412TW-PA-19550

NEW TELEMETRY ANTENNA ACCOMMODATES NATIONAL SPECTRUM CHANGES

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Draft News Article V3 – September 26, 2019

New Telemetry Antenna Accommodates National Spectrum Changes

The growing demand for wireless services – including new internet-of-things and 5G devices – has led to a reallocation of frequencies that for decades had been reserved for military uses, including flight-testing of various weapons systems. To accommodate that shift in the allocation of the national spectrum, engineers at the Georgia Tech Research Institute (GTRI) have developed a prototype telemetry antenna that would allow continued testing of a widely used surface-to-air missile.

The prototype C Band antenna is designed to provide telemetry data on flight tests of the RIM-116 Rolling Airframe Missile (RAM), a homing surface-to-air missile used by the U.S. Navy and the armed forces of several other nations. The missile is unusual because it rolls along its longitudinal axis in flight path, stabilizing the missile – and providing a significant challenge for the antenna designed to downlink test data to a ground station.

Researchers addressed the challenge by pairing GTRI's patented fragmented aperture antenna design technology with a switched beamformer. The fragmented aperture is an antenna concept that can be highly customized to fit the requirements of a particular application by optimizing a patchwork of discrete conducting and dielectric units distributed over the specified aperture.

"As the missile rolls at a fairly high rate, the antenna will switch the beam to keep it pointed at a position on the ground," said Kevin Cook, a GTRI senior research engineer who led the project. "The fragmented aperture technology relies heavily on computational electromagnetic modeling and optimization. For this application, it allowed us to achieve an antenna design that has the radiation pattern required to meet the customer's requirements."

The antenna, which would only be used during test firings, had to be conformable to wrap around the five-inch diameter missile. The antenna also had to survive temperatures of 500 degrees Fahrenheit, which along with challenging electrical requirements, dictated the use of a ceramic substrate.

The new antenna operates at a frequency range of 4400 MHz to 5150 MHz to stay within the new spectrum allocation. Going to a higher frequency with an antenna the same size as the old one created significant functional challenges that require the new antenna to have active electronics, whereas the old one was passive.

While the antenna design itself was challenging, fabrication of the prototypes offered an unexpected set of issues, Cook said.

"To get the performance we needed, we had to use a substrate with a high dielectric constant – a ceramic material," he said. "We had to work out how to get the curved shape needed for a conformal antenna using this ceramic material, which had to be quite thin to fit mechanically."

The ceramic components, created in two halves, were fabricated in the GTRI Machine Shop. They have a very smooth surface, which presented problems for adhering the substrates carrying the metal patterns that compose the rest of the antenna. The first prototypes suffered cracks, which required some research to develop a solution.

“Some materials that might have been easier for us to assemble would not have been able to survive the required temperature profile,” Cook explained. GTRI engineers ultimately chose a high temperature adhesive system along with an RF material known as TLY-5, which has a fiberglass weave held together by an epoxy resin.

The antenna uses two five-to-one switches to control the active electronics. To maintain the beam direction, two of ten subarrays are active at any given time in alternating patterns. The configuration was selected to keep gain variation to 5 dB or less. “The kind of interleaving we chose allowed us to meet and exceed the program’s requirements for gain variation,” Cook said.

Electromagnetic performance testing of the prototype was done in GTRI’s indoor compact range. Further tests were done in August 2019 on a five-axis flight simulator at a government test facility in China Lake, California.

Further development will likely be needed before the antenna can be tested on a real missile and ultimately be manufactured by a contractor for the Department of Defense (DoD).

The research was supported by the National Spectrum Consortium, which receives funding from the sale of national spectrum to commercial users such as wireless companies. The consortium is supporting other projects at GTRI, all aimed at solving problems caused by the loss of spectrum for DoD users while simultaneously advancing the associated technologies. The technical customer for the antenna is the Test Resource Management Center, which operates test facilities for DoD agencies.

“Changes in spectrum allocation are a big concern for the test and evaluation community,” Cook said. “There is a lot of effort going into figuring out how to co-exist with commercial users. We’re pleased to contribute our expertise with a unique antenna designed for that effort.”

IMAGE CAPTIONS:

03: A prototype telemetry antenna developed by GTRI researchers is shown with test equipment. The antenna uses fragmented aperture antenna design technology with a switched beamformer.

08: GTRI senior research engineer Kevin Cook holds a prototype telemetry antenna developed by GTRI in an indoor compact range. The antenna, shown with test equipment, uses fragmented aperture antenna design technology with a switched beamformer.

09: A prototype telemetry antenna developed by GTRI researchers is shown with test equipment in an indoor compact range. The antenna uses fragmented aperture antenna design technology with a switched beamformer.

123: A prototype telemetry antenna developed by GTRI researchers is shown on a five-axis flight simulator at the government Integrated Battle Arena test facility at China Lake, California. The antenna uses fragmented aperture antenna design technology with a switched beamformer.

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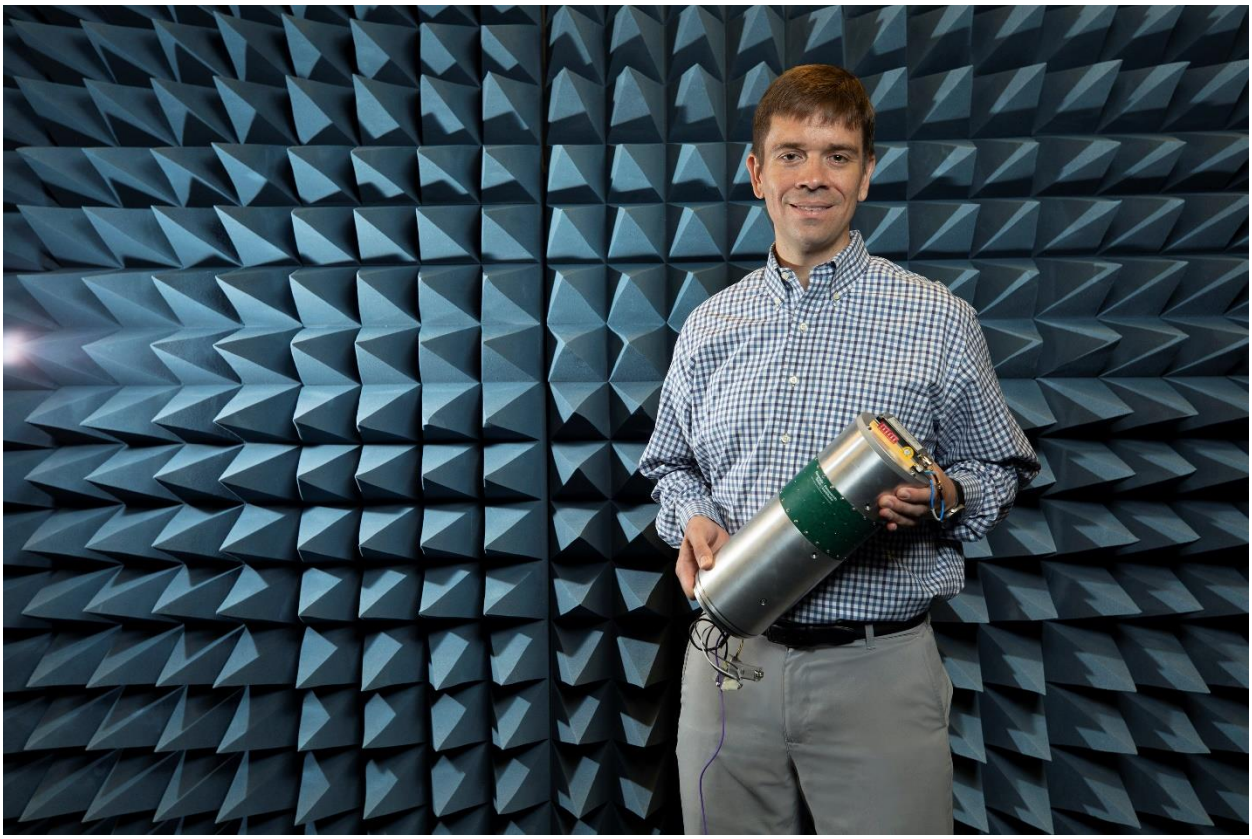


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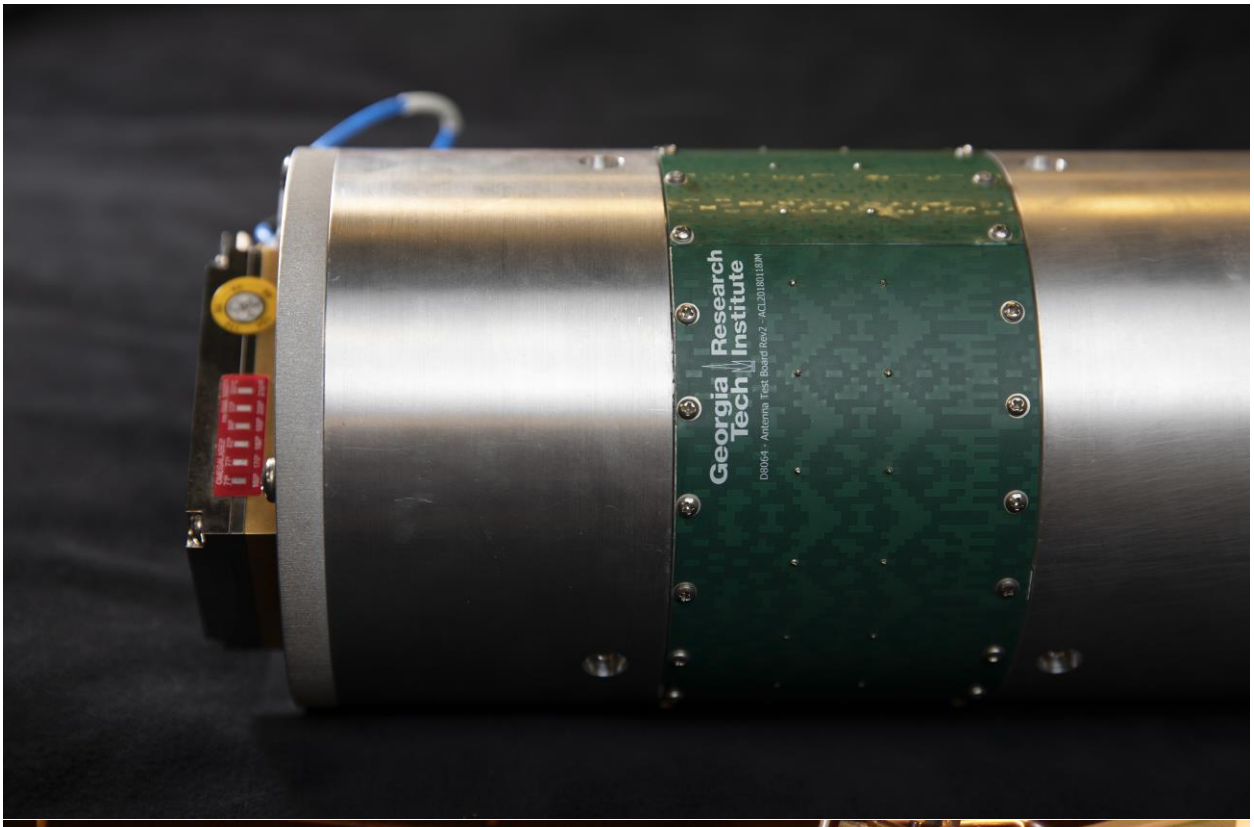
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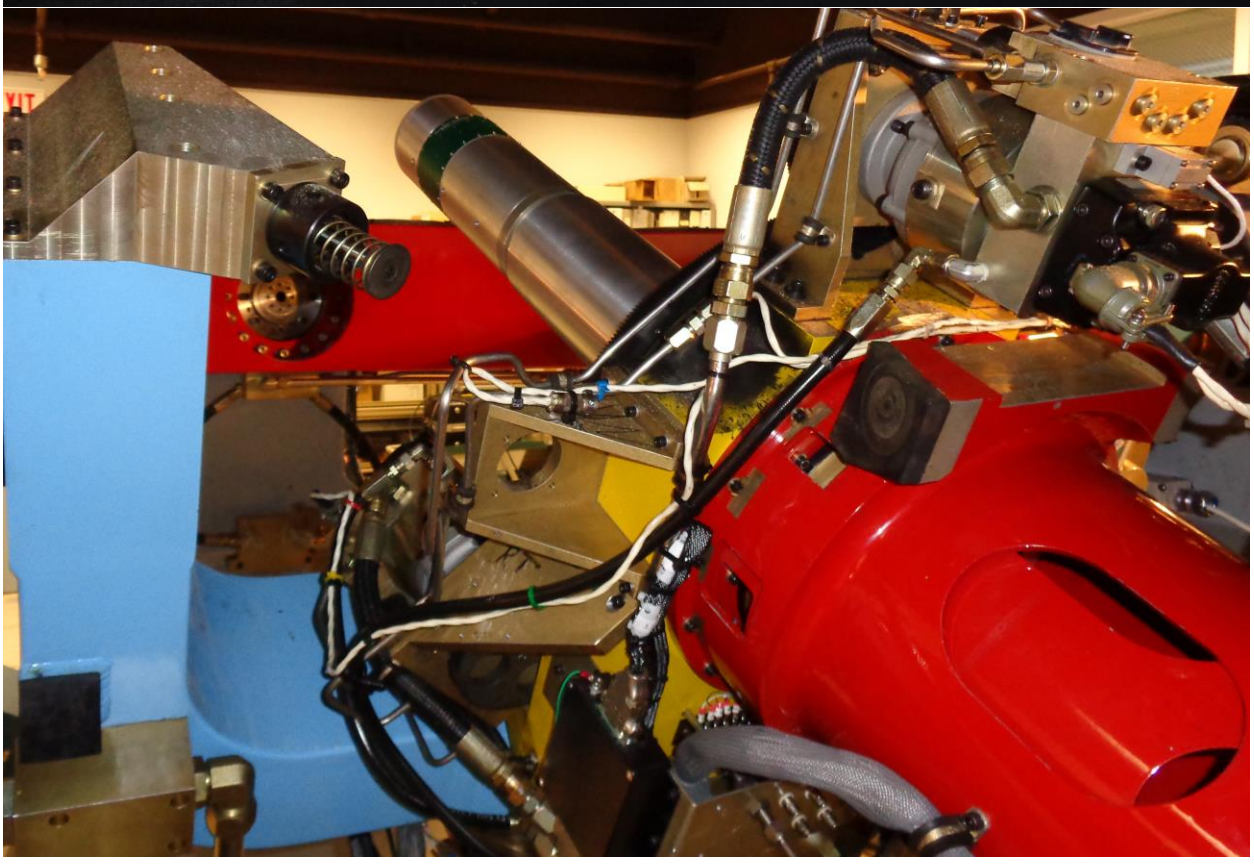
D8064 - Antenna Test Board Rev2 - ACL20180118M



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	**2. REPORT TYPE**	**3. DATES COVERED** *(From - To)*
13-11-2019	News Article	

4. TITLE AND SUBTITLE
New Telemetry Antenna Accommodates National Spectrum Changes

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Kevin Cook

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES)
Georgia Tech Research Institute (GTRI)
GTRI Headquarters
250 14th Street, NW
Atlanta, GA 30332

8. PERFORMING ORGANIZATION REPORT NUMBER
412TW-PA-19550

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
412th Test Wing
195 E Popson Ave
Edwards AFB CA 93524

10. SPONSOR/MONITOR'S ACRONYM(S)
N/A

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release A: distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

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15. SUBJECT TERMS
Georgia Tech; Telemetry Antenna

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
					412 TENG/EN (Tech Pubs)
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**	None	6	**19b. TELEPHONE NUMBER** *(include area code)*
Unclassified	Unclassified	Unclassified			661-277-8615