**3GPP TSG-RAN WG4 Meeting # 114bis R4-2504003**

**Wuhan, China, 7th – 11th April, 2025**

**Title: Simulation results on spatial channel model for demodulation performance requirements**

**Source: ZTE Corporation, Sanechips**

**Agenda item: 7.16.2**

**Document for: Discussion**

**1 Introduction**

In RAN #104 meeting, the new WID of study on spatial channel model for demodulation performance was approved in [1], wherein the study item includes the following objectives :

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| * Study practical spatial channel modelling methodology for both SU- and MU-MIMO demodulation requirements and CSI reporting requirements:   + Identify the limitations of the current (i.e. up to and including Release 18) channel models and corresponding scenarios and how they relate to UE MIMO performance   + Consider both Clustered Delay Line (CDL)-based and TDL-based channel modelling approaches     - For CDL-based channel modelling, use the tuned repeatable spatial channel model of TR38.827 as the starting point and identify any necessary changes.   + Study and verify test methodology feasibility including test complexity and achievable results uncertainty. The test complexity shall not be significantly increased.   + The methodology shall include both FR1 (conducted) and FR2 (wireless cable), with first priority for FR1. |

In this contribution, we give some initial simulation results on the practical spatial channel modelling methodology.

**2 Discussion**

During the last meeting, RAN4 discussed how to construct the SCM channel model, and agreed some simulation parameters to do link level simulation. Regarding the methodology of SCM model, RAN4 prioritized 38.827 UMa-CDL-C for initial comparison and alignment. Based on this agreement [2], we give some initial simulation results for CDL-C channel model.

Regarding simulation assumptions[2], and for CDL-C channel model, we reused the channel parameters in TR38.827, TR38.901 and TR38.901 with truncation to generate the channel coefficient. We also evaluated the performance of the TDL based approaches under 4T4R and 8T8R scenarios. The detailed parameters can be found in the following Table 1 and Table 2 to generate the TX-RX beams.

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| * 4T4R,4Layers: Enhanced TDLC300-100, XPL, high with 2 Tx-Rx beams as defined in Table C.3 * PMI test: Enhanced TDLC300-100, XPL, high with 2 Tx-Rx beams as defined in Table C.3 * 8T8R, 8Layers: Enhanced TDLC300-100, XPL, high with 4 Tx-Rx beams as defined in Table C.4 and 6 Tx-Rx beams as defined in Table C.5 |

**Table 1. Enhanced TDLC300 channel with 2 TX-RX beams**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tap | Delay(ns) | Power(dB) | Tx-Rx Beam | Beam Power(dB) |
| 1 | 0 | -6.9 | Beam 1 | 0 |
| 2 | 65 | 0 |
| 3 | 70 | -7.7 |
| 4 | 190 | -2.5 |
| 5 | 195 | -2.4 | Beam 2 | -1.52 |
| 6 | 200 | -9.9 |
| 7 | 240 | -8.0 |
| 8 | 325 | -6.6 |
| 9 | 520 | -7.1 |
| 10 | 1045 | -13.0 |
| 11 | 1510 | -14.2 |
| 12 | 2595 | -16.0 |

**Table 2. Enhanced TDLC300 channel with 4 TX-RX beams**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Tap | Delay(ns) | Power | Beam steering | Beam Power(dB) |
| 1 | 0 | -6.9 | Beam1 | 0 |
| 2 | 65 | 0 |
| 3 | 70 | -7.7 | Beam2 | -2.16 |
| 4 | 190 | -2.5 |
| 5 | 195 | -2.4 | Beam3 | -2.50 |
| 6 | 200 | -9.9 |
| 7 | 240 | -8.0 | Beam4 | -2.45 |
| 8 | 325 | -6.6 |
| 9 | 520 | -7.1 |
| 10 | 1045 | -13.0 |
| 11 | 1510 | -14.2 |
| 12 | 2595 | -16.0 |

In this section, we present the simulation results in terms of the normalized PDSCH throughput as function of the signal to noise ratio (SNR). We depict the SNR value corresponding to 30% and 70% of the peak throughput. All figures have been provided in the following Table 4.

Table 3. Summary of simulation results for CDL-C channel model

|  |  |  |  |
| --- | --- | --- | --- |
| Rank | Channel model and antenna virtualization | SNR(dB)@30% of maxTP | SNR(dB)@70% of maxTP |
| Rank 4 | CDL-C, Fixed Sub Array (M,N,P,Ms,Ns) = (8,2,2,8,1) with Table 7.2.1-8 in TR 38.827 | 0.9 | 11.2 |
| CDL-C, Fixed Sub Array (M,N,P,Ms,Ns) = (8,2,2,8,1) based on Table 7.7.1-3 in TR 38.901 without truncation | 0.2 | 10.0 |
| CDL-C, Fixed Sub Array (M,N,P,Ms,Ns) = (8,2,2,8,1) based on Table 7.7.1-3 in TR 38.901 with truncation | 0.4 | 10.3 |
| (M,N,P,Ms,Ns)=(1,2,2,1,1) with Table 7.2.1-8 in TR 38.827 | 9.8 | 20.6 |
| (M,N,P,Ms,Ns)=(1,2,2,1,1) based on Table 7.7.1-3 in TR 38.901 without truncation | 8.7 | 18.6 |
| (M,N,P,Ms,Ns)=(1,2,2,1,1) based on Table 7.7.1-3 in TR 38.901 with truncation | 8.9 | 18.6 |
| Rank 8 | CDL-C, FixedSubArray (M,N,P,Ms,Ns) = (8,4,2,8,1) | 7.9 | 23.1 |
| CDL-C, Fixed Sub Array (M,N,P,Ms,Ns) = (8,4,2,8,1) based on Table 7.7.1-3 in TR 38.901 without truncation | 8.4 | 27.0 |
| CDL-C, Fixed Sub Array (M,N,P,Ms,Ns) = (8,4,2,8,1) based on Table 7.7.1-3 in TR 38.901 with truncation | 7.2 | 22.4 |
| CDL-C,WithoutAAV(M,N,P,Ms,Ns)= (1,4,2,1,1) | 8.6 | 23.8 |
| (M,N,P,Ms,Ns)=(1,4,2,1,1) based on Table 7.7.1-3 in TR 38.901 without truncation | 8.8 | 27.8 |
| (M,N,P,Ms,Ns)=(1,4,2,1,1) based on Table 7.7.1-3 in TR 38.901 with truncation | 8.0 | 23.0 |

***Observation 1. From simulation results, we can observe that the performance with AAV sub array is better than without AAV configuration under Rank 4 scenario.***

Table 4. Throughput curves for CDL-C channel model with different AAVs

|  |  |
| --- | --- |
| Figure 1. Fixed Sub Array (M,N,P,Ms,Ns) = (8,2,2,8,1) | Figure 2. Fixed Sub Array (M,N,P,Ms,Ns) = (1,2,2,1,1) |
| Figure 3. Fixed Sub Array (M,N,P,Ms,Ns) = (8,4,2,8,1) | Figure 4. Fixed Sub Array (M,N,P,Ms,Ns) = (1,4,2,1,1) |

Table 5. Summary of simulation results for TDLC300-100 with 2 TX-RX beams and 4TX-RX beams

|  |  |  |
| --- | --- | --- |
| Rank | Channel model and antenna virtualization | SNR(dB)@70% of maxTP |
| Rank 4 | TDLC300-1000 XP High with 2 TX-RX beams | 15.8 |
| Rank 8 | TDLC300-1000 XP High with 4 TX-RX beams | 16.2 |

Table 6. Throughput curves for TDLC300-100 with 2 TX-RX beams and 4 TX-RX beams

|  |  |
| --- | --- |
| Figure 5. TDLC XP High with 2 TX-RX beams for Rank 4. | Figure 6. TDLC XP High with 4 TX-RX beams for Rank 8. |

*Observation 2. The TDL based approach can achieve a better SNR point under XP high condition with 2 TX-RX and 4 TX-RX beams.*

**3 Conclusion**

In this contribution, we give some initial simulation results on spatial channel model for demodulation performance requirements.

***Observation 1. From simulation results, we can observe that the performance with AAV sub array is better than without AAV configuration under Rank 4 scenario.***

*Observation 2. The TDL based approach can achieve a better SNR point under XP high condition with 2 TX-RX and 4 TX-RX beams.*

**4 References**

1. RP-241610, New WID: Study on spatial channel model for demodulation performance requirements, Nokia.
2. R4-2502378, Way Forward [114][322] NR\_SCM. Nokia.