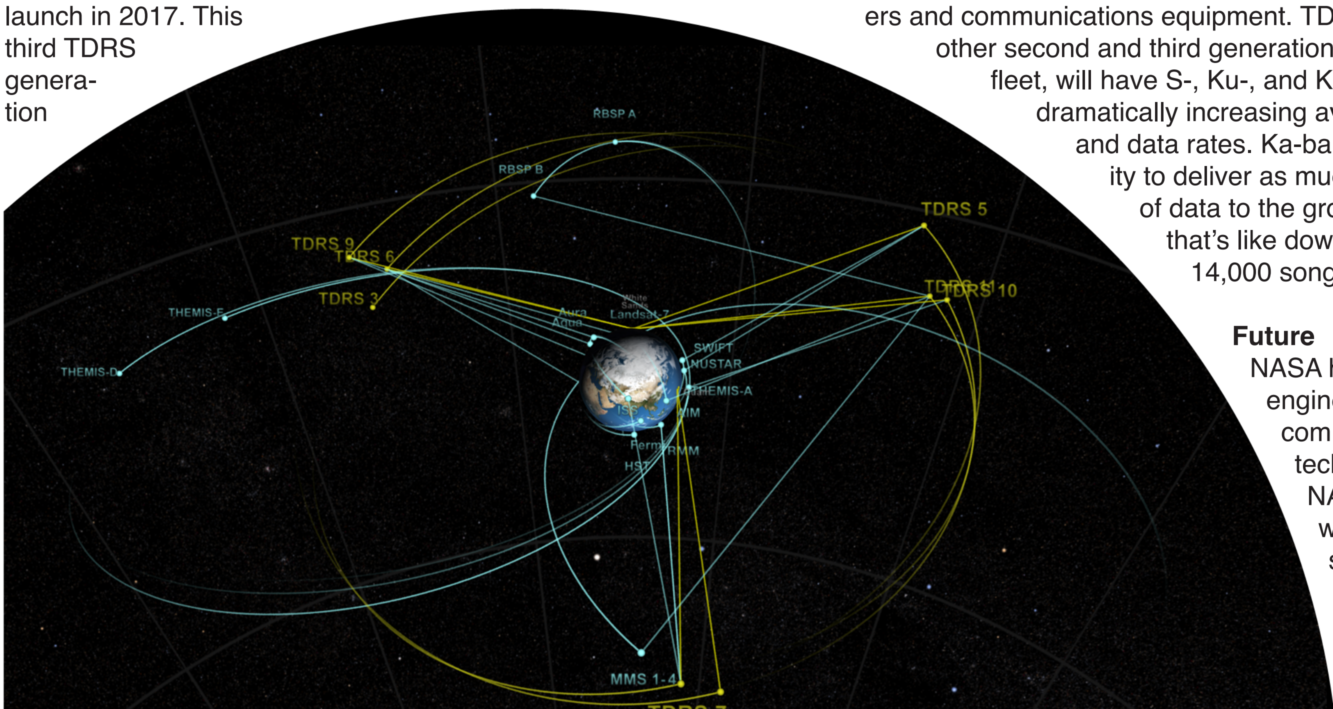
The Next Frontier

The last of the third-generation fleet, TDRS-M will extend the overall life of the TDRS network. The satellite will be powered by two solar array wings, each of which contains two panels of solar cells to convert different spectrums of sunlight into energy.

Like K and L, TDRS-M has two main components: its unique telecommunications payload and its bus, the Boeing 601 satellite.

The bus houses all essential hardware. One bus module contains the propulsion system, bus electronics and batteries. The other module contains shelves that have heat pipes, electronics and mission-critical communications equipment. Solar arrays, antennas and other elements are attached to the outside of the bus.

The payload includes antennas, amplifiers, frequency converters and communications equipment. TDRS-M, like the other second and third generation satellites in the fleet, will have S-, Ku-, and Ka-band capabilities, dramatically increasing available bandwidth and data rates. Ka-band has the capability to deliver as much as six gigabytes of data to the ground per minute – that's like downloading almost 14,000 songs a minute.



NASA's TDRS constellation provides communications services to more than 35 low-Earth-orbiting missions, ensuring near-continuous global communications coverage to the missions that need this particular service. Missions like the International Space Station and the Hubble Space Telescope depend on TDRS's reliability.

Future

NASA has spent decades engineering innovative communications technology. Still, NASA continues to work on a future space communications architecture, finding creative solutions like to meet future mission needs. As the world sends out more spacecraft to expand our understanding of the universe, NASA will be there every step of the way, providing this critical lifeline to future missions.

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