International Journal of Applied Information Systems (IJAIS) – ISSN : 2249-0868
Foundation of Computer Science FCS, New York, USA
Volume 2– No.2, February 2012 – www.ijais.org

PDP of the 3GPP SCME channel models Emulation, Reverberation

Bouchaib MARAH
TIC TEAM, LSI,
ESTEM Research Center
Casablanca Morocco
lsi_marah@estem.ma

Wafaâ BOUAB BENNANI
TIC TEAM, LSI,
ESTEM Research Center
Casablanca Morocco
w.bouab@estem.ma

Pierre NLEND
TIC TEAM, LSI,
ESTEM Research Center
Casablanca Morocco
lsi_nlend@estem.ma

ABSTRACT
The MIMO OTA way forward was approved at the 3GPP RAN4 #62bis meeting in Jeju (Korea) [1], and among the remaining works to be accomplished it was highlighted that the channel model had to be validated across methods in order to ensure that a minimal number of artifacts are inserted into the channel model by any given methodology and that the different methods reproduce, and the DUT experiences, the same radio conditions regardless of the methodology.

Keywords
SCME, Reverberation chamber, Power Delay Profile, Over The Air (OTA).

1. INTRODUCTION
The objective of this contribution is to validate the power delay profile (PDP) for the 3GPP SCME Urban macro (UMA) and Urban micro (UMI) channel models emulated in a mode-stirred reverberation chamber for the reverberation chamber

2. EMULATION OF 3 GPP SCME WITH THE USE OF REVERBARATION CHAMBER
All A test bed was prepared to validate 3GPP SCME PDP emulation in an RC (candidate methodology 1) using a Vector Signal Generator (VSG) and a Digitizer. On this platform, a multi-cluster emulation method which complies with channels defined by 3GPP SCME models was implemented using only one VSG in combination to a reverberation chamber. For the purpose of this contribution, the delay spread control was achieved through modifying the RC quality factor by loading it with absorbing materials, as described earlier. On this special test-bed, the measurements were not carried out in real time, and were not dedicated to performance evaluation in terms of throughput, but rather on the validation of SCME PDP channel model emulation using reverberation chambers. However, through the use of the RF digitizer and some baseband processing, the influence of several transmission chain and MIMO antenna, signal and reception aspects such as coupling, correlation coefficient, synchronization, equalization or MIMO coding are allowed. A detailed analysis of these aspects has been sent for publication at IEEE and can be found in [3] when published along 2012.

The measurement test bed, illustrated in figure 1, was based on the Aeroflex PXI 3000 series architecture, with two PXI chassis integrating a control PC for generating frames on transmission and for processing received data.

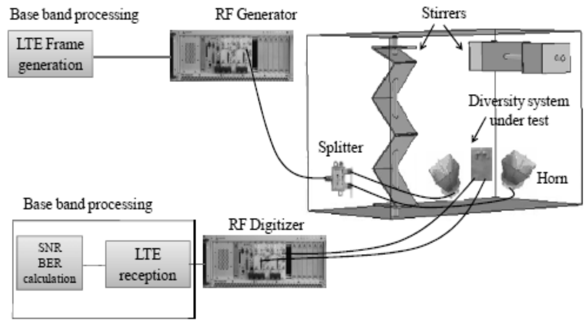

Figure 1. Test bed for 3GPP PDP validation using RC candidate methodology 1.

The transmit part includes one RF wideband signal generator (76 MHz - 6 GHz), which can provide a level of RF power from -120 dBm to +5 dBm over a modulation bandwidth of 33 MHz. The receiver integrated two synchronized digitizers (SIMO configuration), which provided conversion of the RF signal to baseband digital IQ symbols [4]. Data processing was done with MATLAB®. At the transmitter side, a frame based on LTE specifications was generated. The duplex mode used was TDD, with a bandwidth of 5 MHz and a 64QAM modulation scheme over a carrier frequency of 2.35 GHz.

An LTE–OFDM frame using diversity at the receiver side was implemented in the test bed. The frame was generated based on the 3GPP standard, which specify a downlink (DL) transmission system using an orthogonal frequency division multiplexing access (OFDMA). The modulation schemes supported for payload in the uplink and downlink are QPSK, 16QAM and 64QAM. The duration of the LTE frames were

10 ms. The frames were divided into 10 subframes, being every subframe 1 ms long. Each subframe contained two slots of 0.5 ms of duration, which were composed of 6 or 7 OFDM symbols, depending on the employment of the normal or the extended cyclic prefix.

The 3GPP urban micro-cell (UMI) and urban macro-cell (UMA) tap-delay channel models were employed for measurements. For each tap a RMS DS of 90±5 ns was considered. For the purpose of this contribution, the RMS DS was modified by loading the chamber with an appropriate amount of absorbing material. The measurements shown below in figure 2 illustrate the dependence of the RMS DS on absorbing material located inside the RC. For the unloaded chamber case, the measured RMS DS was 256.4 ns. When the chamber was loaded with a piece of solid, pyramidal shaped, carbon loaded, urethane foam absorber with dimensions of 16 cm x 9 cm x 4 cm, placed in a corner of the RC, the RMS DS was around 93 ns. The use of absorbing materials decreased considerably the value of the RMS DS, and allows achieving the desired result which should be within 90±5 ns.

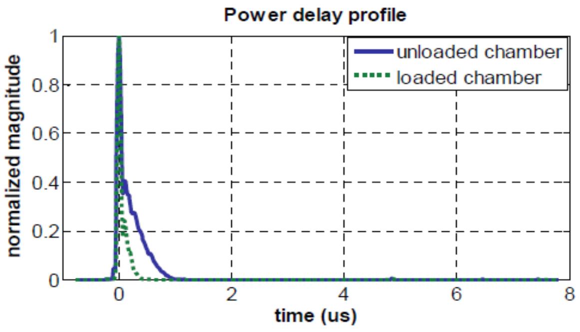

Figure 2. Measured PDPs for unloaded and loaded RC.

In order to check the fading distribution, a power measurement was also made at the central frequency to plot the normalized CDF. Figure 3 below shows that the fading is still Rayleigh even after the addition of losses. The difference concerning the measured mean powers before and after adding absorbing materials was around 3 dB.

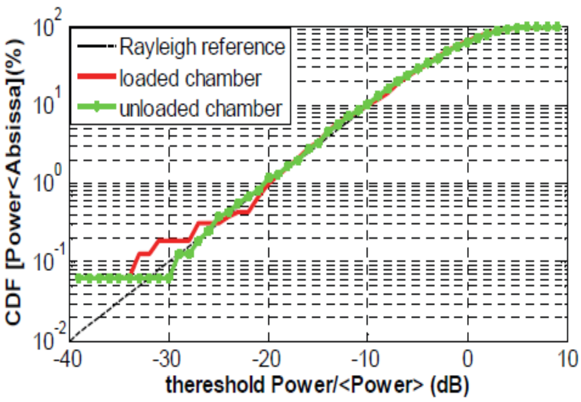

Figure 3. CDF measured in the loaded and unloaded RC.

In order to emulate a multi-cluster channel with the same delay spread for each cluster, which is the 3GPP SCME channel model that has to be injected to an RC following the CTIA method [5], the base band signal to be transmitted was convolved with the urban macro-cell or urban micro-cell channel model tap delay line generated using MATLAB®.

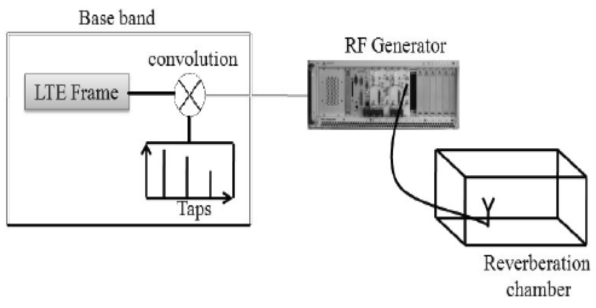

Figure 4. 3GPP SCME convolution overview.

In order to validate the proper functioning of this method, a channel sounding based on a sliding correlation [6] was performed, with a sampling frequency Fe of 64 MHz at carrier frequency f0 of 2.35 GHz. The sampling frequency was chosen initially higher in order to obtain a good time resolution, and validate that the channel model was accurately emulated. Figures 5 and 6 shown below present the power delay profile curves measured in RC for the UMI and UMA channel models, respectively.

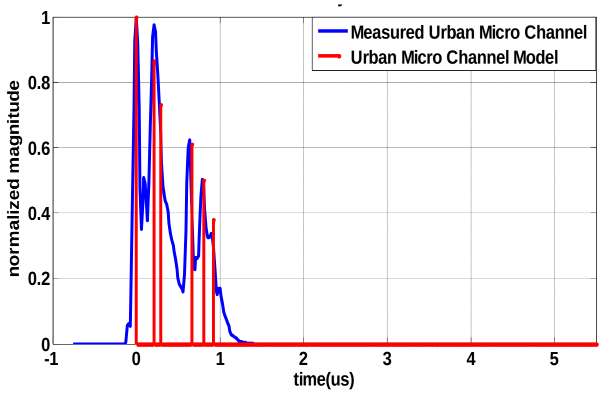

Figure 5. PDP measured in RC for the urban micro-cell (UMI) channel model emulation.

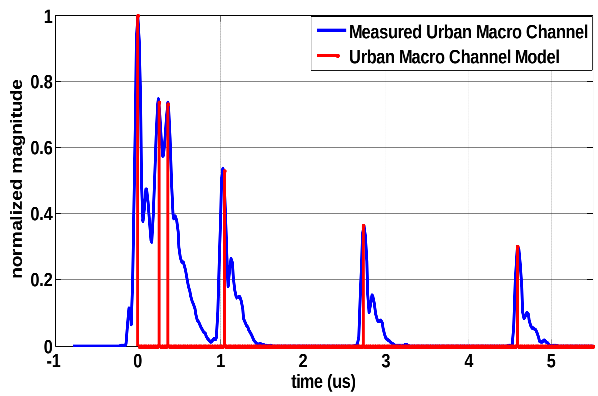

Figure 6. PDP measured in RC for urban macro-cell (UMA) channel model emulation.

The measured PDP results match very well with the theoretical channel models, in a similar way to what was shown for the anechoic chamber method in figure 5 of [7], previously presented as figure 10 in [8] or figure 7 in [9]. In addition, the Rayleigh behavior of the measured CDF has also been shown to be maintained.

The different results presented above highlight the possibility of controlling RMS DS for each cluster and emulating 3GPP urban micro- and macro-cell channel models. This is obtained simply by combining a digital preprocessing and a RC to manage the RMS DS value.

Furthermore, in narrowband channel models, all contributions arrive with the same delay. To be more precise, all contributions arrive with delays that differ from each other by less than the system time resolution. The PDP and RMS DS measurements in an RC represent the averaged value of the measured sample set. To be more precise, they represent the averaged value of the different fading scenarios under which the RC measures samples that conform the sample set, that is, the different positions of paddles, platform, sources, shifts in frequency, etc. Wideband systems, on the other hand, are capable of discriminating multipath arrivals in time. If B is the system bandwidth, they are capable of discriminating arrivals whose delays differ by more than $\delta\tau=1/B$.

Consequently, the Sample Selection technique could also be used to obtain a subset from the measured sample set with different RMS DS properties. This is illustrated in figure 7 below, wherein a histogram of the different subsets that can be selected from a sample set using Sample Selection measured in a small RC are depicted. Figure 8 illustrates that sample selection does not pose a threat to the power accuracy. The availability of different RMS DS target values is enhanced by multiple-cavity RCs, which can also add different test runs employing different coupling structures to the original sample set over which Sample Selection is to be applied. The application of Sample Selection for RMS DS tuning to single-cavity RCs is foreseen to be limited as it was explained earlier.

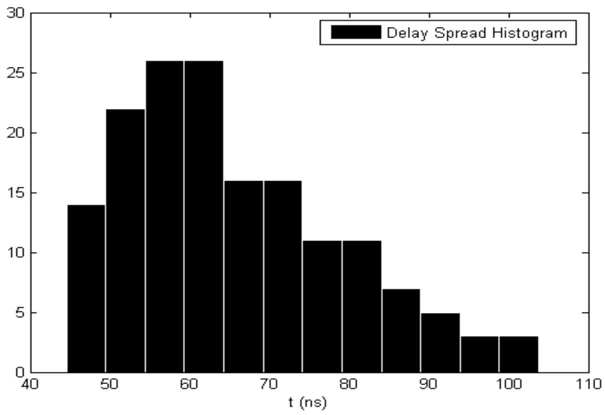

Figure 7. RMS DS histogram showing different possible subsets in single-run measurements.

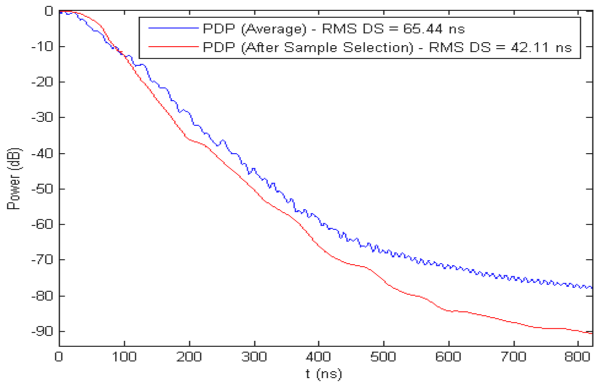

Figure 8. PDP measured in RC for different RMS DS using Sample Selection.

3. CONCLUSION

The reverberation chamber, either as a stand-alone unit with a vector signal generator and a digitizer or in conjunction to a channel emulator, has shown to be able to accurately emulate the PDP of the 3GPP SCME channel models.

The measured PDP results match very well with the theoretical channel models, in a similar way to what was shown previously for the anechoic chamber method. The PDP results using the technique of inverse injection proposed in this contribution provides for a better matching with the theoretical 3GPP channel models without the need of using absorbers for RMS DS tuning in the reverberation chamber. This eliminates any undesired effect on isotropicity and leaves measured mean powers unaffected. Future research is envisaged to emulate 3GPP SCME PDP with just a reverberation chamber.

Whether the 3GPP SCME channel models are really needed to clearly distinguish a good from a bad MIMO device and thus serve the goal for tier 1 testing of MIMO OTA is a different story. Results from another contribution [15] show that the innate NIST channel model in a reverberation chamber, used as a building block, in conjunction to the Sample Selection technique and multiple tests runs with diverse RC settings suffice for accurately emulating realistic channels using a reverberation chamber.

4. REFERENCES

[1] Vodafone Group, “MIMO OTA way forward”, TSG-RAN WG4 meeting #62bis, Jeju, Korea, 26th – 30th March 2012. Document R4-122132.

[2] 3GPP TR 37.976, “Measurement of radiated performance for MIMO and multi-antenna reception for HSPA and LTE terminals (Release 10)”, version 1.1.0.

[3] Arsalane, N. et al., “3GPP Channel Model Emulation with Analysis of MIMO-LTE Performance in Reverberation Chamber”, Hindawi International Journal

on Antennas and Propagation, MIMO OTA special issue, 2012 (Accepted for Publication).

[4] A. Belhouji, A., et al., "Active measurements of a MIMO Wimax-OFDM based system in reverberation chambers", Microwave and Optical Technology Letters, Vol. 52, No. 10, pp. 2347-2352, 2010.

[5] AT&T, "Test Plan for Multi-Antenna OTA Performance Measurements in Reverberation Chamber", CTIA Reverberation Chamber Subgroup contribution RCSG100905, Oct. 2010.

[6] Lin, J.C. and Lin, C.Y., "Noncoherent sequential PN code acquisition using sliding correlation in DS/SS", Proceedings of the IEEE International Conference on Communications, Vol. 1, pp. 341-345, 2000.

[7] Elektrobit, Satimo Industries, Spirent Communications, Intel, Motorola Mobility, Nokia, "Verification of Channel Model Implementations", TSG-RAN WG4 meeting RAN WG4 #62bis, Jeju, Korea 26th – 31th February 2012. Document R4-122098.

[8] Elektrobit, "Verified Performance: Anechoic chamber and fading emulator based MIMO OTA method", TSG-RAN WG4 meeting AH#4, Xi'an, China, 11th – 15th October 2010. Document R4-103856.

[9] Kyösti, P. et al., "Reconstruction and measurement of Spatial Channel Model for OTA", COST 2100 Meeting, Valencia, May 2009. Document TD(09)860.

[10] D. Matolak, K. Remley, C. Holloway, "Outdoor-to-Indoor Channel Measurements and Models", CTIA Reverberation Chamber Subgroup contribution, September 2009. Document RCSG090913.

[11] Agilent Technologies, "Analysis of MIMO OTA performance using 2D and 3D channel models", 3GPP TSG RAN WG4 #62bis, Jeju, Korea, 26-30 Mar, 2012. Document R4-121979.

[12] Claude Oestges and Bruno Clerckx, "MIMO wireless communications – From real-world propagation to space-time code design", Ed. Elsevier, 2007. ISBN 13:9-78-0-12-372535-6.

[13] AT&T, "Baseline Criteria for SIMO/MIMO Radiated Performance Testing", 3GPP TSG-RAN WG4 Meeting #52bis, Miyasaki, Japan, 12- 16 October, 2009. Document R4-093930.

[14] Azimuth Systems, "Additional LTE Round Robin test results", 3GPP TSG-RAN WG4 #61, November 14-18, 2011, San Francisco, USA. Document R4-115545.

[15] EMITE, UPCT, "Use of NIST channel model in mode-stirred reverberation chamber for emulation of realistic fading scenarios", CTIA MIMO OTA Subgroup (M OSG) contribution MOSG120505, May 2012.