NASA team develops new Ka-band communications system to break through the noise

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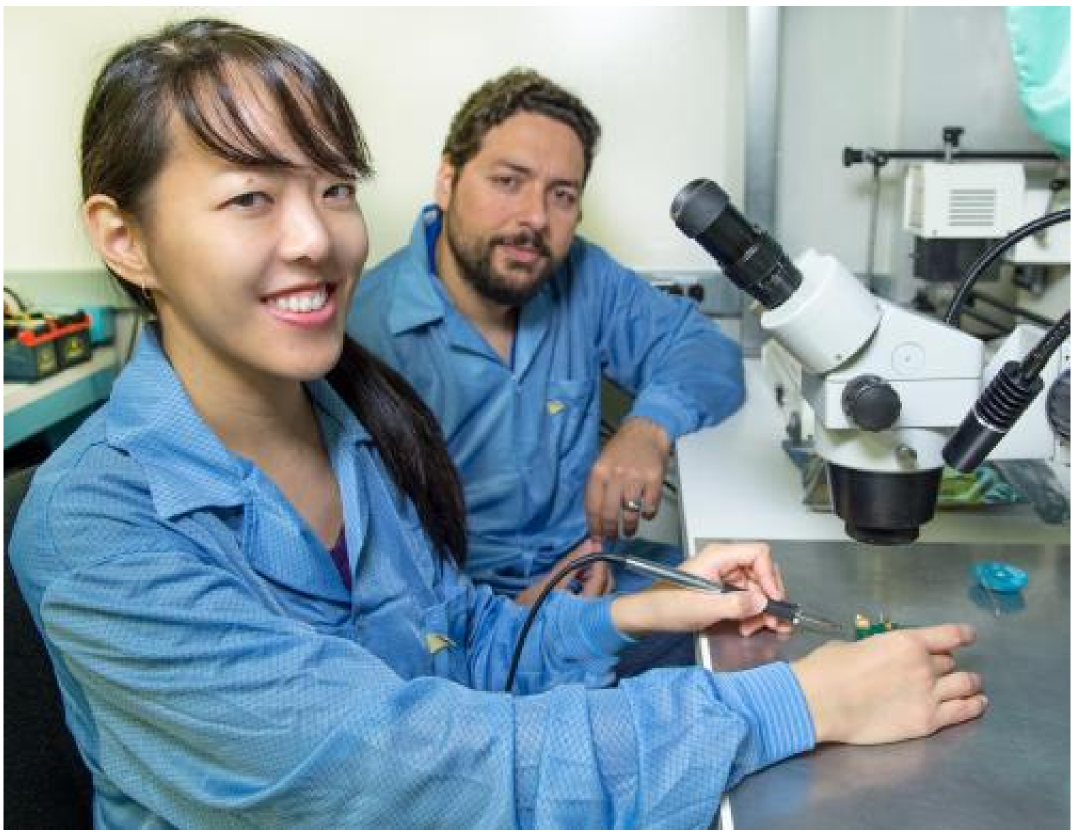

In this photo, Huang is holding a test board upon which her Ka-band/microwave design is mounted and bonded. and Marrero-Fontanez is on her right.
Credit: NASA/W. Hrybyk

The radio frequency band that many NASA missions use to communicate with spacecraft—S-band—is getting a bit crowded and noisy, and likely to get more jammed as science missions demand higher and higher data rates.

A team of NASA technologists at NASA's Goddard Space Flight Center in Greenbelt, Maryland, just may have a solution, particularly for potential missions that plan to operate in low-Earth orbit and have limited real estate to accommodate communications gear.

Under two different research and development projects, technologists Mae Huang and Victor Marrero-Fontanez have collaborated to test and verify components of a prototype end-to-end Ka-band space communications system, which promises significantly higher data rates—a whopping 2.4 gigabits of data per second (Gbps)—over more traditional S-band systems, which theoretically could achieve data rates of 90 megabits of data per second (Mbps).

Huang is working with Goddard's Jeffrey Jaso—a pioneer in Ka-Band communications—to develop a Ka-band transmitter. Marrero-Fontanez, meanwhile, is designing Ka-band antennas to receive the Ka-band signals. Huang and Marrero-Fontanez plan to assemble a prototype in 2015.

Huang also will be delivering an engineering test unit of her transmitter to a Goddard team that is considering the technology's use on the proposed Wide-Field Infrared Survey Telescope (WFIRST). WFIRST, a next-generation observatory proposed for launch in the mid-2020s. WFIRST would carry out wide-field imaging and slitless spectroscopic surveys of the near-infrared sky, with an emphasis on studying dark energy and exoplanets. Due to its heavy data-rate requirements, the project provided Huang with some funding to advance her technology, she said.

WFIRST isn't the only mission looking for a compact, low-power, end-to-end system. Future Earth-observing missions also are expected to generate higher and higher data rates that could overwhelm the S-band allocations that are shared by space missions using NASA's Near-Earth Network and Deep Space Network and Federal and commercial operations.

"In a sense it's like rush-hour traffic. When you start your morning commute, you may notice fewer cars, but before you know it, you're in stop-and-go traffic as more cars merge onto the highway. The world's frequency bands are beginning to look a lot like bumper-to-bumper traffic," she said. "Cell phones, streaming video, and data communications are all placing big strains on available bandwidth. Meanwhile, commercial businesses are putting pressure on the government to free up other bands, pushing more Federal operations into the S-band that NASA uses. Couple that with NASA's expected need to transmit and receive greater and greater amounts of mission data, something will have to give."

Although NASA has had the Ka-band allocation for years and has used the frequency on past missions, the band has remained underused for a variety of reasons, mainly because of limited technology development, perceived technical challenges, among other things," Marrero-Fontanez said. "However, NASA has always had a strong interest in using this frequency allocation," he added, particularly because it can significantly increase data throughput by a factor of more than 100 as compared with S-band.

Making the switchover to Ka-band is further complicated, Huang said, because technologists have few, if any, options to buy Ka-band hardware and components from commercial vendors. "The design is challenging and Goddard has past experience in developing reliable space hardware, and more specifically, reliable Ka-band hardware."

To overcome those challenges, Huang received support from both NASA and Goddard to advance what she believes is the bandwidth of the future for NASA communications in low-Earth orbit—at least until more advanced techniques, such as laser or X-ray communications, become broadly available. "Those investments have certainly paid off," she said.

"Our technology achieves high data rates and includes several innovations," Huang continued, adding that Jaso deserves most of the credit for pioneering Goddard's Ka-band technology. The Solar Dynamics Observatory, launched in 2010, used a first-generation Ka-band transmitter to deliver 300 Mbps using 2.5 watts of power. The Lunar Reconnaissance Orbiter, launched in 2009, contained a second-generation Ka-band unit that delivered three switchable rates from 57 to 228 Mbps.

In comparison, the Goddard team has tested and verified the current third-generation technology capable of delivering 2400 Mbps (2.4 Gbps), with a higher transmitted power option of 10 watts. Instead of a fixed frequency, the third-generation operates over the entire Ka-band downlink range with a tunable data rate while in operation. She has started investigating the possibility of integrating data encoding as a core function of the Ka-band transmitter. "This is something that has been an interest of some future missions," she said.

"Missions will be interested in our technology not only because it provides a low-risk option, but because it can be adopted without spending on non-recurring engineering. We're compact, low mass, offer low-power requirements," she continued. "It really has great potential."

Provided by NASA