**3GPP TSG RAN WG4 Meeting #112bis R4-24xxxxx**

**Hefei, Anhui, China, 14th – 18th October, 2024**

**Agenda item:** 6.17.4.1

**Source:** vivo, NTU

**Title:** Link-level simulation assumptions for AI/ML based BM

**Document for:** Approval

# Introduction

In this contribution, the link-level simulation assumption for AI/ML based BM case-1 is captured. Companies are encouraged to provide simulation results to evaluate the impact of the measurement error based on the performance metric in section 4.

# Simulation assumptions

Link level simulation (LLS) assumptions for evaluation of measurement error on AI/ML based BM case-1 performance are defined in Table 1-5.

Table 1 Baseline Link Level Simulation assumptions for AI/ML in beam management evaluations

|  |  |
| --- | --- |
| Parameter | Value |
| Frequency | 30GHz. |
| Subcarrier spacing | 120kHz |
| Channel model | NLOS channel: CDL-A/C extension, DS = 100nsOther channel models are not precluded. |
| BS antenna configurations | One panel: (M, N, P, Mg, Ng) = (4, 8, 2, 1, 1), (dV, dH) = (0.5, 0.5) λ as baseline.Number of Tx beams is 32 |
| BS antenna element radiation pattern | Table 2 |
| BS antenna height and antenna array down-tilt angle | 25m, 110° |
| UE antenna configurations | Panel structure: (M, N, P) = (1, 4, 2), - 2 panels (left, right) with (Mg, Ng) = (1, 2) as baseline- 1 panel as optionalNumber of Rx beams is up to UE |
| UE antenna element radiation pattern | Table 3 |
| UE moving speed | 3km/h |
| Reference signal | SSB as baseline, CSI-RS (optional) |
| DRX | No |
| Number of samples | 1 |
| Note 1: Number of Tx beams is 32Note 2: Number of Rx beams is up to UENote 3: TXRU weights mapping for BS and UE is up to company. |

Table 2 BS antenna radiation pattern

|  |  |
| --- | --- |
| Parameter | Values |
| Antenna element vertical radiation pattern (dB) |  |
| Antenna element horizontal radiation pattern (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 8dBi |

Table 3 UE antenna radiation pattern model

|  |  |
| --- | --- |
| **Parameter** | Values |
| Antenna element radiation pattern in dim (dB) |  |
| Antenna element radiation pattern in dim (dB) |  |
| Combining method for 3D antenna element pattern (dB) |  |
| Maximum directional gain of an antenna element *GE,max* | 5dBi |
| Note: are in local coordinate system. |

Table 4 Cell-specific parameters

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Unit** | **Value** |
| PBCH and DMRS power offset with respect to NR-PSS and NR-SSS | dB | 0 |
| Data and control PSD relative to NR-PSS and NR-SSS | dB | 0 |
| RB Utilization | % | 100 |
| Data Modulation | - | QPSK |
| Slot length | - | 14 symbols |
| CP Length | - | Normal |
| Frequency Offset relative to UE frequency reference | Hz | 0 |
| Relative Delay of 1st Path (synchronous) | µs | 0 |
| SNR  | dB | [-6, -3] |

Table 5 CSI-RS configuration parameters

|  |  |
| --- | --- |
| Parameter | Value |
| CSI-RS bandwidth | 48 PRBs; |
| CSI-RS SCS | 120 kHz |
| Periodicity | 5 ms (optional); 40 ms |
| CSI-RS configuration:<X,D,N,CDM>, where:X=number of CSI-RS ports,D=density [RE/RB/port],N=number of OFDM symbols in the same slot | <32,1,4,FD-CDM2> |

# Reference model

For better alignment of the performance between companies, it is suggested to perform simulations based on a reference model. The model description in Fig. 1 is the proposed reference model for BM-case 1 performance evaluation.



Fig. 1 Reference model description

# Performance metrics

At least the following performance characteristics are to be provided

* Top-1, 2, 4, 5 prediction accuracy
	+ with considering measurement errors
	+ without considering measurement errors
* 90%-tile L1-RSRP difference between the predicted L1-RSRP of the Top-1/Top-5 predicted beam(s) and the ideal L1-RSRP of the same beams
	+ with considering measurement errors
	+ without considering measurement errors

Note:

L1-RSRP difference = predicted L1-RSRP – ideal L1-RSRP .

90%-tile L1-RSRP difference = max(abs(95%-tile L1-RSRP), abs(5%-tile L1-RSRP))

# Simulation procedures (For information)

We provide the following procedures for companies to perform simulations to evaluate the impact of measurement error.

1. Companies to generate ideal L1-RSRP dataset from the SLS assumption defined in TR 38.843 Table 6.3.1-1.
2. Use subset samples of the ideal dataset generated from the 1st step for training models.
3. Use the other subset samples of the ideal dataset (none overlap samples with the subset dataset in 2nd step) as the ideal dataset for inference and to evaluate the performance metric without considering measurement errors.
4. Use the LLS simulation assumptions defined in Table 1-5 to generate L1-RSRP difference under specific SNR as the baseband errors.
5. Add the baseband errors generated from LLS into the ideal SLS dataset to derive the dataset with errors.
6. Use the dataset with errors for inference and to evaluate the performance metric with considering measurement errors.

# References

1. TR 38.843 Study on Artificial Intelligence (AI)/Machine Learning (ML) for NR air interface (Release 18)

# Annex

In addition, the impact of RF errors should also be considered. -4.5dB RF error is considered. Following options can be used to generate RF errors.

* Option 1: Uniform distribution
* Option 2: Gaussian distribution
* Other options are not precluded

Companies are also encouraged to provide simulation results with considering RF errors.