**3GPP TSG-RAN WG4 Meeting #94-e R4-200xxxx
Electronic Meeting, 24 Feb. – 6 Mar., 2020**

**Agenda item:** 10.2.4

**Source:** Keysight Technologies

**Title:** Initial phase definition of channel models

**Document for:** Approval

# Introduction

This contribution is discussing the need for the scalar initial phase terms to be fixed.

# Discussion

Radio channel models for NR OTA testing are specified in [1]. Mathematical descriptions in Section 7.2 of [1] are adopted from [2] with some modifications. Some of the modifications are targeted for removing unwanted randomness of CDL models. For example, the matrix initial phase terms have been fixed to prevent random variation of power angular spectrum between model uses. Instead, the scalar phase terms were introduced in Section 7.2 of [1].

During the last and this meeting, questions were raised whether these scalar initial phase terms $Φ\_{n,m}$ in eq. (7.2-9) of [1] [4] should be fixed also or even completely removed. This document discusses this question and provides three arguments for not fixing these scalar initial phase terms.

Firstly, keeping the random initial phases does not alter model statistics and thus does not cause any unwanted variation to generated channel impulse responses. Namely, the statistics of a sum-of-sinusoids model are fully specified by three parameters: the number of sinusoids, amplitudes of sinusoids, and frequencies of sinusoids, as described in [3]. An infinite number of fading sequences can be realized, with different time behaviour, but identical statistical properties by fixing the three mentioned parameters and altering initial phases of sinusoids. The Doppler phases (=initial phases) have no influence on the statistical properties [3], but only on the instantaneous fading coefficients. Scalar initial phases can be considered as the seed number of random number generator.

Secondly, almost all standardized channel models from past decades to present day have generated random radio channel realizations, typically time variant channel impulse responses. In other words, almost all 3GPP models starting from 3G SISO tapped delay line models up to 5G NR [2] have specified model statistics, but not the exact model output sequences of channel impulse response realizations.

Thirdly, this stochastic modelling principle has guaranteed evaluations with close to ergodic conditions, because fading sequences have been different on each model run (but with the specified statistics). Fixing or removing the scalar initial phase terms would result in the same sequence of impulse responses on each and every model run. All evaluations would be always performed with the same fading sequence. This may not be beneficial, especially if the test time is very short and only a very limited set of channel conditions will be evaluated. The past experience shows that there is strong pressure to specify tests with short measurement times.

We therefore proposed to keep the random initial phases as defined in [1]

Proposal 1: Keep the random initial phases as defined in [1]

Following online discussions on this topic, it was agreed to study the number of the samples further in the WI by adding a statement “For NR FR1 and FR2 MIMO OTA testing, the number of samples is FFS” in [1]. A sufficiently high number will average out the statistical variation of fast fading as shown in [4] and minimize lab misalignments.

Proposal 2: Add a statement in the TR to study the number of samples.

# Conclusion

The following observations and proposals were made in this contribution

**Proposal 1: Keep the random initial phases as defined in [1]**

**Proposal 2: Add a statement in the TR to study the number of samples.**

# References

1. 3GPP TR 38.827 “Study on radiated metrics and test methodology for the verification of multi-antenna reception performance of NR User Equipment (UE)” V1.0.0, December 2019.
2. 3GPP TR 38.901 “Study on channel model for frequencies from 0.5 to 100 GHz” V15.0.0 (2018-06)
3. Mathias Pätzold, "Mobile Fading Channels", John Wiley & Sons, 2002.
4. R4-2000798, Initial phase of MIMO OTA channel model, MediaTek Inc., 3GPP TSG-RAN WG4 Meeting #94-e, February-March 2020
5. R4-111381, Fading emulation length in MIMO OTA tests, Elektrobit, TSG-RAN Working Group 4 (Radio) meeting #58, February 2011

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## 7.1 General

The different channel models are defined to create corresponding complex multipath radio propagation conditions for FR1 and FR2. The following scenarios are selected for NR MIMO OTA:

FR1 scenarios:

* For 2x2 MIMO: Urban Macro
* For 4x4 MIMO: Urban Micro

FR2 static testing scenarios:

* Urban Micro street canyon and Indoor

In order to describe unambiguously the procedure of generating realizations CDL channel models, various aspects need to be clarified, e.g., details of scaling procedure, inclusion of BS antenna arrays and beams to the model output, and removing unwanted randomness of model realizations.

The concept of angular scaling is based on rotating AoDs/ZoDs and scaling CDL model using the methods in TR 38.901 (section 7.7.5.1) to make them fit the median values in TR 38.901 Table 7.5-6 for the accepted scenarios.

For NR MIMO OTA testing, the following channel models are required to be measured: FR1 UMi CDL-A in table 7.1.1-1, FR1 UMa CDL-C in table 7.2.1-8; FR2 InO CDL-A in table 7.2.2-6, FR2 UMi CDL-C in table 7.2.2-3.

For NR FR1 and FR2 MIMO OTA testing, the number of samples is FFS.

<<< END OF CHANGES >>>