Creating a better transmission system for deep-space applications

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Recent advances in wireless computing technology could improve deep-space missions like asteroid research and remote spacecraft operations by changing the way signals are sent from Earth.

A new method designed to effectively deliver commands and instructions using hundreds of millions of tiny transmitters linked together could also free the giant satellite dishes currently used to send and receive the long-range information for other applications. A research paper describing the scheme for relatively simple high-power transmitters will be published in the October issue of Radio Science, a journal of the American Geophysical Union.

The technique is based on a principle known as a phased array, a method to align a number of mini-transmitters alongside one another and direct their combined beam into the sky. Such a system has previously been used for military radar technology, but has only recently become cost effective for civilian use because of improvements in consumer computing technology, according to the paper authored by Louis Scheffer at Cadence Design Systems. He indicates that the advantages from so many individual transmitters, using designs similar to cell phone technology, could include improved reliability and efficiency over currently used systems while reducing the transmission costs associated with the mammoth satellite dishes. Overall, he suggests that the net result could be significantly lowered costs for space communications, more data from science spacecraft, and an increase in planetary and deep-space research that requires remote signals.

Currently, planetary radars and distant spacecraft communications need transmitters with extremely high power, which has been accomplished by combining a strong microwave source with a large reflective antenna. This is now done with giant satellite dishes mechanically steered to a point in the sky. NASA's Goldstone radar, for example, the agency's sensitive, deep-space analysis radar, uses a 500 kilowatt transmitter and a 70-meter [230-foot] reflector for tracking asteroids that may collide with Earth. The large antenna is focused on only a small point in space at a time, and must be adjusted--and occasionally shut down--due to changing weather conditions. In addition, Scheffer points out that while almost all of the world's largest antennas are used to both send and receive, the powerful transmissions severely hinder their ability to detect faint signals from space.

"Imagine trying to listen for a whisper while you are shouting," Scheffer said. "Also, these antennas are incredibly busy, so only a small fraction of the possible science gets done."

He proposes a large, flat array of low-power transmitters printed on a number of circuit boards and attached to an unmoving infrastructure on the ground, controlled by computers, which can deliver an enormously powerful beam in any direction, or even multiple directions at once. The paper outlines the requirements of a new system that would offer enhanced reliability, since a single failure would not affect the overall signal, and improved maintenance costs because of its lack of moving parts and weather resistance. The system Scheffer proposes is designed solely to transmit, as is needed for planetary radar and spacecraft control. The transmitters would also allow existing antennas to operate in a more efficient receive-only mode.

If available mass-production manufacturing techniques used for electronics can be assumed for the centimeter-sized chips, a transmitter similar to the Goldstone radar could be constructed for nearly onequarter the cost, Scheffer reports. He notes that the significant amount of research and work done in the field of phased array radars renders the development of such a system plausible, though no previous applications to earth and space sciences have been studied. He further suggests that as computer chip technology continues to improve, additional wavelength and smaller antennas are possible to further improve the systems.

The first possible application would likely be for spacecraft command and asteroid research to observe objects that may pose a threat to Earth. A more speculative application, according to Scheffer, is that sending powerful signals to distant stars is easier and cheaper than previously thought. This dramatically reduces the cost of potential interstellar transmissions, such as searched for by SETI.

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