**3GPP TSG-RAN WG4 Meeting #116 R4-2509113**

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**Source: Nokia**

**Title: pCR on TR 38.753 Conclusions Chapter**

**Agenda item: 7.12.2**

**Document for: Endorsement**

1. Introduction

During RAN#104 the study item on Spatial Channel Model was agreed, whereby the SI started during RAN4#112, within this contribution we present some views on the work plan of the Study Item as well as details of what Nokia believes should be included in TR 38.753.

Furthermore, during RAN#107 the study item was extended, such that the revised completion plenary was RAN#109, indicated in the new SID [1].

During RAN4#113 the work split for the TR was agreed, in this document, TR content for the conclusions chapter is included.

1. Text Proposal

***<Start of Change 1>***

8 Summary

8.1 General

* This Technical Report has studied candidate spatial channel models for NR demodulation performance requirements in FR1, considering both SU-MIMO and MU-MIMO scenarios, and evaluating CDL-based and Multi cluster TDL-based modelling approaches. The study has:Investigated methodology to generate repeatable spatial channel effects with manageable test complexity
* Compared performance outcomes across candidate models against agreed test cases
* Collected alignment results from multiple contributors to determine the span and average for key performance metrics.

The following subsections capture the preliminary consensus points and highlight areas requiring further discussion.

8.2 Summary of SU-MIMO Results

8.2.1 PDSCH

8.2.1.1 Rank 8

For rank-8 SU-MIMO PDSCH scenarios, for [rCDL-C1] 6 out of 7 sources could achieve SNR span <2.5dB for both CW1 and CW2 at both 30% and 70% normalized throughput, for [xTDL-C1] 2 out of 3 sources could achieve SNR span < 2.5dB for CW1 at both 30% and 70% normalized throughput

8.2.1.1 Rank 4

For rank-4 SU-MIMO PDSCH scenarios, for [rCDL-C1] 7 out of 8 sources could achieve SNR span <2.5dB for both CW1 and CW2 at both 30% and 70% normalized throughput, for [xTDL-C1] 4 out of 4 sources could achieve SNR span < 2.5dB for CW1 at both 30% and 70% normalized throughput.

8.2.2 PMI

8.2.1.1 4 layer, type-I

For PMI testing with 4 layer transmission, with [rCDL-C1], In type-I codebook case, 8 out of 9 sources could achieve SNR span < 2.5dB at 70% and 90% normalized throughput, for [xTDL-C1] 4 out of 4 sources could achieve SNR span < 2.5dB for both 30% and 70% normalized throughput.

8.2.1.1 4 layer, eType-II

For PMI testing with 4 layer transmission, with [rCDL-C1], in eType-II codebook case, three clusters of results can be observed; Cluster 1: include source #7, Cluster 2: include source #3, #4, #5, #6, #9. The span of this cluster is < 2.5dB for both 70% and 90% normalized throughput percentiles, and Cluster 3 include source #1, #2, #8. The span of this cluster < 2.5dB for both 70% and 90% normalized throughput percentiles.

For PMI testing with 4 layer transmission, with [xTDL-C1], in eType-II codebook case, 2 out of 3 sources could achieve SNR span < 2.5dB at 70% normalized throughput and 3 out of 3 sources could achieve SNR span < 2.5dB at 90% normalized throughput.

8.3 Comparison of SCM Candidates

Regarding legacy TDL the following observations can be drawn:

* Spatial properties of legacy channel models do not match the measured typical deployment MIMO characteristics
* The PDSCH post-EQ SINR profiles, when using TDL channel models do not match measurements. SDM processing does not impact performance, when using TDL channel models.
* TDL channel models are very simple and extensively used in RAN4 demodulation and CSI testing.
* Legacy TDL correlation models and related correlation derivation models introduce strong spatial selectivity so that higher transmission ranks are either infeasible or require unreasonably high SNR or low MCS.

Regarding rCDL-C1 the following observations can be drawn:

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* For CDL models, both spatial and temporal properties are drawn from a common ray-based framework that resembles physical environments.
* CDL (link level) models are based on the same paradigm that is extensively used for system-level simulations by RAN1 and regularly used for link-level simulations by RAN1 to develop MIMO related features.
* Each tabulated CDL model corresponds to a single possible physical environment example with static long-term spatial properties, with the realization chosen by RAN1 to match the median of the system level environment distribution.
* In this study item, RAN4 contributors spent considerable effort to clarify and align the understanding of the details of CDL models.
* The angular values of the agreed CDL model are fixed. This results in non-uniform PMI statistics and a fixed precoder (for example, PMI (i1,1, i1,2, i2)=(4,0,0) for single-panel I codebook) may perform better than channel adaptive precoders performed by PMI selection algorithm. For example, UE constantly reporting PMI (i1,1, i1,2, i2)=(4,0,0), which can be pre-configured without precoder selection may also past the PMI test. The legacy principal beam direction steering framework from LTE and NR specs (e.g., TS 101-4 B.2.3.2.3) is independent of the channel model itself and can be applied, if thought necessary.
* The CDL model implementations have been found to be both alignable and aligned between [8] contributors.
* [6] contributors judge the CDL model to be ready for normative requirement derivation.
* [5] contributors judge the CDL model to be useful for normative requirements, especially for 2CW PDSCH and enhanced codebook PMI cases.

Regarding xTDL-C1 the following observations can be drawn:

* Multi-cluster TDL models, which are builds on top of the well-known and well-aligned legacy TDL models, are very simple and extensively used in RAN4 demodulation and CSI testing, and should therefore be easy to take into use by RAN4.
* The multi-cluster TDL model reduces the spatial limitations of the underlying spatially correlated legacy TDL model so that higher ranks can be supported.
* The multi-cluster TDL model does not alter the Doppler spread or the frequency selectivity of the underlying legacy TDL model.
* The multi-cluster TDL model can be configured using a limited number of beam-steering parameters to match various desired test behaviours. The steered beam directions and relative beam power offsets are configured based on agreement for the desired test behaviour.

***<End of Change 1>***

References

1. RP-241610, “Study on spatial channel model for demodulation performance requirements for NR”, Nokia, BT Plc, RAN#107, Incheon, Korea, March 2025.