OTA testing of 5G's massive MIMO antenna arrays requires 3D perspective and high-performance equipment

5G will apply multiple antenna systems and combine them with enhanced spatial multiplexing to provide data for multiple users – known as massive MIMO. One consequence is that performance evaluation of radiation patterns cannot be performed using conducted methods, so connection over-the-air (OTA) will be essential. ***Reiner Stuhlfauth and Dr. Corbett Rowell, Technology Marketing Managers at test & measurement provider, Rohde & Schwarz*** *outline the technical aspects of how to measure three-dimensional antenna patterns using an over-the-air testing setup.*

The upcoming 5G standard promises more throughput, capacity and implementation flexibility, while delivering lower operational expenses (OPEX). Other goals include enabling ultra-reliable low-latency communications (uRLLC) and massive machine type communications (mMTC). Software-defined networks (SDN) and massive MIMO multiple antenna scenarios are likely technology choices for achieving these goals.

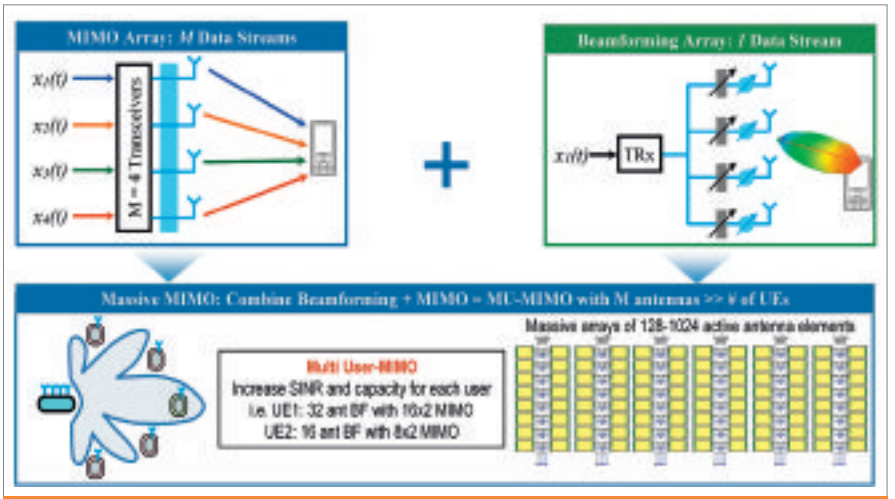

Figure 1. Massive MIMO – the combination of beamforming and spatial multiplexing

To obtain the wider bandwidths for higher throughput, 5G systems will use frequencies in the cm and mmWave ranges. One drawback to this approach is higher free-space path loss.

Antenna arrays that provide a much higher antenna gain can compensate for free-space path loss. To maintain the same Rx power at a frequency of 28GHz (compared to 900MHz), the antenna gain must be increased by 30dB. Using a high number of antenna elements, known as beamforming, can achieve this goal.

Beamforming also significantly reduces the energy consumption by targeting individual UEs with their assigned signal. In a base station without beamforming, energy not received by the UE can create interference for adjacent UEs, or is simply lost.

Current standards like LTE or WLAN employ multiple-input multiple-output (MIMO) antennas to obtain a higher capacity through spatial multiplexing. Multi-user MIMO extends MIMO by sending data to different UEs simultaneously using beamforming. The term 'massive MIMO' describes the combination of beamforming and spatial multiplexing in a dynamic manner, depending on hardware configuration and channel conditions (see Figure 1).

With 5G and massive MIMO, meaningful characterisation of signals and measurements of antenna array power can only be accomplished using over-the-air (OTA) testing.

Challenges for massive MIMO

While massive MIMO offers many advantages, there are also several challenges, including:

1) High throughput for fronthaul interface connection
2) Antenna array calibration
3) Mutual coupling between antenna elements
4) Irregular antenna arrays
5) Antenna array complexity

Massive MIMO introduces similar challenges for characterising signals and measuring antenna array power, which cannot be met by the traditional conductive interface with a cable. Meaningful characterisation can only be