Impact of 5G MIMO Antenna Arrays Mutual Coupling on Amplifier Linearity and Efficiency

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Modern and future 5th Generation transmitter architectures are driven toward multi-input multi-output (MIMO) transceivers in which several radio frequency (RF) power amplifiers (PAs) drive an antenna array. In 5G sub 6 GHz and, in particular, future millimeter-wave bands, the isolators often present between the antennas and the PAs must be removed, since they are based on bulky, and incompatible with integrated circuit technology, non-reciprocal ferrite-based devices.

Because the antenna array elements are electromagnetically coupled, the waves feeding each of the antennas are also driving the output ports of all the other PAs. This effect creates an apparent variable load at the output of each PA, which can be caused by the different phases with which each antenna is excited – in a single-channel beam-steering scenario –, and so dynamically depends on the mobile position, or even simply induced by the interchanged information – in a multi-channel transmitting scenario.

In such a system, the behavior of each PA cannot be fully described as a function of, solely, its input, as it will change according to the coupled signal originated in all the other PAs. To predict and understand the behavior of these complex MIMO systems, simulation becomes a powerful, but also indispensable, engineering design tool.

In this work, the Wireless Circuits and Systems group of IT-Aveiro, not only demonstrated the unexpected impact of these load variations on the PAs' efficiency as, using their prize-winning double-input-double-output signal and dc PA behavioral model, were able to develop a simulator capable of predicting the MIMO transmitter FoMs of interest.

Because of the dramatic need to save energy in future 5G communication systems, the experimental demonstration and subsequent simulation of the impact of MIMO array antenna coupling onto the transmitters' power consumption efficiency was highlighted as a ground-breaking technology in the November, 2017, IEEE Microwave Newsletter.