Simulation of OTA System Performance Parameters in a mm-Wave CATR for 5G Testing

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***Abstract*—The fifth generation (5G) mobile network promises to deliver multi-Gbps data capacity [1]. Achieving this requires the widespread adoption of several new technologies with the use of higher frequency, millimeter wave, bands and more complex massive MIMO (Multiple Input Multiple Output) architectures being principal among them [1, 2]. As the intended *circa* 10 to 20 fold increased in data capacity is one of the most prominent promises of the 5G roll-out, absolute data throughput is perhaps the primary Figure of Merit (FOM) used for the verification of network performance and to discriminate between respective base-station subsystems (BSS) in terms of absolute over the air (OTA) performance [1]. The adoption of OTA communication system level performance metrics and the tighter integration between the physically smaller massive MIMO array antenna and the increasingly complex active electronics means that widespread interest in classical antenna performance parameters is waning. Instead, focus is shifting towards alternative communication system level parameters such as far-field error vector magnitude (EVM), bit error rate (BER), signal-to-interference-plus-noise-ratio (SINR), *etc.* which predicate the use of quadrature amplitude modulation (QAM) waveforms of varying orders and more directly relate to data-rates [2].**

This, therefore, represents a very significant shift for the far-field antenna measurement community where hitherto monochromatic continuous wave (CW), or at most a pulsed CW, RF signal was used almost exclusively. The requirement for broadband orthogonal frequency-division multiplexing (OFDM) with quadrature amplitude modulation (QAM) schemes when combined with the requirement that system performance be determined in far-field mode has resulted in the recent, and very significant, resurgence of interest in the compact antenna test range (CATR). CATR's have the inherent advantage that they offer a way to determine real-time, broadband, far-field performance at a very much reduced, fixed, range-length. This is of particular importance for 5G applications where testing the higher-frequency, larger apertures required by active mm-wave massive-MIMO antennas results in far-field distances that are very much larger than those which were previously required when working with prior generations of networks at sub-6 GHz frequencies and which cannot otherwise be conveniently realized economically indoors.

Although CATR modeling is a well established, mature discipline capable of determining quiet-zone (QZ) quality [3] and measurement uncertainties for a range of typical antenna parameters for a known antenna under test (AUT) / CATR combination [3], it has not previously been possible to equate this to the effect that this would have on OTA system-level properties such as EVM, BER, *etc.* In this paper we present the results of a recent study that extended our previously published simulation technique [4, 5, 6] to include these system performance metrics to enable the design and optimization of a CATR test system that is capable of providing sufficient reliability, repeatability and an acceptable level of measurement uncertainty for a given 5G OTA testing application. Preliminary results are presented and discussed.

***Index Terms*—5G, Massive MIMO, mm-Wave, OTA, CATR, EVM, BER, Range Simulation.**

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