A longtime collaboration between NASA’s Glenn Research Center and L-3 has led to technology enabling the unprecedented transmission of scientifically significant data related to our home planet, moon, and solar system, as well as the search for Earth-like planets. The jointly developed high-speed, high-capacity traveling wave tube amplifier (TWTA) has performed flawlessly aboard the Cassini spacecraft, the Lunar Reconnaissance Orbiter (LRO), the Kepler Mission, and the International Space Station (ISS). More recently, funding from NASA’s Technology Transfer Program supported additional advancements that achieved a laboratory proof-of-concept demonstration of a 20-gigabit-per-second (Gbps) transmission, which represents a 200-fold improvement over data rates previously used on such missions. As ground stations increase their receiving capacity, this breakthrough in ultrahigh-throughput technology will open the door to new levels of Earth science. It also lays the foundation for the next generation of high-throughput satellites for the commercial communications industry and the military.

**Benefits of Tech Transfer**

- **Enhanced space communications**: Enables super-rapid downloads of enormous volumes of science data
- **Extraordinary images**: Transmits images with very high resolution
- **Improved disaster monitoring**: Allows for real-time monitoring of potentially devastating weather systems and natural disasters, saving countless lives
- **Expansion of Earth science**: Enables better study of climate, species, and natural resources
- **Telecommunications industry advances**: Is prompting the communications industry to design next-generation satellites
- **Company growth**: Enabled L-3 to create profitable new market areas, securing a multimillion-dollar contract with the Air Force Research Laboratory

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On the Record

“Working with L-3, we have demonstrated the feasibility of a high-power, high-efficiency, wideband space TWTA that will enable a host of satellite communications applications, including a high level of Earth science and disaster monitoring, as well as dramatic improvements in high-speed Internet and high-definition television (HDTV) on the ground and on airplanes. It has had a tremendous return on investment.” —Rainee Simons, Senior Research Engineer and IEEE Life Fellow, NASA Glenn Research Center

“It has been a good collaboration for L-3 in terms of capability and visibility. By working with NASA and combining L-3’s amplifier and modem technology, we were able to demonstrate data rates. And NASA didn’t have to spend as much to achieve greater utilization of its science assets.” —Francis Smith, Senior Technical Fellow, L-3 Communications

About L-3

U.S.-headquartered L-3 is a prime contractor in aerospace and national security, as well as a provider of a broad range of communication and electronic systems and products used on military and commercial platforms. Various divisions of L-3 collaborated with NASA on this work, including the Electron Technologies, Inc. (ETI) unit based in Torrance, California, and Communication Systems-West (CS-West) in Salt Lake City, Utah.

Technology Origins

Researchers at NASA Glenn and L-3’s ETI division developed the TWTA as a novel high-efficiency, high-reliability microwave power amplifier capable of transmitting massive amounts of science data and images. When installed as a critical part of the LRO primary communications system, this award-winning technology was able to transmit video images and science data from six onboard instruments, as well as data from advanced radar experiments. It achieved unprecedented improvements over previously available TWTA s, with throughput to handle data volumes of 572 gigabits per day at a rate of 100 megabits per second. Its design minimized power losses while providing excellent thermal reliability/stability, wide bandwidth coupled with low signal attenuation for high efficiency, and a robust package that withstood launch vibrations.

The exceptional performance on LRO led to the technology’s selection as the transmitter for a software-defined radio (SDR) experiment on ISS. Thanks to the NASA–L-3 technology, scientists were able to prove that a fully programmable, reconfigurable SDR could operate as a generic space radio platform in the Ka-band frequency range. Its ability to provide exceptionally high data-rate communication and data transmission over multiple waveforms reduces the cost, time, and risk associated with developing future missions.

Taking the Next Step

These successes prompted NASA to take the TWTA technology to the next level by working with L-3’s CS-West, which specializes in multigigabit-per-second transceivers. The project, which began in June 2010 and included funding from NASA’s Technology Transfer Program, allowed NASA to use L-3’s advanced transmitter technology and software-defined modem emulators to achieve major performance breakthroughs. For the first time ever, researchers demonstrated data throughput rates as high as 20 Gbps, achieving a 200-fold improvement. In addition, with support from NASA Glenn Special Projects, engineers have completed the design for a new high-power, wide-bandwidth traveling wave tube for the next generation of ultrahigh-throughput satellites operating at Q-band frequencies.

Looking Ahead

Because of the rate at which spacecraft gather data during each orbit, ultrahigh download rates have major implications for science as well as for communications, including air traffic control of transoceanic flights and the tracking of ships at sea. NASA is configuring ground stations capable of handling 20-Gbps transmissions, at which point the floodgates will open to a massive wave of scientific data that will enable us to better understand our world and our place in the universe. The achievement of ultrahigh throughput is also prompting the communications industry to design next-generation satellites that can accommodate the technology and optimize the sensors. L-3 is working with satellite vendors to experiment with higher data rates over new transponders.

For More Information

For more information about this collaboration success or licensing opportunities at NASA Glenn, contact:

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