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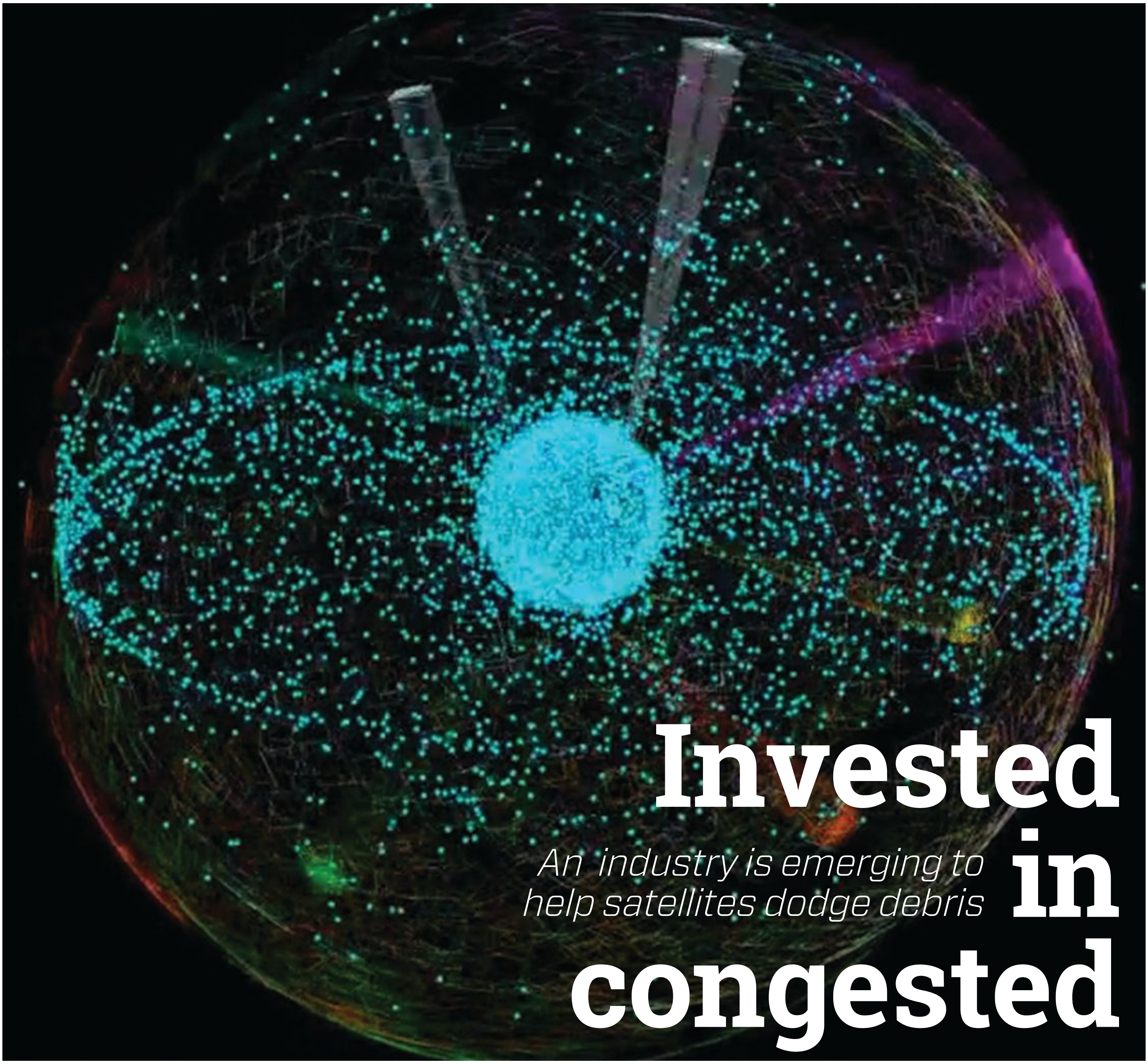


Invested in congested

An industry is emerging to help satellites dodge debris

INSIDE

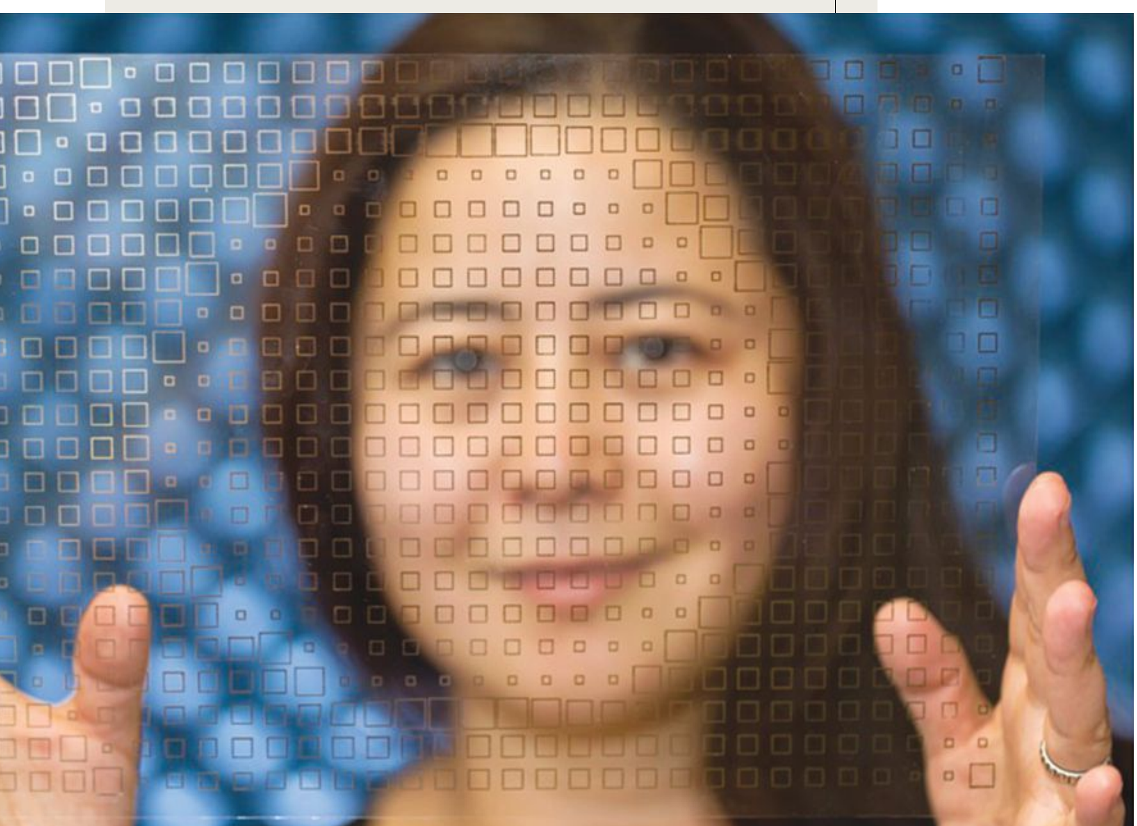
DoD demand stabilizing

Is space capital drying up?

A CLEAR solution for minimizing antenna mass

DEBRA WERNER

A Utah State University researcher has shown that reflectarray antennas printed directly on solar panels can relay data without significantly reducing the panels' ability to produce power, in a study with implications for space projects, ranging from tiny cubesats to Mars rovers.



UTAH STATE UNIVERSITY

Reyhan Baktur, associate professor of electrical and computer engineering at Utah State University, has developed a method to print high-gain antennas onto glass.

Reyhan Baktur, Utah State University associate professor of electrical and computer engineering, used silver-based ink to print high-gain X-band antennas on thin layers of glass over solar panels. During ground tests conducted in September, the antennas functioned well, and the glass remained 95-percent transparent, which meant the antennas had little impact on the solar panels' performance.

If the design works as well in space, it could eliminate the need for satellites to carry standalone high-gain antennas, which add weight and complexity because they must be stowed during launch and

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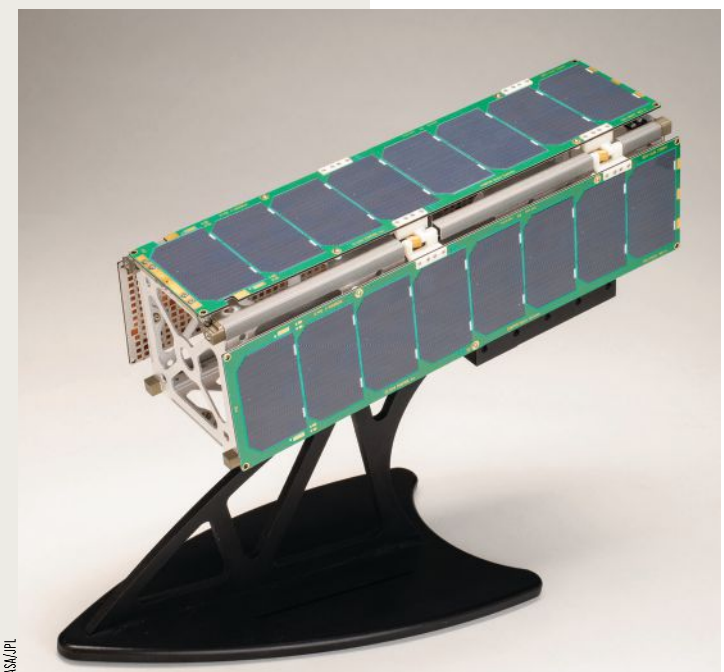
deployed in orbit.

"Anything you can do to minimize the mass and volume of antennas and solar panels is a good thing because you want to save as much space as possible for the payload," said John Hines, former NASA Ames chief technologist and now managing director of JH Technology Associates LLC, a San Francisco-based consulting firm.



NASA/JPL

ISARA reflectarray antenna in launch configuration

In addition, high-gain antennas printed on solar panels would be useful for Mars rovers and for satellites in low-Earth orbit sending information through NASA's Tracking and Data Relay Satellites because, in both cases, the missions call for antennas and solar panels to point in the same direction, said Baktur, principal investigator for Integrated Solar Panel and Antenna Array for Cubesats (ISAAC), a project NASA selected in 2015 as one of eight small-technology partnerships that pair university researchers with NASA scientists and engineers. Both the NASA Ames Research Center and NASA Goddard Spaceflight Center have provided funding for ISAAC.

To further evaluate the ISAAC technology, Baktur hopes to conduct tests at a NASA Center to determine how well the antennas will withstand the environmental extremes of spaceflight. After that, she is eager to find an opportunity to test the technology in orbit.

A similar technology developed by NASA's Jet Propulsion Laboratory, Integrated Solar Array and Reflectarray Antenna (ISARA), a five-kilogram satellite designed to send data to ground stations at speeds of more than 100 megabits per second, is awaiting its first orbital test flight. ISARA differs from ISAAC because ISARA carries a ka-band high-gain antenna produced with printed circuits mounted on the back of a solar panel.

ISARA was scheduled to launch in September on a SpaceX Falcon 9 rocket, but the launch has been delayed as a result of the Sept. 1 Falcon 9 launch-pad explosion. JPL also plans to integrate X-band reflectarray antennas with solar panels for Mars Cubesat One (MarCO), a mission that includes twin six-unit cubesats roughly the size of a briefcase that are designed to relay data from NASA's Interior Exploration using Seismic Investigations, Geodesy and Heat Transport mission or InSIGHT mission, a lander scheduled to launch in 2018 to study Mars' interior.

ISARA is a step in the right direction because it combines solar panels with reflectarray antennas, Hines said. ISAAC continues that trend by further reducing the thickness of the combined antenna-solar panel.

What's more, ISAAC may demonstrate that antenna arrays could be printed on a single substrate or a variety of substrates, including flexible materials that could be stowed and deployed more easily than current antennas, Elwood Agasid, NASA Ames Small Spacecraft Technology deputy program manager, said by email.

Richard Hodges, NASA Jet Propulsion Laboratory's ISARA principal investigator, said there are advantages and disadvantages to both the ISARA and ISAAC designs. A remote-sensing or communications satellite in low-Earth orbit, for example, may need to point its solar panel toward the sun and its reflectarray antenna in the opposite direction.

Nevertheless, the ISAAC "technology does look very promising," Hodges said, adding, "it probably still has some technical challenges." SN