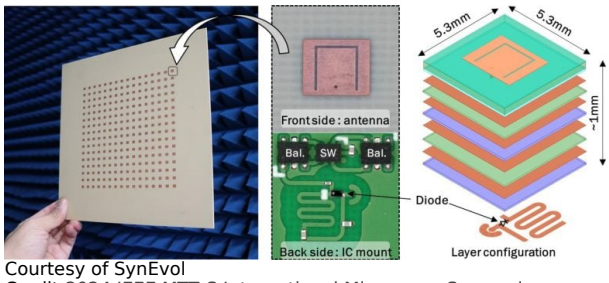
Scientists in Japan Create an Effective Wireless Transceiver Array

Posted by Okachinepa 07/12/2024

Courtesy of SynEvol
Credit: Researchers at Tokyo Tech

Tokyo Tech researchers have created a novel wireless transceiver array with 256 elements for 5G non-line-of-sight communication. This innovative design can improve 5G network coverage even in locations where links are blocked because to its high power conversion efficiency and effective wireless power transmission. Improved coverage area and flexibility may make low-latency, high-speed communication more widely available.

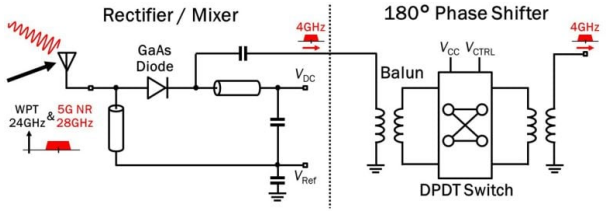
With its fast speed, low latency, and massive network capacity, millimeter wave 5G communication, which employs radio transmissions at extremely high frequencies (24 to 100 GHz), is a promising technology for next-generation wireless communication. Present 5G networks, however, confront two major obstacles. The poor signal-to-noise ratio (SNR) is the first. Effective communication requires a high SNR. Link blockage, or the disturbance of the signal between the transmitter and the receiver as a result of obstructions like buildings, is another problem.



Courtesy of SynEvol
Credit:2024 IEEE MTT-S International Microwave Symposium

Beamforming is a crucial millimeter wave long-distance communication technology that increases signal-to-noise ratio. Similar to focusing a flashlight beam on a single point, this approach uses an array of sensors to focus radio signals into a narrow beam in a specified direction. It can only be used for line-of-sight communication, which requires a straight path between the transmitter and the receiver. Obstacles can also deteriorate the received signal. Additionally, contemporary glass materials and concrete can result in significant propagation losses. Therefore, a non-line-of-sight (NLoS) relay system is desperately needed to increase the coverage of the 5G network, particularly indoors.

A group of researchers from the Tokyo Institute of Technology (Tokyo Tech) Laboratory for Future Interdisciplinary Research of Science and Technology led by Associate Professor Atsushi Shirane created a unique wirelessly powered relay transceiver for 28 GHz millimeter-wave 5G communication in order to solve these problems (see Figure 1). The IEEE MTT-S International Microwave Symposium Proceedings from 2024 contain a publication of their study.



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Shirane explains the rationale for their research, saying, "In the past, two types of 5G relays have been explored: an active type and a wireless-powered type: for NLoS communication. The active relay consumes a lot of power, but it can still maintain a decent signal-to-noise ratio even with few rectifier arrays. The wirelessly powered kind uses CMOS diodes with less than ten percent power conversion efficiency and requires several rectifier arrays to maintain SNR due to poor conversion gain. However, this form of power supply is not needed. Our solution makes use of semiconductor integrated circuits (ICs) that are readily available in the market to meet their problems.

With wireless power transfer operating at 24 GHz, the suggested transceiver is composed of 256 rectifier arrays (WPT). These arrays are made up of discrete integrated circuits (ICs), such as gallium arsenide diodes, and baluns, which serve as interfaces between DPDT switches, digital ICs, and balanced and unbalanced (bal–un) signal lines (see Figure 2). The transceiver is noteworthy for its ability to transmit data and power simultaneously, converting a 24 GHz WPT signal to direct current (DC) and enabling simultaneous bi-directional 28 GHz transmission and reception. While the 28 GHz signal is delivered and received using beamforming, the 24 GHz signal is received at each rectifier separately. The 28 GHz signal can be sent either

retro-reflectively with the 24 GHz pilot signal, and both signals can be received from the same direction or different directions.

Testing showed that the suggested transceiver can outperform traditional transceivers while retaining SNR over extended distances, with a power conversion efficiency of 54% and a conversion gain of –19 dB. It also generates roughly 56 milliwatts of electricity, which can be further enhanced by expanding the number of arrays. Additionally, the transmission and reception beams' resolution may be enhanced as a result. Regarding the advantages of their product, Shirane says, "The proposed transceiver can contribute to the deployment of the millimeter-wave 5G network even to places where the link is blocked, improving installation flexibility and coverage area."

With the widespread use of 5G networks, this novel transceiver will enable high-speed, low-latency communication for all!
