Upgrades to NASA's space communications infrastructure pave the way to higher data rates

July 28 2021, by Kendall Murphy

Tracking and Data Relay Satellite (TDRS) ground antennas at NASA's White Sands Complex in Las Cruces, New Mexico. Credit: NASA's Goddard Space Flight Center

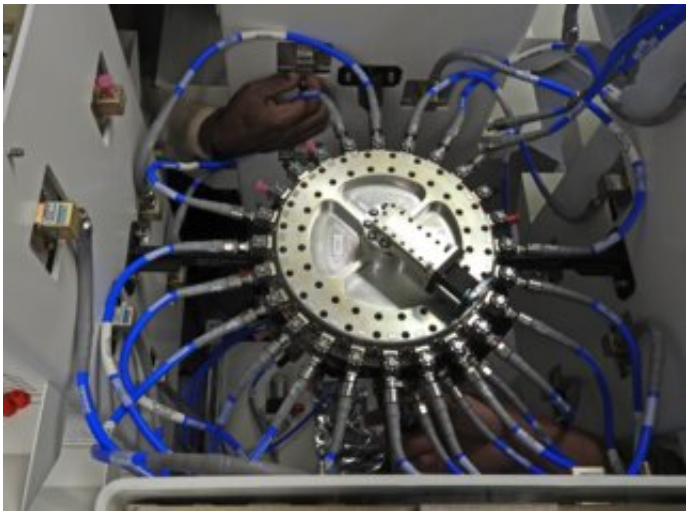
The ability to transmit and receive data is crucial in space exploration. Spacecraft need robust networking capabilities to send data—including large files like photos and videos—captured by onboard instruments to Earth as well as simultaneously receiving commands from control centers. NASA has made significant strides to improve the agency's space communications capabilities while simultaneously maintaining ongoing operations and service to a large number of missions.

The Space Network Ground Segment Sustainment (SGSS) project implemented critical upgrades to NASA's space communications infrastructure by modernizing Tracking and Data Relay Satellite (TDRS) ground terminals and improving many system capabilities. Orbiting 22,300 miles above Earth, multiple TDRS provide communication links between orbiting satellites, such as the Hubble Space Telescope and the International Space Station, and ground-based control centers. TDRS allow missions to be in nearly constant contact with their control and data centers on Earth.

In April 2021, the SGSS team finished initial upgrades to systems at the Second TDRS System Ground Terminal (STGT) and the White Sands Ground Terminal (WSGT) sites, located at NASA's White Sands Complex in Las Cruces, New Mexico.

These upgrades included installing new equipment to support TDRS communication antennas at the STGT and WSGT locations. Approximately 40 racks of electronic and computing equipment were installed in each of the two locations, reflecting more than an approximately 80 percent reduction in the number of racks needed to support TDRS operations as compared to the old equipment. Additionally, the team upgraded several ground antennas, including one main mission antenna, four test antennas, and one backup communications antenna that can be used if any of the mission antennas become unavailable.

The improvements allow more data to flow through the system, create additional data transfer modes, and increase antenna reliability. These features are designed to ensure the uninterrupted flow of data, enabling future discoveries.



SGSS radial combiner/divider surrounded by the solid-state power amplifier for Ku-band transmission. Credit: NASA's Goddard Space Flight Center

"Upgrading the existing ground system has modernized the electronics and uses more commercially available products. This should help reduce the cost of maintaining systems like TDRS, and helps make extensibility, flexibility, and scalability more straightforward," said Tom Gitlin, the deputy project manager, technical for SGSS. "SGSS is still compatible with the old system, but will provide new functions, higher data rates, and support more modern data coding schemes."

The SGSS project converted a WSGT legacy antenna to support two radio frequency bands for communication to and from a TDRS. This newly modified antenna can transmit using Ku-band—used for

communications with the TDRS for normal operations, and at S-band—used when storing a TDRS on orbit or when the Ku-band is unavailable for any reason. Prior to this upgrade, the antenna only supported the Ku-band frequency. With the SGSS system operational, this antenna can easily switch between the two bands when needed, ensuring TDRS communications services are not interrupted and minimizing the need to switch antenna assets.

NASA has never performed an upgrade of this magnitude while simultaneously maintaining operations. Much of the existing ground terminal technology uses analog signaling that suffers degradation as it travels through the ground terminal. The SGSS system converts signal transport paths to digital form, which does not suffer losses or signal degradation. SGSS digitizes signals immediately at the ground station antenna.

"This is the first major upgrade of a full ground station while the legacy equipment was still in use," said Richard Von Wolff, deployment, transition, and operations manager for SGSS.

Working on-site at White Sands, Von Wolff took charge of getting the equipment ready for deployment and ensured there was a seamless transition of operations. In addition to performing those tasks in tandem with the equipment turnover, he made sure operations training and documentation would be ready so that once the upgrades are complete, the SGSS system can be transferred to NASA's Advanced Communications Capabilities for Exploration and Science Systems (ACCESS) project. ACCESS has assumed responsibility for the system and is conducting additional tests and modifications as necessary.

These upgrades are the third generation of improvements at the site and take White Sands into the digital era, enabling lower TDRS system maintenance costs, and providing higher data rates with minimal

disruptions. The new infrastructure will support the next generation of satellites, allowing NASA to discover more about our planet, the solar system, and beyond.

Provided by NASA's Goddard Space Flight Center