

Source: Motorola Mobility LLC

Title: Update results on DUT Polarization discrimination among MIMO OTA test methods

Agenda Item: 8.3 – Verification of Radiated multi-antenna reception performance of UEs in LTE/UMTS [HSPA_LTE_measRP_MIMO-Perf]

Document for: Discussion

1 Introduction

During RAN1 #73 in Fukuoka, Japan. RAN1 provided a response for [1] RAN4 LS R4-131988 “Proposal of Additional Channel Models for MIMO Performance Characterization”. After deliberation RAN1 offered a brief summary of its discussion in this topic [2] including this statement:

“RAN1’s understanding is that the isotropic and geometric models under consideration by RAN4 are different. There is no consensus in RAN1 on the questions raised. RAN1 understands that consideration of the questions is ongoing in RAN4 and therefore respectively suggests that RAN4 continue its investigations and ask RAN1 if questions within RAN1’s expertise remain after RAN4’s investigations are complete.”

Despite the summarized answer, RAN1 had useful off-line discussions around this subject. In one of these discussions, a question regarding the capability of discriminate the EU MIMO antenna system polarization was raised. In this contribution, we will start to investigate how effectively different MIMO OTA test methodologies are capable to make such discrimination.

2 Proposal

In this continuation of preliminary study [3], a simplified test setup based on anechoic multi-cluster boundary array and reverberation chamber is proposed. Two antennas based on the same CTIA MIMO 2x2 reference antennas RF enclosure and magnetic loop (H) and $1/2\lambda$ sleeve dipoles (V) were adopted, one antenna system having cross-polarized antennas and $1/2\lambda$ apart Fig 2-1, and both antennas horizontally polarized and $1/2\lambda$ apart Fig 2-2.

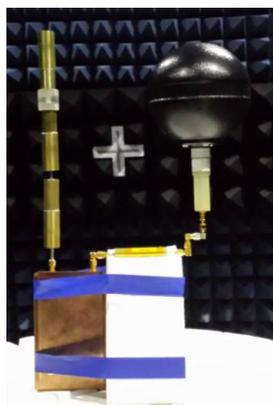


Fig 2-1. Cross-polarized



Fig 2-2. H Co-polarized

The test setup adopted in the anechoic and reverberation chamber measurements are defined in the table 2-1 below

Table 2-1 Anechoic and reverberation chamber test settings

Test settings	Anechoic chamber settings	Reverberation chamber settings
ID	AC Cross-Poll v1	RC Cross-Pol v1
Lab	ETS-Lindgren – Cedar Park	ETS-Lindgren – Cedar Park
Date	09/26/2013	09/26/2013
Methodology	Anechoic chamber Multi-cluster, 8DP	Reverberation chamber
eNodeB emul.	R&S CMW500	R&S CMW500
eNodeB emul. ver	Installed SW V 3.2.20	Installed SW V 3.2.20
eNodeB ant config	Sec 7.2 in 37.977	Sec 7.2 in 37.977
eNodeB PHY config	Sec 7.1 in 37.977	Sec 7.1 in 37.977
Band	13	13
DL channel	5230	5230
UL channel	23230	23230
RMC	R35	R35
Num subframes per SNR pt	5000	5000
Channel emul.	Spirent VR5	NA
Channel emul. ver	2.5.341.3	NA
Channel model config	Sec 8.2 in 37.977	NA
Channel model	SCME Umi, SCME Uma	NIST, 80 ns delay spread
Emul. veh. speed	30 km/h	NA
UE mfg	HTC	HTC
UE model	Rezound	Rezound
UE ID	IMEI: 990000327075422 - MOSG-RD-13-01	IMEI: 990000327075422 - MOSG-RD-13-01
Transmission Mode	TM3	TM3
Max theoretical throughput	35.424 Mb/s	35.424 Mb/s
Num theta pos.	Sec 9.3.1.3 in 37.977	NA
Theta pos.	Sec 9.3.1.3 in 37.977	NA
Num phi pos.	Sec 9.3.1.3 in 37.977	NA
Phi pos.	Sec 9.3.1.3 in 37.977	NA
Test plan version	Lab "E1" 001	Lab "E2" 001
Comments	Base station XPR = 9dB	

2.1 Anechoic chamber setup.

The OTA test system consisted of an ETS-Lindgren AMS-8700 boundary array with eight active dual polarized antennas at a radius of 1.95 meters driven by two Spirent VR5 8 output channel emulators for 16 total output channels used to generate the applied channel model and resulting signal levels within the test volume. Two ETS-Lindgren 8-channel power amplifiers were used to amplify the outputs of the channel emulators to produce the required signal levels within the test volume. The reported measurements were captured using a Rohde & Schwarz CMW-500 as the eNodeB emulator/communication tester. The two outputs were each split and fed into the two VR5s. A separate circularly polarized conical log spiral antenna was used to provide the uplink from the DUT. The uplink path was then fed through a pre-amplifier to provide additional downlink isolation prior to feeding the signal to the eNodeB input. Fig 2.1-4 contains a system schematic for the test setup, while Table 2.1-1-1 contains the detailed equipment list.

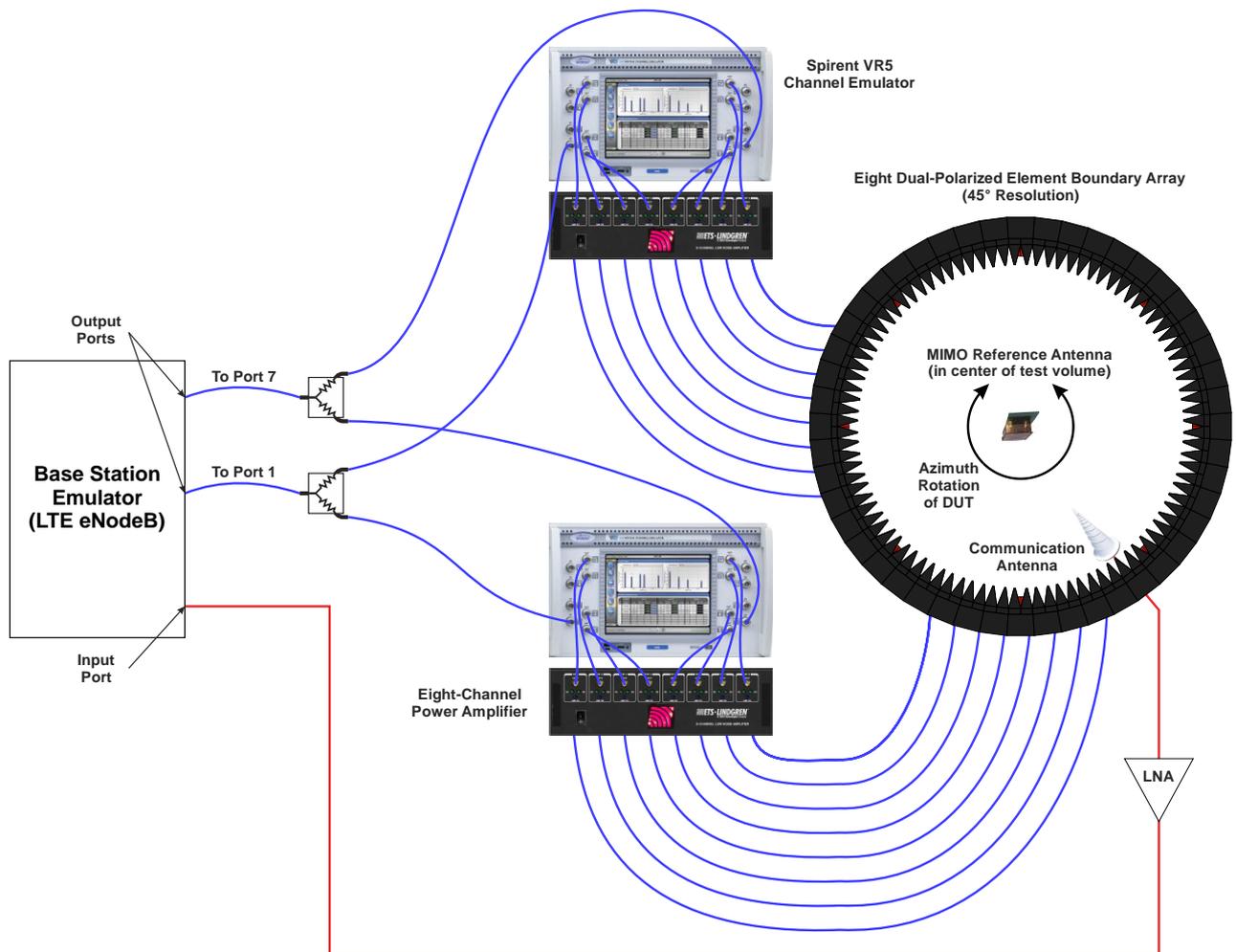


Fig 2.1-1 ETS-Lindgren AMS-8700 Boundary Array Schematic Diagram

Table 2.1-1 Test Equipment List

Equipment	Manufacturer	Model	Firmware Revision
MIMO Boundary Array System	ETS-Lindgren	AMS-8700	NA
Channel Emulator (2X)	Spirent	VR5	2.5.341.3
8-Channel Power Amplifier (2X)	ETS-Lindgren	P/N 117907	NA
eNodeB Emulator/ Communication Tester	Rohde & Schwarz	CMW-500	3.2.20
Power Splitters (2X)	Mini Circuits	ZFSC-2-2500-S+	NA
Uplink Preamp	ETS-Lindgren	NA	NA

2.2 Reverberation chamber setup

An ETS-Lindgren AMS-7000 wireless OTA reverb test system was used to perform the average isotropic (uniform probability distribution) testing. The system consists of a compact reverberation chamber (2.00 x 1.20 x 1.50 m) with two independent stirring paddles and a DUT turntable having a lowest operating frequency of ~700 MHz, connected to a Rohde & Schwarz CMW-500 as the eNodeB emulator/communication tester. The cell was selectively loaded to produce an RMS delay spread of 80 ns for the NIST model. Tests were performed using continuous stirring of all positioners for an integral number of rotations of all positioners at a fixed ratio and timed such that one long throughput measurement was performed per revolution of the slowest positioner, thus producing one average throughput measurement per power level.

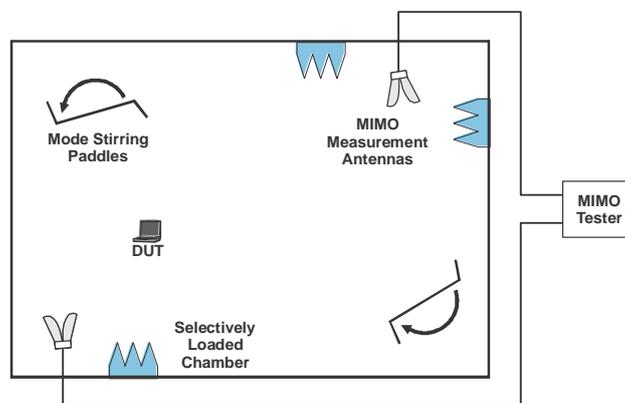


Fig 2.2-1 ETS-Lindgren Reverberation chamber schematic diagram

3 Measured data

3.1 Anechoic chamber MIMO OTA absolute data throughput vs. RS EPRE

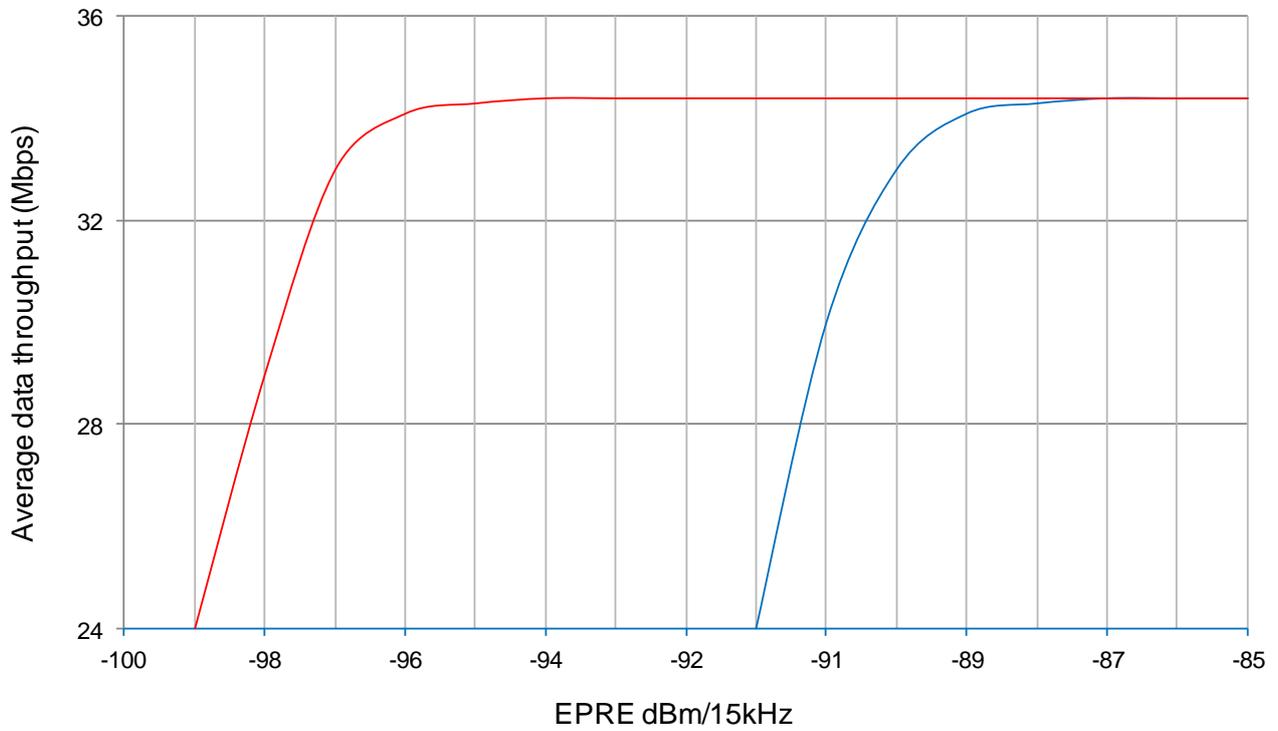


Fig 3.1-1, Anechoic chamber boundary array with 8 DP antennas, SCME Umi, 30kph, XPR = 9dB, 12 UE azimuth positions throughput average benchmark. Solid (red) cross-pol, solid (blue) H-pol.

3.2 Reverberation chamber DUT antenna setup

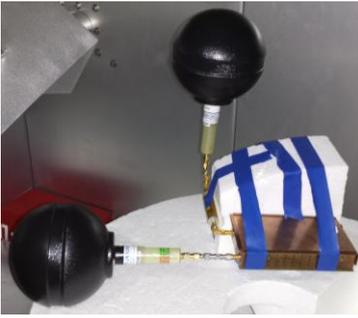


Fig 3.2-1. Cross-polarized



Fig 3.2-2 V Co-Polarized



Fig 3.2-3. H Co-polarized

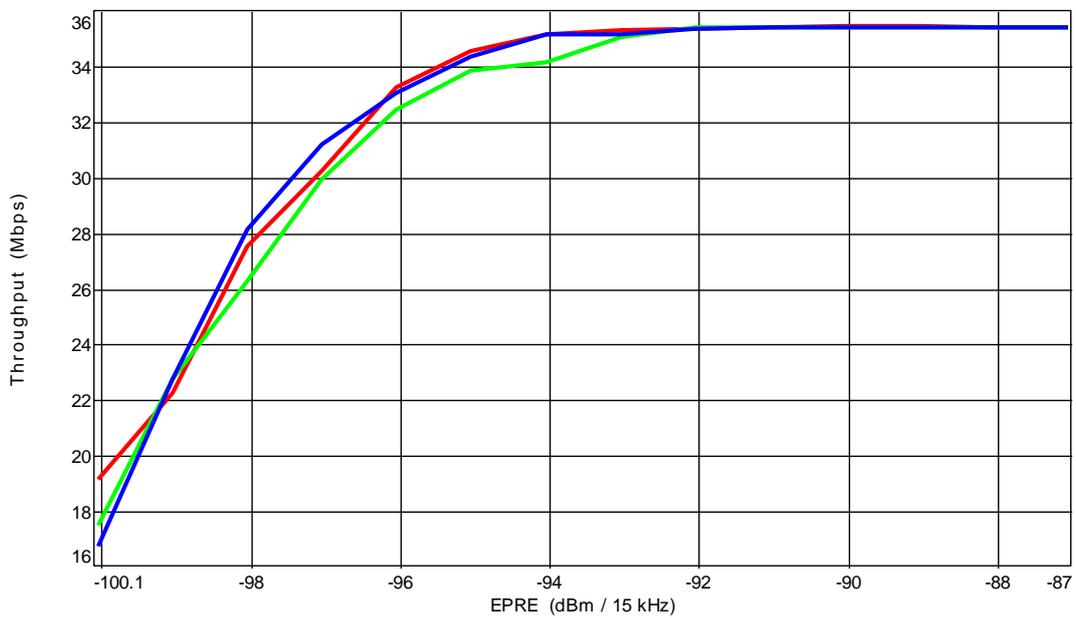


Fig 3.2-4, Antennas benchmark, NIST (80ns RMS Delay Spread) Isotropic channel model

The three antennas described in session 3.2 (cross-pol, V co-pol and H co-pol), were measured in the MIMO OTA test method based on reverberation chamber. While same antennas could be discriminated by its unique polarization in anechoic chamber (up to 8dB). In the reverberation chamber, such discrimination could not be verified.

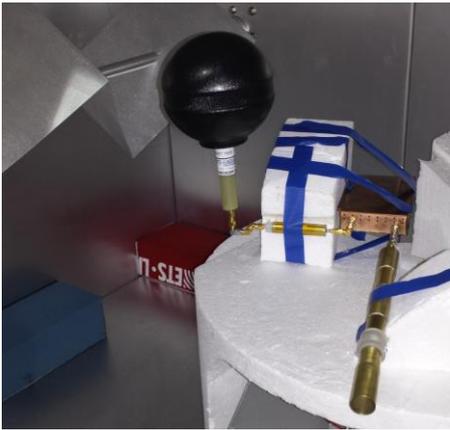


Fig 3.2-5. H Co-polarized



Fig 3.2-6 V Cross-Polarized(a)



Fig 3.2-7. Cross-polarized(b)

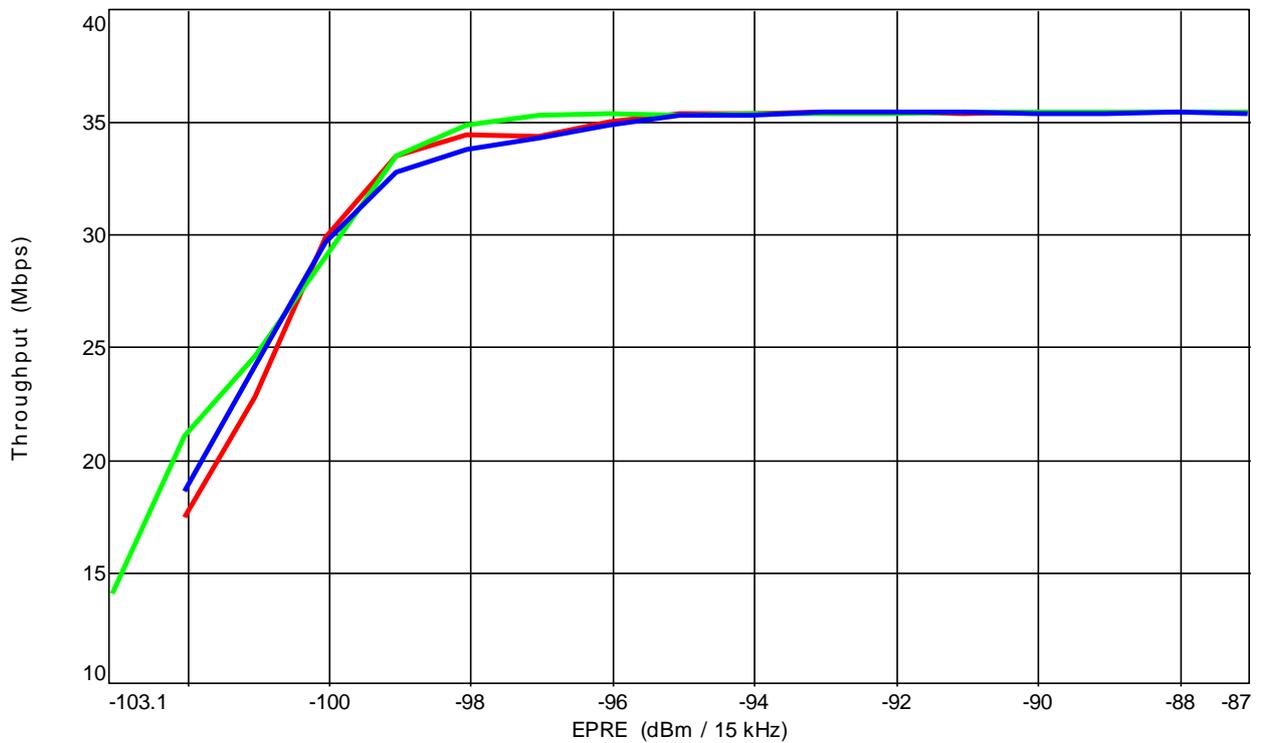


Fig 3.2-8, Antennas benchmark, NIST (80ns RMS Delay Spread) Isotropic channel model

The three antennas described in session 3.2 (H co-pol, V cross-pol (a,b), were measured in the MIMO OTA test method based on reverberation chamber. While same antennas could be discriminated by its unique polarization in anechoic chamber (up to 8dB). In the reverberation chamber, such discrimination could not be verified.

4 Conclusion

These antennas have different MIMO OTA radiated performance, when evaluated under the assumption of the agreed spatial channel models defined in the TR37.977 and defined $XPR = 9\text{dB}$, however the same antennas can't be discriminated in the statistically uniform MIMO OTA test environment where by definition $XPR = 0\text{dB}$.

The measured performance of the presented antennas in this work, in conjunction with the currently adopted CTIA MIMO Reference antennas IL/IT results. Continue to question the validity of relative "ranking" as pass/fail criteria for MIMO OTA. As it was demonstrated, the same MIMO antenna systems can have different results in different test methodologies due its fundamental limitations, i.e. lack of antenna polarization discrimination.

5 References

- [1] R4-131988, Proposal of Additional Channel Models for MIMO Performance Characterization
- [2] R1-132814, Reply LS on Proposal of Additional Channel Models for MIMO Performance Characterization
- [3] R4-134154, "DUT Polarization Discrimination, among MIMO OTA test methods"