Name of the Project

Providing a Service that Doubles the ISS Science Data Return

Description of the project

NASA's missions rely on the Space Network to relay critical mission data to control centers and scientists here on Earth. The international Space Station is NASA's most critical missions that relies on this network. The International Space Station plays a key role in the international science community, enabling human spaceflight, space and Earth science experiments, as well as technology demonstrations, in the space environment. The unique environment of the station's approximately 250-mile-high orbit allows astronauts to conduct experiments which provide valuable insight in the fields of physics, biology, astronomy, meteorology and more. The station also transmits time-sensitive, mission-critical data like information about the crew's health and the status of the station's systems.

A team with women in key leadership roles worked over the past several years to double the rate at which that data can come down to Earth, enabling the station to accommodate new experiments and technology demonstrations which require higher resolution and more detailed data than was previously possible. The impact of this on the science community and on astronaut safety and health cannot be overstated.

The space station communicates with Earth through radio frequency signals. The system previously transmitted data through a 300 Megabit per second (Mbps) connection, about twice the speed of a high-speed internet connection in American homes. Thanks to the work of the Providing a Service that Doubles the ISS Science Data Return, beginning in May 2019, the station will support a 600 Mbps connection, effectively doubling the amount of data that station can transmit and receive at a time. This was made possible by the Space Network modifying its service in concert with a software update, converting its communications capability from analog to digital, similar to switching from dial-up internet to today's broadband.

The space station uses a system of Tracking and Data Relay Satellites (TDRS) and ground-based antennas called the Space Network (SN) to transmit its signals. The TDRS are placed in a high orbit, above the station, over various strategic locations so that they can relay the station's signal to the ground from anywhere in its orbit, routing them to ground stations in White Sands, New Mexico or Guam. Landlines then send the signal to various NASA centers, and their computer systems turn the radio signal back into readable data. To send data back, the process repeats in the other direction. This happens with less than a one second delay in communication.

All of this means there were a number of components in this global communications system that needed upgrading in order to support the increased data rate. The space station's software based modem was updated, data processors were improved at various NASA centers, and routers, interfaces and other equipment and software were enhanced at the ground stations. The circuits and bandwidth of the terrestrial data lines between the various Earth-based components were also upgraded. After the upgrades were completed, the team performed extensive testing to ensure the upgrades worked correctly. All of this had to be done while still providing real-time support to the more than 40 missions the SN regularly supports. Other NASA missions will also be able to take advantage of this capability.

Women filled lead roles in every facet of the team in both government and contractor capacities. Many of these positions have not traditionally been held by women making this team and project a leap forward in many different ways.

The project was a collaboration between two NASA programs: the Space Communications and Navigation program office at NASA Headquarters in Washington, DC, and the International Space Station Program at Johnson Space Center in Houston, TX. They chartered the Space Network teams at Goddard Space Flight Center in Greenbelt, MD, and the Engineering Directorate's Communications and Tracking System team at Johnson to complete this enhancement. The Space Network was supported by Peraton headquartered in Herndon, VA and the Space Station project was supported by the Boeing Company in El Segundo, CA.

What impact has the initiative had or is expected to have?

Science experiments and technology demonstrations are increasingly reliant on high data rates in order to provide knowledge and solutions which can improve our lives on Earth and reach points beyond Earth orbit. The work done on the space station provides knowledge in human research, from biology to psychology, experience in long-duration spacecraft operations, and serves as a testbed for technology demonstrations of new capabilities which enable future missions.

George Morrow, the deputy center director of Goddard Space Flight Center, said, "Goddard's communications networks play a pivotal role in every NASA mission, enabling data from human spaceflight, space and Earth science research missions and technological demonstrations to reach Earth for the benefit of humanity. This increase in data rate capability for the International Space Station underlines our commitment to provide high-quality operational services for NASA exploration missions today and in the future."

Through the "STEM on Station" program, the station uses its communications systems for in-flight education downlinks. Astronauts on the station often interact with students across the United States through video and voice calls.

Ronna Kirchoff of Peraton, the SN's integration contractor for the ground segment, said, "The successful implementation of the ISS 600 Mbps Upgrade Project provides an incredible opportunity to educate the children of today to be the leaders and space explorers of tomorrow. The increased International Space Station data rate allows more complex experiments to be developed by our children through science, technology, engineering and math (STEM) educational projects and organizations."

Throughout the upgrade process, the team developed unique techniques and strategies to improve performance in a highly efficient manner. This upgrade will be scalable and reproducible in other NASA missions as well as commercial industry. Including the Gateway which is analogous to the Space Station, but will be orbiting around the moon instead of Earth in 2022.

Chris Badgett of RT Logic, the company which provided the digital modem, said, "We were proud to be called upon to help on this upgrade for the International Space Station. This was significant for us because it gave us the opportunity to partner with NASA and deliver new technology for waveforms and digital signal processing."

In summary, the Space Network service upgrades have a wide-ranging impact to scientific knowledge in the future. Many missions will be able to take advantage of this capability. The ability to make software changes on a remote spacecraft demonstrates the scalability for future missions as they go deeper into space.

What is unique about this initiative? Can it be scaled-up and replicated in other places?

One of the reason the doubling the science data return for the Space Station initiative is unique, is that the team contains several women in leadership positions. This is highly uncommon in the technology industry. Due to the distributed nature of project, geographically and organizationally, a key element of the success of this initiative is cross communication and collaboration and effective relationship building, which led to successfully achieving a common goal. The team is comprised of both experienced women project managers and early career women engineers in various leadership positions. Trust and respect were key elements of success. Each key team member trusted each other and their respective organization to accomplish their responsibilities and highly respected one another. The team created a safe environment to be able to express opinions and feedback, even in times of disagreement. In addition, the team worked like a fine-tuned machine to complete the project on budget and ahead of schedule, exceeding the expectations of both the International Space Station Program and the Space Communication and Navigation Program. From an organizational perspective, this model can be utilized for other organizations to replicate. This initiative demonstrates that, if given the opportunity, women and can rise and shine and produce great outcomes.