OTA Throughput Testing of LTE MIMO capable terminals

[#]Alessandro Scannavini [1], Lars. J. Foged [1], Nicolas Gross [2], Francois Chauvet [3]
[1] SATIMO Italian Office
Via Castelli Romani 59, 00040 Pomezia Italy
ascannavini@satimo.com , lfoged@satimo.com
[2] SATIMO Main Office
17, Avenue de Norvegé, 91953 Courtaboeuf Cedex, France
ngross@satimo.fr
[3] SATIMO Hong Kong Office
Suite 702, 7/F Cyberport 1, 100 Cyberport Road, Hong Kong
fchauvet@satimo.fr

Abstract

This paper gives an overview of the OTA testing performed by using the SATIMO StarMIMO test range. It is based on the well –documented SFE (Spatial Fading Emulation) technique [1-2] for OTA measurements of multi-antennas and MIMO (Multiple – Input Multiple-Output) based devices. Throughput versus average channel model power is presented. The reported measurement campaign is part of the 3GPP/COST2100 MIMO OTA round robin testing activity [3-4]. Comparison of Throughput results when using different channel models, and different setups is also highlighted.

Keywords : 3GPP, COST2100, LTE, MIMO, OTA, SCME, STARMIMO

1. Introduction

Test range is composed of 24 dual polarized probes placed on a horizontal full circle. Probes are evenly spaced, 15 deg and radius of the test range from probe to DUT is 1.2m. For the testing campaign two different probes' setups have been used. They can be divided in two categories, single cluster and multiple cluster setups. Figure 1 shows the test range block diagram for single (left) , and multiple cluster (right) setups. Probes' numbering is chosen according to the channel emulator mapping algorithm to the either 8 or 4 probes in order to emulate at the center of the arch a spatial channel model with SCME settings in terms of Power-Delay-Profile (PDP), doppler spread, delay spread, and angular spread (AS) [4].

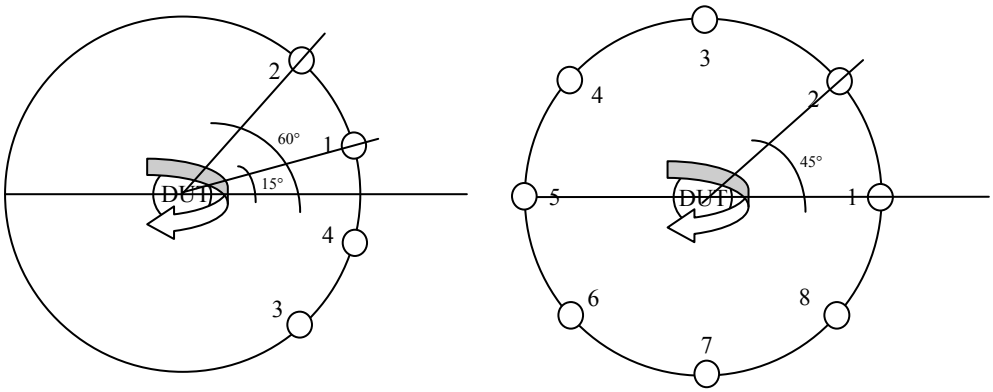

Figure 1: Single Cluster (left) and multiple cluster (right) setups.

Anritsu MT8820C has been used as eNode-B emulator in order to emulate an LTE MIMO radio link. Two data streams of the downlink signal from the eNode-B emulator go into the channel emulator and via an amplifiers rack to the probes. Due to the fact that testing must be done when a call has been established between the DUT and eNode-B emulator the loopback is done by using a so called "link" antenna placed in the turning table.
Figure 3 shows the StarMIMO test range.

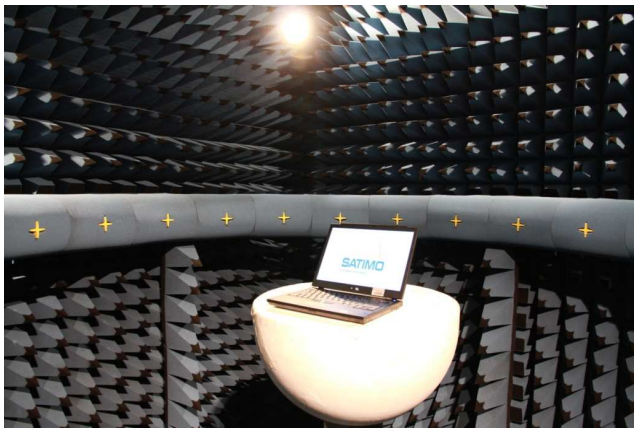

Figure 3: SATIMO StarMIMO test range

2. Calibration and Power Measurements

Before starting any measurements with the above mentioned set up, calibration and average channel power measurements must be performed by using a reference antenna placed in the center of the test set up for each polarization being used. The following dipoles have been used:

- SD2600, and MD2600 -> LTE Band 7 (RX: 2620-2690MHz)

2.1 **Calibration**

Attenuation from eNode-B emulator output to the DUT location through each path was measured using Agilent PNA network analyzer and the above mentioned dipoles as reference antennas. It has to be noted that calibration must be performed for both V, and H polarization of the probes. It implies the use of one Sleeve dipole for V polarization and one magnetic dipole for H polarization [3-4].

2.2 **Average Channel Power**

Average channel power is defined as the power at the center of the array when all used probes are transmitting [3-4]. Power has been calculated and verified for each channel model, for each polarization and for both single cluster and multiple cluster approaches. Total power is the sum of power in the vertical polarization and power in the horizontal polarization.

3. DUT setups

Five USB Dongles have been tested, all of them operating in the LTE Band 7 and implementing MIMO technology on the DL. Figure 4 shows two different used setups when USB dongle is connected to Laptop DELL D43 (left), and DELL E6400 (right) used as Host Laptop.


Figure 4: SATIMO StarMIMO test range

Center of rotation is the geometrical center of the laptop. Lid is open at 110deg as per CTIA OTA Test plan version 3.1 Appendix L4 [5].

3. Channel models

Channel models used in the measurements were the following:

- SCME UMi and UMa for multiple cluster as it is defined in 3GPP TR 37.976 [3]

- SCME UMi single cluster as it is defined in 3GPP TR 37.976 [3]
- SCME UMa from TR 37.976 [3] modified for a single cluster set up by setting all AoA to 0°

Mobile speed used was 3km/h. XPR is defined in [3], and it is taken into account in the measurements due to the fact that dual polarized probes have been used.

4. eNodeB-emulator settings

Table 1 shows the general parameters of the Anritsu call box.

General	
Model name	Anritsu MT8820C (Signaling mode)
Firmware version	22.10 #18 (for LTE signaling mode)
Communication technology	LTE
DL MIMO mode	2×2 (open loop spatial multiplexing)
Duplex mode	FDD
Operating band	Band 7 and 20
Schedule type	Reference Measurement Channel (RMC)
Connection mode of UE	Connection Established

Table 1: eNodeB-emulator common parameters settings

Downlink channel Bandwidth was 10MHz.

Downlink Modulation was set to 16QAM, while uplink was QPSK.

5. Measurements

For all the above specified channel models, throughput is measured for different angles of rotation of the DUTs while average channel power is kept constant at the center of the probe array. Average throughput of 360° rotation is then calculated and plotted versus the average channel power. It has to be noted that average channel power has been measured with a Spectrum Analyzer with an integration BW of 10MHz and then converted to dBm/15KHz (RS EPRE).

Average channel power has been decreased with 1dB step in a 30dB power range, and TP has been measured at each step and rotation angle over 20000 blocks.

Figure 5 shows a Throughput Vs Power comparison between Huawei E398, and SAMSUNG GT-B3710 USB dongles when SCME UMi, UMa channel models, and both single cluster (left) and multiple cluster approaches are used for.

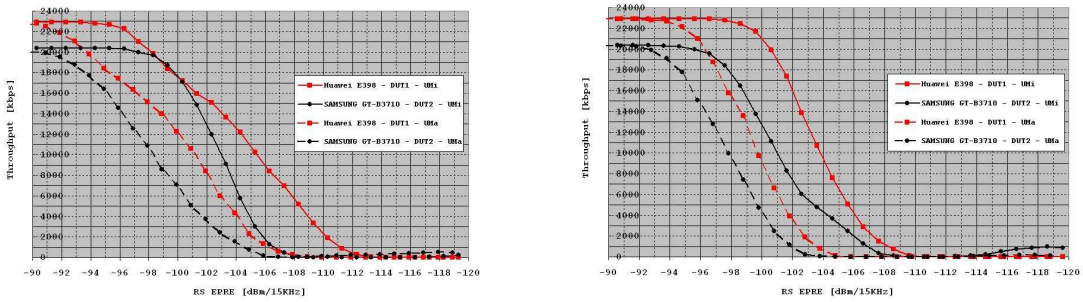

Figure 5: E398 Vs GT-B3710 – Single Cluster (left), and Multiple Cluster (right)

Figure 6 shows a comparison between Single Cluster and Multiple Cluster approaches when UMi (left), and UMa (right) channel models are used.

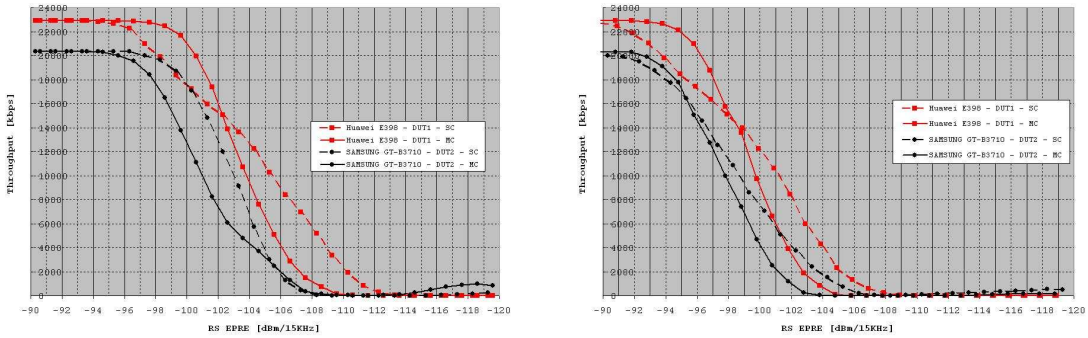

Figure 6: Single Cluster Vs Multiple Cluster UMi (left), and UMa (right)

Figure 7 shows Throughput Vs Power curves taken on a Huawei E398 data card by using single cluster approach and setting the mobile speed on the UMi channel model to 3Km/h and 30Km/h.

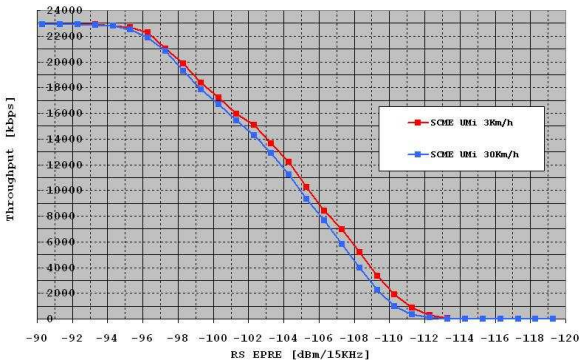

Figure 7: E398 – SCME UMi 3Km/h Vs 30Km/h

6. Conclusions

Differences in DUTs performances were found by using both the single cluster and multiple cluster approaches. It means we could differentiate between a bad and good DUTs by using the single cluster approach and hence reducing the complexity of the test setup since only one channel emulator must be used for. Differences in TP results when comparing Single Cluster Vs Multiple cluster could be due to the fact that the spatial characteristics are different. It means different correlation at the DUT and hence different TP Vs Power results. Slightly different TP Vs Power results can be achieved when testing the Huawei data card with SCME UMi 3Km/h Vs 30Km/h. UMa channel model looks more challenging than UMi for the DUTs. Maximum TP cannot be achieved even at high power level at the center of the probes' array.

References

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Acknowledgments

The authors would like to thank Elektrobit Oy for their support during the testing activities.