**3GPP TSG-RAN WG4 Meeting #116bis R4-25xxxxx**

**Prague, Czech Republic, 13 – 17 Oct 2025**

**Agenda Item: 6.11.1**

**Source: OPPO, CAICT, vivo, Nokia, Ericsson, Qualcomm, CMCC, CTC, Huawei, Hisilicon, Mediatek, CATT, Samsung, ZTE Corporation, Apple**

**Title: Demodulation and CSI reporting requirements for CSI prediction**

**Document for: Approval**

# Introduction

In this contribution, according to companies’ inputs and agreements in RAN4 #116bis meeting, updated simulation assumptions for AI/ML based CSI prediction are proposed.

# Updated simulation assumptions for AIML based CSI prediction

**For information**

* By RAN4 #116bis meeting, RAN4 has 6 inputs for step2 and 5 inputs for step3, all for FDD.
* For the new updated step3 results, which is more important to define the CSI prediction performance requirement, seems the variance among different companies is still quite heavy, potentially due to the generated wireless channel by different companies(e.g., different simulation platform), the utilized model(e.g., different backbone, detailed design), the channel estimation approach, and the type1 baseline performance simulated and claimed by different companies.
* For the simulation assumption, as agreed in RAN4 #116 bis meeting, “Introduce tests for 20Hz Doppler with MCS [17or19] with 16Tx ports and 2Rx in FDD, Introduce test for TDD with the details FFS”, following revising will be captured in the updated simulation.
	+ Remove the 50Hz doppler and remove the mixed Doppler assumption
	+ keep MCS 17 and MCS 19, remove MCS 13
	+ Use 2RX for FDD
	+ Use 4RX for TDD (update is allowed if any new agreement)
	+ Remove the assumptions on 32Tx ports

**Way forward for next step simulation for CSI prediction**

* + For step-3,
		- Interested companies are encouraged to provide more CSI prediction simulation results in RAN4#117 meeting, for both FDD and TDD.

**Table 1: Updated simulation assumptions for AIML based CSI prediction**

|  |  |
| --- | --- |
| Parameter | Value |
| Duplex, Waveform  | FDD, TDD, OFDM |
| Carrier frequency | 2GHz for FDD4GHz for TDD |
| Subcarrier spacing | 15kHz for FDD, 30kHz for TDD |
| Bandwidth | 10MHz for FDD, 40MHz for TDD |
| Symbol | 1 symbol for step-1 and step-2 simulation  |
| Number of subbands | 13 subbands, 4RB as a bundle for FDD14 subbands, 8RB as a bundle for TDD |
| gNB TX antennas | 16(N1,N2)=(4,2) as defined in Rel-18 CSI prediction requirements |
| UE RX antennas | 2RX for FDD4RX for TDD |
| Channel model | TDLA30 with XP medium correlation as baseline  |
| Doppler spread | 20Hz |
| Channel estimation for CSI prediction | Step-1: * Ideal DL channel estimation, for the purpose of calibration and/or comparing intermediate results (e.g., accuracy of AI/ML output CSI, etc.).

Step-2: * Ideal DL channel estimation, for the purpose of calibration and/or comparing intermediate results (e.g., to check SGCS after CSI feedback).

Step-3:* Practical DL channel estimation, use a common CSI-RS configuration as in demodulation test (may need to define/choose a CSI-RS configuration)
 |
| CSI-RS configuration | For 16Tx

|  |  |
| --- | --- |
| Number of CSI-RS ports (*X*) | 16  |
| CDM Type | CDM4 (FD2, TD2)  |
| Density (ρ) | 1  |
| First subcarrier index in the PRB used for CSI-RS (k0, k1, k2, k3) | (2, 4, 6, 8) |
| First OFDM symbol in the PRB used for CSI-RS (l0) | (5)  |

 |
| Rank per UE | Step-1: Rank 1 and 2 to do quick checkStep-2 and Step-3: Rank 2 as baseline |
| CSI feedback assumption | Step-1: check the CSI prediction (outputs Raw channel) performance, do not need to take CSI feedback into account |
| Step-2 and Step-3: take CSI feedback into account* Use Rel-18 eTypeII-Doppler, N4 = 1， N4>1 can be further discussed in the future if needed
 |
| Test setup(timeline) | Only for step-3For FDD test setup with Periodic CSI-RS configuration* CSI-RS periodicity: 5 ms
* CSI feedback periodicity: 5 ms
* Scheduling delay (from CSI feedback to apply in scheduling): 4 slots

Note: If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation using a CSI-RS resource set in which the last CSI-RS resource is transmitted at a downlink slot not later than slot#(n-4), this reported PMI cannot be applied at the gNB downlink before slot#(n+4)* Test setup for FDD test setup with Periodic CSI-RS configuration is captured in Table2

For TDD test setup with Periodic CSI-RS configuration* CSI-RS periodicity: 5 ms
* CSI feedback periodicity: 5 ms
* Scheduling delay (from CSI feedback to apply in scheduling): 6 slots

Note : If the UE reports in an available uplink reporting instance at slot#n based on PMI estimation using a CSI-RS resource set in which the last CSI-RS resource is transmitted at a downlink slot not later than slot#(n-6), this reported PMI cannot be applied at the gNB downlink before slot#(n+6).* Test setup for TDD test setup with Periodic CSI-RS configuration is captured in Table3

FFS test setup for aperiodic CSI-RS configuration |
| Beam steer approach  | For step-3, randomization of the dual-cluster beam directions should be used as specified in AnnexB.2.3.2.3A in 38.101-4. The value of relative power ratio (p) shall be fixed as 1 during the test |
| SNR assumption | Only for step-3Claimed by companies for step-3 first round simulation (TP as KPI) |
| CSI feedback overhead | PC7 as baseline |
| Baseline  | Random PMI with Rel-15 Type I single panel codebook if needed (e.g., for Step-3 or performance requirements) |
| KPI | Step-1: * check SGCS1 before CSI feedback
* SGCS1 is calculated by comparing the SVD of model output (before feedback) with the SVD of the ground truth Raw channel
* Average of SGCS for intermediate results over all subbands per layer (e.g. for rank 2),

Step-2: * check SGCS2 and SGCS3
* SGCS2: Compares the PMI feedback-derived based on Rel-18 eType II-Doppler CB with the model output against the ground-truth raw channel’s SVD

SGCS3: Compares the PMI feedback-derived based on Rel-18 eType II-Doppler CB with the model output against the PMI -derived based on Rel-18 eType II-Doppler CB with the ground truth* Average of SGCS for intermediate results over all subbands per layer (e.g. for rank 2)

Step-3:* check SGCS1 and SGCS3, under practical channel estimation, corresponding to 90% of maximum TP with follow PMI using AI/ML-based CSI prediction
* SGCS1: Compares the SVD of model output (before feedback) with the SVD of the ground truth Raw channel
* SGCS3: Compares the PMI feedback-derived based on Rel-18 eType II-Doppler CB with the model output against the PMI -derived based on Rel-18 eType II-Doppler CB with the ground truth
* Average of SGCS for intermediate results over all subbands per layer (e.g. for rank 2)
* check TPs after CSI feedback for both AI based CSI prediction and Random PMI with Rel-15 Type I single panel codebook, as well as the SNR value corresponding to 90% of maximum TP of the AI based CSI prediction

γ1\_AI/ML: AI/ML based CSI prediction is compared with Rel-15 Type I random PMI* check TPs after CSI feedback for both AI based CSI prediction and Rel-16 eType II codebook(sample and hold), as well as the SNR value corresponding to 90% of maximum TP of the AI based CSI prediction

γ2\_AI/ML: AI/ML based CSI prediction is compared with Rel-16 eType II CB(sample and hold)* Companies are also encouraged to provide the TP curve with corresponding SNRs.
* The test parameters for TPs simulation can be referred as 38.101-4 section of 6.3
	+ FDD with 16Tx4Rx: Table 6.3.3.1.8-1
	+ FDD with 32Tx4Rx: Table 6.3.3.1.4-1:
	+ TDD with 16Tx4Rx: Table 6.3.3.2.8-1
	+ TDD with 32Tx4Rx: Table 6.3.3.2.4-1:
 |
| Model input type | Raw channel matrix |
| Model out type | Raw channel matrix |
| Observation window | Observation window (number/distance): 5/5ms as baselineOptional for 10/5ms |
| Prediction window | Prediction window (number/distance between prediction instances/distance from the last observation instance to the 1st prediction instance): 1/5ms/5ms |
| Training data and test data | Use following combinations:

|  |  |
| --- | --- |
| Training dataset(TDLA30) | Test on(TDLA30) |
| 20Hz Doppler spreads  | 20Hz Doppler spreads  |

 |
| Companies can provide the model complexity information (e.g., flops, backbone) of their AI/ML CSI prediction modelsCompanies are encouraged to clarify whether the SNR dataset for model training is per SNR or with an SNR range when providing the results of step-3 simulation |
| Clarifications on the SGCS calculation:SGCS1: Compares the SVD of model output (before feedback) with the SVD of the ground truth Raw channelSGCS2: Compares the PMI feedback-derived based on Rel-18 eType II-Doppler CB with the model output against the ground-truth raw channel’s SVD.SGCS3: Compares the PMI feedback-derived based on Rel-18 eType II-Doppler CB with the model output against the PMI -derived based on Rel-18 eType II-Doppler CB with the ground truth.A diagram of a software project  AI-generated content may be incorrect. |

Table2: Test setup for FDD test setup with Periodic CSI-RS configuration (based on R.PDSCH.1-24.1 FDD)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Reference channel |  | ~~MCS13~~ | MCS17 | MCS19 |  |  |
| Channel bandwidth | MHz | ~~10~~ | 10 | 10 |  |  |
| Subcarrier spacing | kHz | ~~15~~ | 15 | 15 |  |  |
| Number of allocated resource blocks | PRBs | ~~52~~ | 52 | 52 |  |  |
| Number of consecutive PDSCH symbols |  | ~~12~~ | 12 | 12 |  |  |
| Allocated slots per 2 frames | Slots | ~~16~~ | 16 | 16 |  |  |
| MCS table |  | ~~64QAM~~ | 64QAM | 64QAM |  |  |
| MCS index |  | ~~13~~ | 17 | 19 |  |  |
| Modulation |  | ~~16QAM~~ | 64QAM | 64QAM |  |  |
| Target Coding Rate |  | ~~0.48~~ | 0.43 | 0.50 |  |  |
| Number of MIMO layer |  | ~~2~~ | 2 | 2 |  |  |
| Number of DMRS REs (Note 3) |  | ~~24~~ | 24 | 24 |  |  |
| Overhead for TBS determination |  | ~~0~~ | 0 | 0 |  |  |
| Information Bit Payload per Slot  |  |  |  |  |  |  |
| For CSI Slots i, if mod (i, 5) = {0}, i={0,…,19} |  | ~~N/A~~ | N/A | N/A |  |  |
|  For Non CSI-RS Slot | Bits | ~~24072~~ | 32264 | 37896 |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
|  For CSI Slots i, if mod (i, 5) = {0}, i={0,…,19} |  | ~~N/A~~ | N/A | N/A |  |  |
|  For Non CSI-RS Slot | Bits | ~~24~~ | 24 | 24 |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
|  For CSI Slots i, if mod (i, 5) = {0}, i={0,…,19} |  | ~~N/A~~ | N/A | N/A |  |  |
|  For Non CSI-RS Slot | CBs | ~~3~~ | 4 | 5 |  |  |
|  |  |  |  |  |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 msNote 2: Slot i is slot index per 2 framesNote 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without dataAn example for FDD test setup with Periodic CSI-RS configuration |

Table3: Test setup for TDD test setup with Periodic CSI-RS configuration (based on R.PDSCH.2-38.1 TDD)

|  |  |  |
| --- | --- | --- |
| Parameter | Unit | Value |
| Reference channel |  | ~~MCS13~~ | MCS17 | MCS19 |  |  |
| Channel bandwidth | MHz | ~~40~~ | 40 | 40 |  |  |
| Subcarrier spacing | kHz | ~~30~~ | 30 | 30 |  |  |
| Number of allocated resource blocks | PRBs | ~~106~~ | 106 | 106 |  |  |
| Number of consecutive PDSCH symbols |  | ~~12~~ | 12 | 12 |  |  |
| Allocated slots per 2 frames | Slots | ~~24~~ | 24 | 24 |  |  |
| MCS table |  | ~~64QAM~~ | 64QAM | 64QAM |  |  |
| MCS index |  | ~~13~~ | 17 | 19 |  |  |
| Modulation |  | ~~16QAM~~ | 64QAM | 64QAM |  |  |
| Target Coding Rate |  | ~~0.48~~ | 0.43 | 0.50 |  |  |
| Number of MIMO layer |  | ~~2~~ | 2 | 2 |  |  |
| Number of DMRS REs (Note 3) |  | ~~24~~ | 24 | 24 |  |  |
| Overhead for TBS determination |  | ~~0~~ | 0 | 0 |  |  |
| Information Bit Payload per Slot  |  |  |  |  |  |  |
|  For Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | ~~N/A~~ | N/A | N/A |  |  |
| For CSI-RS Slot i, if mod(i, 10) = {0} for i from {0,…,39} | Bits | ~~N/A~~ | N/A | N/A |  |  |
| For CSI-RS Slot i, if mod(i, 10) = {1,2,3,4,5,6} for i from {1,…,39} |  | ~~49176~~ | 65576 | 77896 |  |  |
| Transport block CRC per Slot |  |  |  |  |  |  |
|  For Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | Bits | ~~N/A~~ | N/A | N/A |  |  |
| For CSI-RS Slot i, if mod(i, 10) = {0} for i from {0,…,39} | Bits | ~~N/A~~ | N/A | N/A |  |  |
|  For Non CSI-RS Slot i | Bits | ~~24~~ | 24 | 24 |  |  |
| Number of Code Blocks per Slot |  |  |  |  |  |  |
|  For Slot i, if mod(i, 10) = {7,8,9} for i from {0,…,39} | CBs | ~~N/A~~ | N/A | N/A |  |  |
| For CSI-RS Slot i, if mod(i, 10) = {0} for i from {0,…,39} | CBs | ~~N/A~~ | N/A | N/A |  |  |
|  For Non CSI-RS Slot | CBs | ~~6~~ | 8 | 10 |  |  |
| Note 1: SS/PBCH block is transmitted in slot #0 with periodicity 20 msNote 2: Slot i is slot index per 2 framesNote 3: Number of DMRS REs includes the overhead of the DM-RS CDM groups without dataAn example for TDD test setup with Periodic CSI-RS configuration |