Beamforming and population exposure: 5G NR measurement methodologies applied to LTE AAS

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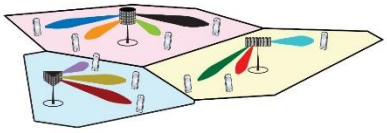
INTRODUCTION

The deployment of AAS (Active Antenna Systems) as TLC systems for new mobile radio technologies represents a great discontinuity and improvement compared to legacy generation TLC systems .
These antennas enable massive-MIMO (mMIMO) and beamforming mechanisms, with enormous advantages for radio resource management, performance and energy efficiency.
The international scientific community has to go into detail for updating and defining efficient operational procedures to estimate the EMF exposure of the population produced by AAS in TLC BTS.
Active antennas could actually be used not only by the 5G NR systems, mMIMO mechanism is also enabled for telecommunications systems of legacy generations: practical examples illustrated in IEC TR 62669 to support the definition of the statistical attenuation factor FPR are use-cases of TLC systems with LTE technology signals.

OBJECTIVES



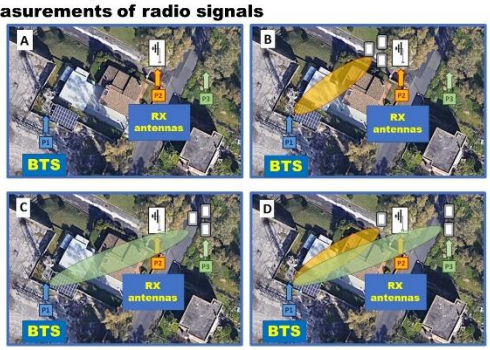
The aim of this work is showing results of a measurement campaign conducted by ARPA Lazio of downlink signals from an LTE mMIMO system in a Wind TRE S.p.A. (IT MNO) BTS. With the help of MNO different controlled operating conditions was been tested to characterize the behavior of this kind of signals emitted from an AAS. The results will be useful to increase knowledge regarding LTE mMIMO systems operating with AAS. This knowledge will be useful in the future to update technical procedures for EMF measurements from BTS of CEI (Italian Electro Technical Committee) to be applied for the evaluation of human exposure to EMF from this type of sources.

TEST SITE and OBJECTIVES

MNO operators used 3 mobile devices with proprietary control SW to simulate massive downlink radio traffic and allow measurements and analysis of different radio traffic scenarios and achieve 2 main objectives. 4 different scenarios for power level measurements of radio signals

1
Beamforming operation analysis
Traffic beams power level estimation with measurements of BTS signals using single-user and multi-user MIMO technology

2
Verify costant level of the emission power level of broadcast beams
Continuos monitoring of control channels (RS, PSS, SSS, PBCH) power level



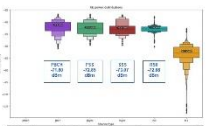
SCENARIO A
No downlink radio traffic. Acquisition of power levels of the LTE broadcast channels.

SCENARIO B
3 MNO mobile devices near P2 to achieve maximum emitted power level of the downlink traffic radio channels and the full saturation of the LTE radio frame. An high gain traffic beam at maximum power level towards receiving antennas simulate the worst case in EMF exposure.

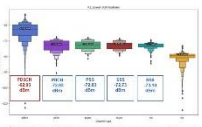
SCENARIO C
3 MNO mobile devices near P3 to investigate the beamforming behavior of mMIMO technology from AAS.

SCENARIO D
Mixed positioning of MNO mobile devices. One device near P2 and 2 devices near P3 to investigate the SU/MU-MIMO technology and simulate a real scenario of of EMF exposure.

CONCLUSION

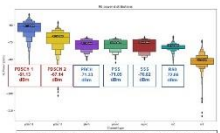


No downlink traffic radio channel, only broadcast channels power levels acquisition.



10 dB difference in power level between downlink traffic radio channel and broadcast channels. Evidence of beamforming technology activation for traffic beams

3 dB difference in power level between downlink traffic radio channel and broadcast channels. Traffic beams are towards MNO devices in P3 and EMF exposure in P2 is reduced



2 different power levels for PDSCH, 2 alternate different traffic beams towards P2 (+10 dB over control channels) and P3 (+3 dB over control channels). Evidence of activation of SU-MIMO technology,

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Verify costant level of the emission power level of broadcast beams
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Channels	Power level	DELTA	BEAMFORMED
Broadcast	-72 dBm	-	No
PDSCH in P3	-68 dBm	+ 3 dB	Yes
PDSCH in P2	-62 dBm	+ 10 dB	Yes

	SCENARIOA	SCENARIOB	SCENARIOC	SCENARIOD
RS port 0 [dBm]	-70.026	-70.058	-69.948	-70.218
RS port 1 [dBm]	-77.655	-78.137	-78.451	-78.388
RS total [dBm]	-69.334	-69.430	-69.375	-69.602

The measurements discussed in this study allow for drawing conclusions on the correct procedures for assessing the exposure produced by LTE AAS in BTS. A first noteworthy result is that the control channels are not beamformed. As a direct consequence, the received power is substantially independent of the user's position in space. In order to further investigate the peculiarities of control channels' transmission, 2 different measurements chains were used: Chain A was used to continuously monitor the received power associated with the RS channel across all four scenarios considered in this study. The monitoring results, reported in Table 1, demonstrate the invariance of the received power, confirming the assumption that the AAS behaves with control channels like a traditional passive transmission system.
Another important result is that, due to the beamforming of the data traffic, assessments regarding the maximum exposure generated by LTE AAS systems should be based on PDSCH received power in conditions where the beam is directed towards the receiving antenna (Scenario B). In fact, as demonstrated by the results, measuring the PDSCH under conditions other than maximum exposure may lead to large underestimations.

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