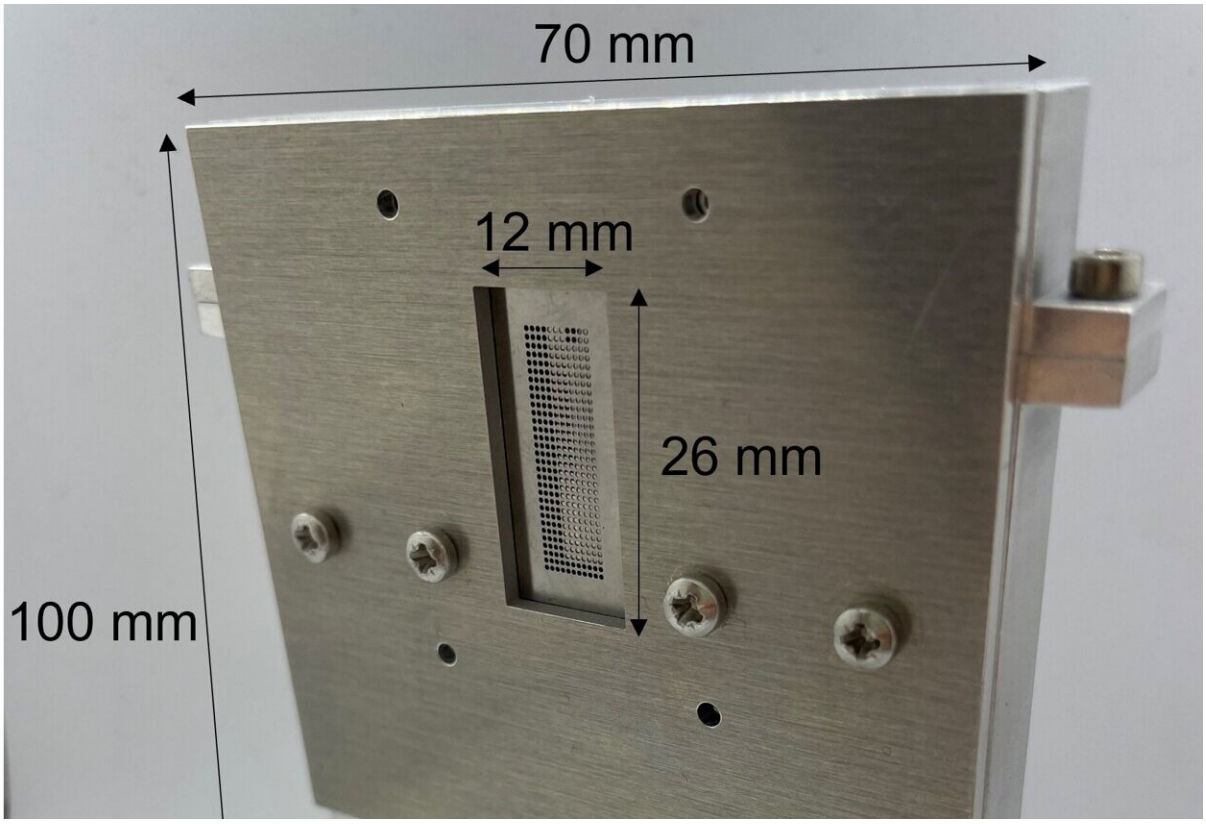
'Beam-steering' technology takes mobile communications beyond 5G

June 3 2022



The beam-steering antenna technology has been developed to increase the efficiency of fixed base station antenna at 5G (mmWave) and 6G, and can also be adapted for vehicle-to-vehicle, vehicle-to-infrastructure, vehicular radar, and satellite communications. Credit: University of Birmingham

Birmingham scientists have revealed a new beam-steering antenna that

increases the efficiency of data transmission for 'beyond 5G'—and opens up a range of frequencies for mobile communications that are inaccessible to currently used technologies.

Experimental results, presented today for the first time at the 3rd International Union of Radio Science Atlantic / Asia-Pacific Radio Science Meeting, show the device can provide continuous 'wide-angle' beam steering, allowing it to track a moving mobile phone user in the same way that a satellite dish turns to track a moving object, but with significantly enhanced speeds.

Devised by researchers from the University of Birmingham's School of Engineering, the technology has demonstrated vast improvements in data transmissoin efficiency at frequencies ranging across the millimeter wave spectrum, specifically those identified for 5G (mmWave) and 6G, where high efficiency is currently only achievable using slow, mechanically steered antenna solutions.

For 5G mmWave applications, prototypes of the beam-steering antenna at 26 GHz have shown unprecedented data transmission efficiency.

The device is fully compatible with existing 5G specifications that are currently used by mobile communications networks. Moreover, the new technology does not require the complex and inefficient feeding networks required for commonly deployed antenna systems, instead using a low complexity system which improves performance and is simple to fabricate.

The beam-steering antenna was developed by Dr. James Churm, Dr. Muhammad Rabbani, and Professor Alexandros Feresidis, Head of the Metamaterials Engineering Laboratory, as a solution for fixed, base station antenna, for which current technology shows reduced efficiency at higher frequencies, limiting the use of these frequencies for long-

distance transmission.

Around the size of an iPhone, the technology uses a metamaterial*, made from a metal sheet with an array of regularly spaced holes that are micrometers in diameter. An actuator controls the height of a cavity within the metamaterial, delivery micrometer movements, and, according to its position, the antenna will control the deflection of the team of a radio wave—effectively 'concentrating' the beam into a highly directive signal, and then 'redirecting this energy as desired'—whilst also increasing the efficiency of transmission.

The team is now developing and testing prototypes at higher frequencies and in applications that take it beyond 5G mobile communications.

Dr. Churm commented: "Although we developed the technology for use in 5G, our current models show that our beam steering technology may be capable of 94% efficiency at 300 GHz. The technology can also be adapted for use in vehicle-to-vehicle, vehicle-to-infrastructure, vehicular radar, and satellite communications, making it good for next generation use in automotive, radar, space and defense applications."

University of Birmingham Enterprise has filed a patent application for this next generation beam-steering antenna technology, and is seeking industry partners for collaboration, product development or licensing.

The efficiency and other aspects of the underpinning technology have been subjected to the peer review process, published in respected journals, and presented at academic conferences[1,2,3,4].

Dr. Churm added: "We are assembling a further body of work for publication and presentation that will demonstrate a level of efficiency that has not yet been reported for transmission of radio waves at these challenging frequencies. The simplicity of the design and the low cost of

the elements are advantageous for early adoption by industry, and the compact electronics configuration make it easy to deploy where there are space constraints. We are confident that the beam-steering antenna is good for a wide range of 5G and 6G applications, as well as satellite and the Internet of Things."

*Metamaterials is the term used for materials that have been engineered to have special properties that are not found in naturally occurring materials. These properties can include the manipulation of electromagnetic waves by blocking, absorbing, enhancing, or bending waves.

More information:

1. Rabbani et al (2022). 'Enhanced Data Throughput Using 26 GHz Band Beam-Steered Antenna for 5G Systems'. *16th European Conference on Antennas and Propagation (EuCAP).*
2. Rabbani et al (2022). 'Continuous Beam-Steering Low-Loss Millimeter-Wave Antenna Based on a Piezo-Electrically Actuated Metasurface'. *IEEE Transactions on Antennas and Propagation.*
3. Rabbani et al (2021). 'Electro-Mechanically Tunable Meta-Surfaces for Beam-Steered Antennas from mm-Wave to THz'. *50th European Microwave Conference (EuMC).*
4. Rabbani et al (2020). 'THz Leaky-Wave Antenna Beam Steering With Low Loss Dynamic Tuning'. IEEE *International Symposium on Antennas and Propagation and North American Radio Science Meeting, 2020.*

Provided by University of Birmingham