**3GPP TSG-RAN WG4 Meeting #111 R4-240XXX**

**Fukuoka City, Fukuoka, Japan, 20th – 24th May, 2024**

**Agenda item:** 7.19.4

**Source:** Moderator (Samsung)

**Title:** Topic summary for [111][328] NR\_MIMO\_evo\_DL\_UL\_demod

**Document for:** Information

# Introduction

This topic summary covers the contributions submitted under the following AI for demodulation performance requirements of Rel-18 NR MIMO evolution for downlink and uplink:

7.19 NR MIMO evolution for downlink and uplink [NR\_MIMO\_evo\_DL\_UL]

7.19.3 Demodulation performance requirements [NR\_MIMO\_evo\_DL\_UL-Perf]

7.19.3.1 UE demodulation performance and CSI requirements [NR\_MIMO\_evo\_DL\_UL-Perf]

7.19.3.2 BS demodulation performance requirements [NR\_MIMO\_evo\_DL\_UL-Perf]

This is the fifth meeting for Rel-18 MIMO WI demod part, in RAN4#108bis and RAN4#109 meetings companies agreed to do feasibility study of introducing PMI reporting requirements for typeII-Doppler-r18 and typeII-CJT-r18 codebooks for UE CSI reporting, and agreed to introduce UE and BS demodulation performance requirements for Rel-18 enhanced DMRS. In RAN4#110 meeting, the agreements about introducing PMI reporting requirements for typeII-Doppler-r18 and typeII-CJT-r18 codebooks for UE CSI reporting was achieved. In RAN4#110bis meeting, the agreements about test setup and simulation assumptions for typeII-Doppler-r18 and typeII-CJT-r18 codebooks for UE CSI reporting was achieved. In this meeting, let’s try to reach agreements on the remaining issues of test setups and simulation assumptions, and the definition of requirements:

* Topic #1 Open issues for UE demodulation and CSI

Sub-topic 1-1 Test setup and simulation assumptions for TypeII Doppler

Sub-topic 1-2 Test setup and simulation assumptions for TypeII for CJT

Sub-topic 1-3 Requirements for Rel-18 DMRS

* Topic #2 Open issues for BS demodulation

Sub-topic 2-1 Requirements for Rel-18 DMRS

# Topic #1: Open issues for UE demodulation and CSI

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407259 | Apple | **Type II Doppler Codebook**  **Proposal #1: Introduce requirements for R18 Doppler codebook with TDLA30-20.**  **Proposal #2: Test metric for FDD – 1.9 for 2RX and 2.0 for 4RX.** |
| R4-2407755 | Nokia | **Timing mismatch between the prediction reference and precoder usage in PDSCH transmission**  **Observation 1:** The currently available delta values in the EMUM list of “typeII-Doppler-r18 -> predictionDelay-r18” does not always enable the NW to provide the UE with high enough delta values matching the used delay (i.e. higher than n2), hence the prediction might not be optimal to the actual configuration used by the NW.  **Proposal 1: RAN4 to send LS to RAN1 requesting RAN1 to consider increasing the number of values for the predictionDelay-r18. As a starting point 4-6 additional values can be suggested to be added, i.e. from ENUMERATED {m0, n0, n1, n2} to {m0, n0, n1, n2, n(x1), n(x2), …, n(x6)}.**  **Test metric of TypeII-CJT-r18 codebook**  **Observation 2:** Based on the provided simulation results from RAN4#110bis a gamma value of [1.8]dB seems reasonable, however if updated/additional simulation results are provided in RAN4#111 the value must be reconsidered.  **Proposal 2: If updated simulation results are provided in RAN4#111, the gamma value must be decided based on the updated results. If no updated results are provided, set gamma to [1.8]dB for both 2Rx and 4Rx cases.** |
| R4-2408498 | Samsung | **Proposal 1: For FR1 FDD, use TDLA30-20 as the propagation channel for the test assumption of TypeII-Doppler-r18 codebook.**  **Observation 1: The agreements about the Test setup for FR1 FDD case and FR1 TDD case require different channel coherence times. For FR1 FDD case, the channel coherence time should be no less than 24ms (from slot#0 to slot#23), while for FR1 TDD case, the channel coherence time should be no less than 8.5ms (from slot#0 to slot#16). The channel coherence time, which is inversely proportional to the maximum Doppler shift as. Hence FR1 TDD case should use a higher Doppler shift value than FR1 FDD case.**  **Proposal 2: For FR1 TDD, use TDLA30-30 as the propagation channel for the test assumption of TypeII-Doppler-r18 codebook.**  **Proposal 3: For FR1 FDD, introduce PMI reporting requirements for TypeII-Doppler-r18 codebook with test metric**  **(using 90% of the maximum throughput) about 2.4 for 2Rx case, and 3.4 for 4Rx case.**  **Proposal 4: For FR1 TDD, introduce PMI reporting requirements for TypeII-Doppler-r18 codebook with test metric**  **(using 90% of the maximum throughput) about 3.6 for 2Rx case, and 5.6 for 4Rx case.**  **Observation 2: Configure the maximum value and maximum N4 value could benefit for solving the timing mismatch problem between the prediction reference and precoder usage in PDSCH transmission.**  **Observation 3: RAN1 has already discussed the higher δ value options in RAN1#110bis-e, RAN1#111 and RAN1#112 meetings. The δ value options are narrowed down from {0, 1, 2, 3, 4, 5, 6, 8} to {0, 1, 2} through rounds of discussions. The agreements of each round discussion are as below.**  **Proposal 5: No need to send LS to RAN1 and RAN2 as the timing mismatch problem between the prediction reference and precoder usage in PDSCH transmission could be solved.**  **Proposal 6: For FR1 FDD, introduce PMI reporting requirements for TypeII-CJT-r18 codebook with the test metric**  **at 90% of the maximum TP as 2.3 for both 2Rx and 4Rx cases.** |
| R4-2408499 | Samsung | **Observation 1: For both FR1 FDD 2Rx and 4Rx PMI reporting performance simulation results on ‘typeII-Doppler-r18’ codebook with N4=1 vs Rel-16 Type II codebook, obvious benefit is observed for TDLA30-20 cases.**  **Observation 2: For both FR1 FDD 2Rx and 4Rx PMI reporting performance simulation results on ‘typeII-Doppler-r18’ codebook with N4=1 vs Rel-16 Type II codebook, no performance gain could be observed for TDLA30-30 cases.**  **Observation 3: For Doppler 20Hz with MCS13 FR1 FDD case, the 90% SNR working point of Rel-18 Doppler codebook could get about 1dB gain over Rel-16 codebook for 2Rx cases, and about 0.6dB gain for 4Rx cases.**  **Observation 4: For Doppler 20Hz with MCS13 FR1 FDD case, the test metric**  **on 90% SNR working point of Rel-18 Doppler codebook is about 2.69 for 2Rx case, and 3.94 for 4Rx case.**  **Observation 5: For both FR1 TDD 2Rx and 4Rx PMI reporting performance simulation results on ‘typeII-Doppler-r18’ codebook with N4=1 vs Rel-16 Type II codebook, obvious benefits could be observed for TDLA30-10, TDLA30-20, TDLA30-30 cases, and the most obvious benefit is achieved at Doppler 30Hz.**  **Observation 6: For Doppler 10Hz, 20Hz and 30Hz with MCS13 FR1 TDD cases, the 90% SNR working point of Rel-18 Doppler codebook could get about 0.4dB, 1.4dB, 2.4dB gain over Rel-16 codebook separately for 2Rx cases, and about 0.3dB, 0.8dB, 1.4dB gain for 4Rx cases.**  **Observation 7: For Doppler 30Hz with MCS13 FR1 TDD case, the test metric**  **on 90% SNR working point of Rel-18 Doppler codebook is about 7.3 for 2Rx case, and 10.1 for 4Rx case.**  Observation 8: For FR1 FDD cases with MCS20 and Rank 2, the test metric on 90% SNR working point of Rel-18 CJT codebook is about 6.56 for 2Rx case, and 5.7 for 4Rx case. |
| R4-2408521 | Nokia | Provide simulation results for Rel-18 CJT codebook. |
| R4-2408780 | Ericsson | **Observation 1: TDLA30-20 shows larger throughput gain compared with TDLA30-30 for both 2Rx and 4Rx.**  **Proposal 1: For the FDD SCS=15kHz PMI reporting requirements with typeII-Doppler-r18, configure TDLA30-20.**  **Proposal 2: For the FDD SCS=15kHz PMI reporting requirements with typeII-Doppler-r18, set γ=2.0 for both 2Rx and 4Rx.**  **Observation 2: TDLA30-10 shows larger throughput gain compared with TDLA30-20 for both 2Rx and 4Rx.**  **Proposal 3: For the TDD SCS=30kHz PMI reporting requirements with typeII-Doppler-r18, configure TDLA30-10.**  **Proposal 4: For the TDD SCS=30kHz PMI reporting requirements with typeII-Doppler-r18, set γ=4.0 for 2Rx and γ=3.5 for 4Rx.**  **Proposal 5: Add the following note to CQI/RI/PMI delay in the Predicted PMI reporting test parameters:**   * CQI/RI/PMI delay: Delay is defined as the time from the first NZP CSI-RS resources for CSI acquisition to the time to the first PDSCH transmission where the reported PMI is applied.   **Proposal 6: Confirm the CQI/RI/PMI delay is 15ms for FDD SCS=15kHz and 7.5ms for TDD SCS=30kHz.**  **Proposal 7: For the PMI reporting requirements with typeII-CJT-r18, set γ=1.8 for FDD/TDD with 2Rx/4Rx.** |
| R4-2408781 | Ericsson | Provide the simulation results to finalize the PDSCH demodulation requirements with Rel-18 enhanced DMRS for Rank 4 scenario. |
| R4-2408963 | Huawei, HiSilicon | **Proposal 1: Select 30Hz for FDD and 10Hz for TDD for TypeII Doppler PMI reporting requirements.**  **Proposal 2: Considering our proposed Doppler value as above, select the gamma as 1.15 for TypeII Doppler PMI reporting requirements.**  **Proposal 3: Select the gamma as 1.6 for TypeII CJT PMI reporting requirements.** |
| R4-2408964 | Huawei, HiSilicon | Provide updated simulation results on UE demodulation requirements for MIMO evolution. |
| R4-2409455 | MediaTek Inc. | Proposals and observations of predicted PMI  Observation #1: No prediction gains in FDD simulations probably due to too many allocated PDSCH slots.  Observation #2: Some prediction gains in TDD simulations with both doppler options.  Observation #3: Higher prediction gains in TDD simulations with 10Hz doppler compared to 20Hz.  Proposal #1: We propose to use only 2 first allocated PDSCH slots, like in TDD, to improve prediction accuracy.  Proposal #2: We propose to use TDLA30-20 channel for FR1 FDD.  Proposal #3: We propose to use TDLA30-10 channel for FR1 TDD.  Proposal #4: We propose gamma value 1.6 for FR1 FDD 4Rx test, if keep the current configuration.  Proposal #5: We propose gamma value 1.4 for FR1 FDD 2Rx test, if keep the current configuration.  Proposal #6: We propose gamma value 3.9 for FR1 TDD 4Rx test.  Proposal #7: We propose gamma value 4.2 for FR1 TDD 2Rx test.  Proposal #8: To fix the timing mismatch between the prediction reference and precoder usage in PDSCH transmission, we propose sending LS to RAN1 to request update to specifications with extended delta parameter options.  Proposals and observations of CJT  Observation #4: We see feasible gamma and SNR values in both 4Rx and 2Rx tests.  Proposal #9: We propose gamma value 1.6 for FR1 FDD 4Rx test.  Proposal #10: We propose gamma value 1.7 for FR1 FDD 2Rx test.  Proposal #11: We propose to confirm CQI/RI/PMI delay is 14ms and all companies have assumed this is simulations. |
| R4-2409456 | MediaTek Inc. | Observations of predicted PMI  **Observation #1: No prediction gains in FDD simulations probably due to too many allocated PDSCH slots.**  **Observation #2: Some prediction gains in TDD simulations with both doppler options.**  **Observation #3: Higher prediction gains in TDD simulations with 20Hz doppler compared to 10Hz.**  Observations of CJT  **Observation #4: We see feasible gamma and SNR values in both 4Rx and 2Rx tests.** |
| R4-2409457 | MediaTek Inc. | LS on delta parameter options extension for predicted PMI |

## Open issues summary

### Sub-topic 1-1 Test setup and simulation assumptions for TypeII Doppler

**Issue 1-1-1:** **Propagation channel for both FDD and TDD cases**

For Rel18 Doppler codebook requirements, decide the propagation channel from below options based on the updated simulation results on the May meeting

* Proposals

For FR1 FDD:

* + Option 1: TDLA30-20 (Apple, Samsung, Ericsson, MTK)
  + Option 2: TDLA30-30 (Huawei, Ericsson also ok)

For FR1 TDD:

* + Option 1: TDLA30-10 (Ericsson, Huawei, MTK)
  + Option 2: TDLA30-20 (Ericsson also ok)
  + Option 3: TDLA30-30 (Samsung)
* Observation: The agreements about the Test setup for FR1 FDD case and FR1 TDD case require different channel coherence times. For FR1 FDD case, the channel coherence time should be no less than 24ms (from slot#0 to slot#23), while for FR1 TDD case, the channel coherence time should be no less than 8.5ms (from slot#0 to slot#16). The channel coherence time, which is inversely proportional to the maximum Doppler shift as. Hence FR1 TDD case should use a higher Doppler shift value than FR1 FDD case.
* Recommended WF
  + More discussion needed

**Issue 1-1-2:** **Test metric of TypeII-Doppler-r18 codebook**

* Proposals

For FR1 FDD:

* + Option 1: 1.9 for 2Rx case, and 2.0 for 4Rx case (Apple)
  + Option 2: 2.0 for both 2Rx and 4Rx (Ericsson)
  + Option 3: 2.4 for 2Rx case, and 3.4 for 4Rx case. (Samsung)
  + Option 4: 1.15 for both 2Rx and 4Rx (Huawei)
  + Option 5: 1.4 for 2Rx if keep current configuration (MTK)

For FR1 TDD:

* + Option 1: 4.0 for 2Rx case, and 3.5 for 4Rx case. (Ericsson)
  + Option 2: 3.6 for 2Rx case, and 5.6 for 4Rx case. (Samsung)
  + Option 3: 1.15 for both 2Rx and 4Rx (Huawei)
  + Option 4: 4.2 for 2Rx case, and 3.9 for 4Rx case. (MTK)
* Recommended WF
  + More discussion needed

**Issue 1-1-3:** **Test setup for FR1 FDD case of TypeII-Doppler-r18 codebook**

* Proposals
  + Option 1: Propose to use only 2 first allocated PDSCH slots, like in TDD, to improve prediction accuracy (MTK)
* Recommended WF
  + More discussion needed

**Issue 1-1-4: Timing mismatch between the prediction reference and precoder usage in PDSCH transmission**

* Proposals
  + Option 1: RAN4 to send LS to RAN1 to request update to specification with extended delta parameter options. (Nokia, MTK)
  + Option 2: No need to send LS to RAN1 and RAN2 as the timing mismatch problem between the prediction reference and precoder usage in PDSCH transmission could be solved. (Samsung)
* Observation: Configure the maximum δ value and maximum N4 value could benefit for solving the timing mismatch problem between the prediction reference and precoder usage in PDSCH transmission.
* Observation: RAN1 has already discussed the higher δ value options in RAN1#110bis-e, RAN1#111 and RAN1#112 meetings. The δ value options are narrowed down from {0, 1, 2, 3, 4, 5, 6, 8} to {0, 1, 2} through rounds of discussions.
* Recommended WF
  + More discussion needed

**Issue 1-1-5: PMI delay definition**

* Proposals
  + Option 1: Add the following note to CQI/RI/PMI delay in the Predicted PMI reporting test parameters (Ericsson)
* CQI/RI/PMI delay: Delay is defined as the time from the first NZP CSI-RS resources for CSI acquisition to the time to the first PDSCH transmission where the reported PMI is applied.
* Recommended WF
  + More discussion needed

**Issue 1-1-6: PMI delay value**

* Proposals
  + Option 1: Confirm the CQI/RI/PMI delay is 15ms for FDD SCS=15kHz and 7.5ms for TDD SCS=30kHz (Ericsson)
  + Option 2: Confirm CQI/RI/PMI delay is 14ms and all companies have assumed this is simulations. (MTK)
* Recommended WF
  + More discussion needed

### Sub-topic 1-2 Test setup and simulation assumptions for TypeII for CJT

**Issue 1-2-1:** **Test metric of TypeII-CJT-r18 codebook**

* Proposals
  + Option 1: 1.8 for both 2Rx and 4Rx case (Nokia, Ericsson)
  + Option 2: 2.3 for both 2Rx and 4Rx case (Samsung)
  + Option 3: 1.6 for both 2Rx and 4Rx case (Huawei)
  + Option 4: 1.7 for 2Rx case, 1.6 for 4Rx case (MTK)
* Recommended WF
  + More discussion needed

### Sub-topic 1-3 Requirements for Rel-18 DMRS

**Issue 1-3-1: Minimum requirements for Rank 4 Rel-18 DMRS**

* + Encourage companies to provide impairment results

# Topic #2: Open issues for BS demodulation

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407135 | Nokia | We have presented Nokia's results for eDMRS and BS demodulation performances with relation to MIMO evolution.  No observations or proposals were made. |
| R4-2407136 | Nokia | **Observation 1:** Enhanced DMRS is a new feature for Rel-18.  **Observation 2:** Multiple companies have provided simulation and CRs to this work item.  **Proposal 1: RAN4 shall use the new simulation results to define requirements for BS Demodulation of eDMRS.** |
| R4-2408349 | Ericsson | **Observation 1: The span of ideal results of 2x2 10MHz CBW 30kHz SCS in R4-2404755 is 2.7dB which is out of the 2 dB span limitation.**  **Observation 2: The performance difference is less than 0.3dB between Rel-15 simulation results and new delivered results besides 2x2 10MHz CBW 30kHz SCS cases.**  Based on the discussion in the previous sections we propose the following:  **Proposal 1: Further alignment is needed on 2x2 10MHz CBW 30kHz SCS cases.**  **Proposal 2: Use new simulation results for enhanced DM-RS port demodulation requirements.** |
| R4-2408961 | Huawei, HiSilicon | Proposal 1: Reuse legacy value for increased number of orthogonal DMRS ports performance requirements. |
| R4-2408962 | Huawei, HiSilicon | In this contribution, we provide our updated simulation results on BS demodulation requirements for MIMO evolution. |
| R4- 2409481 | Samsung | Proposal 1: Define PUSCH requirement with Rel-18 DMRS based new simulation results. Reusing the legacy values of Rel-15 DMRS can be accepted as compromise. |

## Open issues summary

### Sub-topic 2-1 Requirements for Rel-18 DMRS

**Issue 2-1-1: Minimum requirements for tests need to be defined for Rel-18 DMRS**

* Proposals
  + Option 1: Use the new simulation results to define requirements for BS Demodulation of Rel-18 DMRS (Nokia, Ericsson, Samsung)
  + Option 2: Reuse legacy value to define requirements for BS Demodulation of Rel-18 DMRS. (Huawei, Samsung as compromise)
* Recommended WF
  + More discussion needed

# Topic #3: draft CRs and CRs

|  |  |  |
| --- | --- | --- |
| **Draft CR number** | **Source** | **Proposals / Observations** |
| R4-2407260 | Apple | DraftCR for Applicability of requirements for MIMO Evo |
| R4-2407261 | Apple | DraftCR for FRCs for rank 4 requirements with eDMRS |
| R4-2407756 | Nokia |  |
| R4-2408500 | Samsung | Draft |
| R4-2408502 | Samsung | Big CR for UE demodulation and CSI requirements for Rel-18 MIMO in 38.101-4 |
| R4-2408965 | Huawei, HiSilicon |  |
| R4-2407137 | Nokia |  |
| R4-2408966 | Huawei, HiSilicon | BigCR for BS conformance testing for Rel-18 MIMO (TS38.141-1, Rel-18) |
| R4-2408967 | Huawei, HiSilicon | Draft CR on performance requirements for PUSCH with enhanced DMRS (TS38.141-2, Rel-18) |
| R4-2409479 | Samsung | Draft CR on PUSCH performance requirements with enhanced DMRS in 38.104 |
| R4-2409480 | Samsung | Big CR for BS demodulation requirements for Rel-18 MIMO in 38.104 |

## Open issues

**Issue 3-1: draft CRs and CRs review**

* Companies to provide comments and response under e-mail thread [111] [328] NR\_MIMO\_evo\_DL\_UL\_demod –draft CRs and CRs review.