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

**Fukuoka City, JP, May 20-24, 2024**

**Agenda item:** 7.11.4

**Source:** Moderator (China Telecom)

**Title:** Topic summary for [111][324] NR\_demod\_enh3\_Part1

**Document for:** Information

# Introduction

This contribution summarizes the open issues, candidate options as well as the recommended WF for the advanced receiver for MU-MIMO part of the Rel-18 NR demodulation requirement evolution WI under agenda 7.11.

# Topic #1: Test parameters and simulation results

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407113 | China Telecom | Proposal 1: Consider the following case for Rank 1+1 with 2T2R test requirement with modulation order blind detection:  – Case 20: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE  Proposal 2: For 2T4R with rank 1+1, follow the same test configuration for requirements without modulation order blind detection, i.e., Case 23: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE  Proposal 3: Consider the following case for Rank 2+2 with 4T4R test requirement with modulation order blind detection:  – Case#32: Orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE  Proposal 4: For the RRC assistant information configuration on the MCS table, the RRC configuration on MCS Table should be ‘256QAM MCS Table’ for tests without modulation order blind detection.  Proposal 5: Introduce applicability rule to skip tests with modulation order indicated for UEs capable of BD MO.  Proposal 6: Use the following UE demodulation requirement definition rule:  – RAN4 does not consider the farthest result(s) from the ideal AVERAGE value, until the span becomes 2.5 dB or less. The final requirements are derived from AVERAGE impairment results with the corresponding ideal results whose span is within 2.5 dB. |
| R4-2407114 | China Telecom | Discussion on test parameters for the advanced receiver for MU-MIMO: Simulation results |
| R4-2407248 | Apple | Observation #1: For 1+1 with TDLC channel, Low antenna correlation, the performance with R-ML is very close to MMSE-IRC  Observation #2: For 2+2 performance with R-ML with BD-MO is not significantly better than MMSE-IRC  Proposal #1: For requirements with modulation order define requirements with 1+1 alone.  Proposal #2: For requirements with modulation order define requirements with ULA Medium channel and test configuration which has well aligned results among companies.  Proposal #3: In test configuration for tests with modulation order signaled set RRC NWA parameter for MCS table to 256QAM.  Observation #3: Test applicability for UE supporting BD-MO can be introduced only if the test configurations are the same between test with BD-MO and MO explicitly signaled.  Observation #4: For 2+2 if requirements with BD-MO are introduced the test configurations will be different.  Proposal #4: Introduce test applicability rule for 1+1 if the test configuration is the same between test with MO signaled and MO detected. |
| R4-2407249 | Apple | Simulation results for MU-MIMO with advanced receiver |
| R4-2407331 | Qualcomm Incorporated | Proposal 1: The R-ML requirement is applicable only when all the conditions in the previous observation are satisfied and signaled to the DUT UE. We suggest to signal 256QAM MCS table for maximum MCS table of co-scheduled UEs in the test, which is a more practical case.  Proposal 2: Introduce 2+2 demod requirements for R-ML receiver when DCI 6 is signaled unless significant concerns are raised.  Observation 1:  Based on the previous meeting discussions, DCI 1-5 (referring to as test A in the following) may not have the same test configuration in DCI 6 test (referring to as test B in the following). For applicability rule discussion, we need to discuss the following questions:  • Do we expect a UE with MO BD support to pass the DCI 1-5 test after it passed DCI 6 test with the same configuration?  • Do we expect a UE to pass DCI 1-5 test with configurations in test B after it passed test A, and vice versa?  If the answers to both questions are yes, we can conclude that: we expect a UE with MO BD support to pass test A after it passed test B, and therefore applicability rule between test B and A is needed. However, if the answer to the second question is no, there is a test coverage difference between UEs with MO BD capability and without MO BD capability, and the coverage difference is not related to MO BD capability, i.e.,  • UE with MO BD capability: RAN4 verifies that it can pass test A (directly) and DCI 1-5 with configuration from test B (indirectly)  • UE without MO BD capability: RAN4 only verifies that it can pass test A, but don’t know whether it can pass DCI 1-5 with configuration from test B or not.  Therefore, RAN4 either introduces applicability rule, or introduces a test only for UEs without MO BD capability.  Proposal 3: When UE satisfies the requirement of the tests with DCI 6 is signaled, it can skip the corresponding tests with identical test configurations except MU-MIMO DCI signaling being 1 to 5.  Proposal 4: We support the following test configurations for DCI 6:  • 1+1 2 and 4Rx: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE  • 2+2: Orthogonal precoding, TDLA30-10, ULA Low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE  Proposal 5: If RAN4 agrees to not define 2+2 test under DCI 6, we propose to unify the two sub-UE features into one by removing number of layer descriptions to align the definition in the following:  R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression for MU-MIMO when co-scheduled UE(s)’ modulation order is not signaled. |
| R4-2407747 | Nokia | Test setting for when UE is not indicated Modulation order (DCI index 6 is indicated)  Observation 1: Our simulations show that “Case26: Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE” have too high SNR for requirement definition.  Observation 2: Compared to “Orthogonal precoding, TDLC300-100, ULA low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE”, “Case 20: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE” provides the best gain and is also aligned with the already agreed case for DCI index 2 with rank 1+1 with 2T2R.  Proposal 1: For Rank 1+1 with 2T2R define requirements for DCI index 6 using “Case 20: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE”  Observation 3: Our simulations show that “Case 29: Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE” have too high SNR for requirement definition.  Observation 4: Compared to “Orthogonal precoding, TDLC300-100, ULA low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE”, “Case 23: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE” provides the best gain and is also aligned with the already agreed case for DCI index 2 with rank 1+1 with 2T4R.  Proposal 2: For Rank 1+1 with 2T4R define requirements for DCI index 6 using “Case 23: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE”  Observation 5: “Option 1A (Case 32): Orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE” provides the best gain over baseline and can reach span of <2.5dB by removal of only one outlier.  Proposal 3: For Rank 2+2 with 4T4R define requirements for DCI index 6 using “Option 1A (Case 32): Orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE”  RRC assistant information configuration on the MCS table  Observation 6: When DCI index 1-5 is signalled, the target UE is directly informed of the co-scheduled UE modulation order by the DCI, hence there is no need to additionally inform the target UE about the used MCS table.  Proposal 4: Do not introduce RRC assistant information regarding MCS table of co-UEs to UEs not supporting MO BD (option 1).  For UE supporting MO BD, whether to introduce applicability rule to skip test(s) with modulation order indicated  Observation 7: UEs capable of BD MO which has passed the tests with DCI index 6 (with BD MO), should be capable of passing a test with same configuration meant for UEs with DCI index 1-5 signalled (without BD MO support).  Proposal 5: Consider introducing applicability rule to skip tests with DCI index 1-5 if the following applies:  - A test with the same configuration exists for DCI index 1-5 as is tested for DCI index 6.  - There is insignificant difference if SNR @ 70% TP (< 0.5dB) between the DCI index 1-5 test and the DCI index 6 test.  UE capability aspects  Proposal 6: Further discuss the proposed changes to the UE capability definition after all test cases under DCI-6 has been agreed. |
| R4-2407748 | Nokia | On Advanced Receivers - Test parameters - simulations |
| R4-2408496 | Samsung | Proposal 1: For Rank 1+1 with 2T2R, prefer to use Case#26: Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE as the test assumptions.  Proposal 2: For Rank 2+2 with 4T4R, prefer to use Case#31: Orthogonal precoding, TDLA30-10, ULA Low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE as the test assumptions.  Proposal 3: For Rank 1+1 with 2T4R, if test requirements are introduced, prefer to select Case#29: Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE as the test assumptions.  Proposal 4: For UEs not supporting modulation order blind detection, no need for the network to inform MCS table information to the UE.  Proposal 5: For UE supporting MO BD, introducing applicability rule to skip tests with modulation order indicated for UEs capable of BD MO is acceptable for us.  Proposal 6: Keep 36-2a and 36-2b, or combine them as similar as 36-1 like “R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression, for MU-MIMO up to maxNumberMIMO-LayersPDSCH layers across target and co-scheduled UEs with 2 RX and 4RX antennas, when DCI index 6 or 7 in Table 7.3.1.2.2-12 of TS38.212 is signalled.” |
| R4-2408742 | Ericsson | Observation 1: All three candidates have shown enough gain (>3dB).  Proposal 1: Select case 26 for rank 1+1 with 2T2R scenario.  Observation 2: The result of Case 32 and Case 31 has shown 1.4dB and 1.1dB gain respectively.  Proposal 2: Select case 32 for rank 2+2 with 4T4R scenario.  Observation 3: All candidates for rank 1+1 with 2T4R showed enough gain over the baseline receiver.  Proposal 3: Select Case 29 for rank 1+1 with 2T4R scenario.  Proposal 4: Signal the 256QAM MCS table regardless of the capability of MOBD.  Proposal 5: Introduce applicability rule to skip tests without MOBD only if those tests are with the same parameter assumptions as that of the tests with MOBD. |
| R4-2408744 | Ericsson | Additional simulation results for cases with MOBD |
| R4-2409004 | Huawei, HiSilicon | Proposal 1: For case with modulation order detection:   For Rank 1+1: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE   Don’t introduce requirements for Rank 2+2  Proposal 2: Don’t configure RRC assistant information on the MCS table for case without modulation order detection.  Proposal 3: Introduce applicability rule that if UE pass the cases of Rank 1+1 with modulation order detection, cases of Rank 1+1 without modulation order detection is skipped. |
| R4-2409005 | Huawei, HiSilicon | Simulation results on advanced receiver for MU-MIMO. |
| R4-2409085 | ZTE Corporation, Sanechips | Proposal 1. To consider case 20 as a test case for rank 1+1 with 2T2R.  Proposal 2. No need to consider rank 1+1 with 2T4R test case if RAN4 agrees to introduce rank 2+2 with 4T4R test case.  Proposal 3. No need for the network to inform such information to the UE when UEs not support modulation order blind detection.  Proposal 4. Introduce applicability rule to skip tests with modulation order indicated for UEs capable of BD MO.  Proposal 5. Remove FG 36-2b and keep 36-2a from UE feature list. |
| R4-2409086 | ZTE Corporation, Sanechips | Simulation results for MU-MIMO with R-ML receiver |
| R4-2409452 | MediaTek Inc. | Observation #1: All Rank 1+1 tests have enough gains over baseline receiver and SNR is at reasonable level. Tests are sufficient in our view.  Observation #2: All Rank 2+2 tests have only negligible gains over baseline receiver and SNR is at reasonable level. Test usefulness is questionable but 4Rx UE is properly tested in 2T4R test.  Proposal #1: Agreed tests with known modulation order are feasible tests and shall be implemented.  Observation #3: All Rank1+1 tests with MOBD (7, 8, 15, 16) matching agreed known modulation order tests (1, 2, 4, 5) have enough gains over baseline receiver and SNR is at reasonable level. Tests are sufficient in our view.  Observation #4: Rank1+1 tests with MOBD using low antenna correlation with 4 receiver antennas have limited gains over baseline receiver compared to other options.  Proposal #2: For FDD Rank 1+1 2T2R with MOBD, we support Case 7, orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE.  Proposal #3: For FDD Rank 1+1 2T4R with MOBD, we support Case 8, orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE.  Proposal #4: For TDD Rank 1+1 2T2R with MOBD, we support Case 15, orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE.  Proposal #5: For TDD Rank 1+1 2T4R with MOBD, we support Case 16, orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE.  Observation #5: All Rank 2+2 tests with MOBD have only negligible gains over baseline receiver and SNR is at reasonable level. Test usefulness is questionable but 4Rx UE can be properly tested in 2T4R test.  Proposal #6: For FDD Rank 2+2 4T4R with MOBD, we support Case 14, orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1), or MCS17, for Target UE, QPSK for co-UE.  Proposal #7: For TDD Rank 2+2 4T4R with MOBD, we support Case 22, orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1), or MCS17, for Target UE, QPSK for co-UE.  Proposal #8: We support Option 2 to signal MCS table in tests without modulation order blind detection.  Proposal #9: We propose testing both Rank 1+1 2T4R and Rank 2+2 4T4R for 4R UEs.  Proposal #10: We propose to test MOBD capable UEs also with known MO.  Proposal #11: We support Option 1 to combine 36-2a and 36-2b and remove number of layer descriptions if RAN4 agrees to not define 2+2 test under DCI 6. |
| R4-2409453 | MediaTek Inc. | Simulation results of Advanced receiver to cancel inter-user interference for MU-MIMO |
| R4-2407250 | Apple | Simulation result collection for MU-MIMO with advanced receiver |

## Open issues summary

### Sub-topic 1-1 Test parameters

**Issue 1-1-1: Test setting when UE is indicated Modulation order (DCI index 6 is indicated)**

* *Status in the last meeting WF in R4-2406114*

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| *For Rank 1+1 with 2T2R, down-select among the following cases:*   * + *Orthogonal precoding, TDLC300-100, ULA low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE*   + *Case26: Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE*   + *Case 20: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE* ***(as priority for requirement definition)***   + *Companies are encouraged to bring simulation results for all cases above*   *For Rank 2+2 with 4T4R:*   * + *Option 1: Introduce rank 2+2 4T4R requirements with modulation order blind detection*     - *Option 1A (Case 32): Orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE*     - *Option 1B (Case 31): Orthogonal precoding, TDLA30-10, ULA Low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE*   + *Option 2: Do not introduce rank 2+2 4T4R requirements with modulation order blind detection*   *For Rank 1+1 with 2T4R, if introduced, down-select among the following test cases:*   * + *Orthogonal precoding, TDLC300-100, ULA low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE*   + *Case 29: Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE*   + *Case 23: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE*   + *Companies are encouraged to bring simulation results for all cases above* |

* Proposals for Rank 1+1 with 2T2R:
  + Option 1 (Case 9): Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE (Samsung, Ericsson)
  + Option 2 (Case 7 same as Case 1): Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE(priority for requirement definition, China Telecom, Qualcomm, Nokia, Huawei, ZTE, MTK)
* Proposals for Rank 1+1 with 2T4R:
  + Option 1 (Case 10): Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE (Samsung, Ericsson)
  + Option 2 (Case 8 same as Case 2): Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE (China Telecom, Qualcomm, Nokia, [Huawei], MTK)
  + Option 3: No need to consider rank 1+1 with 2T4R test case if RAN4 agrees to introduce rank 2+2 with 4T4R test case. (ZTE)
* Proposals for Rank 2+2 with 4T4R
  + Option 1: Introduce rank 2+2 4T4R requirements with modulation order blind detection (China Telecom, Qualcomm, Nokia, Samsung, MTK)
    - Option 1A (Case 14): Orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE (China Telecom, Nokia, Ericsson, MTK)
    - Option 1B (Case 13): Orthogonal precoding, TDLA30-10, ULA Low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE (Qualcomm, Samsung)
    - QC: We see up to 2dB gains under DCI 6 from R-ML w.r.t. LMMSE.
  + Option 2: Do not introduce rank 2+2 4T4R requirements with modulation order blind detection (Apple, Huawei)
* Summary of performance gain over baseline IRC receiver (FDD 15kHz SCS with 10MHz)
  + For rank 1+1 with 2T2R:

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| Case Number | Rank | MIMO | Channel Model | Antenna correlation | MCS for the target UE | Modulation order for the co-scheduled UE | Gain over baseline | | | | | | |
| MTK | Apple | CTC | Nokia | Huawei | ZTE | E///  (Over E-IRC) |
| 7 | 1+1 | 2T2R | TDLC300-100 | ULA medium | MCS 13 | QPSK | 5.2 | 2.9\* | 3.2\* | 6.8 | 5.8 | 7.4 | 5.0 |
| 9 | MCS17 | 16QAM | 7.2 | INF | 6.1\* | 4.8 | 5.2 | 5.5 | INF |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | | | | | | | |

* + For rank 1+1 with 2T4R:

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| Case Number | Rank | MIMO | Channel Model | Antenna correlation | MCS for the target UE | Modulation order for the co-scheduled UE | Gain over baseline | | | | | | |
| MTK | Apple | CTC | Nokia | Huawei | ZTE | E///  (Over E-IRC) |
| 8 | 1+1 | 2T4R | TDLC300-100 | ULA medium | MCS 13 | QPSK | 7.8 | 2.5\* | 6.2 | 7.9 | 7.0 | 8.9 | 6.2\* |
| 10 | MCS17 | 16QAM | 10.7 | INF | 7.6\* | 6.1 | 7.0 | 8.0\* | 5.2 |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | | | | | | | |

* + For rank 2+2 with 4T4R:

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| Case Number | Rank | MIMO | Channel Model | Antenna correlation | MCS for the target UE | Modulation order for the co-scheduled UE | Gain over baseline | | | | | | |
| MTK | Apple | CTC | Nokia | Huawei | ZTE | E///  (Over E-IRC) |
| 13 | 2+2 | 4T4R | TDLA30-10 | ULA Low | MCS 13 | QPSK | 1.0 | 0.5 | 2.9 |  | 1.5 |  | 1.1 |
| 14 | XP medium | 1.2 | 0.5 | 3.5 |  | 1.3 |  | 1.4 |

* Recommended WF
  + Need discussion based on the simulation result summary

**Issue 1-1-2: RRC assistant information configuration on the MCS table**

* *Status in the last meeting WF in R4-2406114*

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| *For UEs not supporting modulation order blind detection:*   * + *Option 1: No need for the network to inform such information to the UE*   + *Option 2: Signalled regardless of whether the UE supports MO BD*     - *Option 2A: 256QAM MCS Table*     - *Option 2B: 64QAM MCS table*   *For UEs supporting modulation order blind detection:*   * + *Agreement:*     - *256QAM MCS Table* |

* Proposals:
  + For UEs not supporting modulation order blind detection:
    - Option 1: No need for the network to inform such information to the UE (Nokia, Samsung, Huawei, ZTE)
    - Option 2: Signalled regardless of whether the UE supports MO BD (China Telecom, Apple, Ericsson, MTK)
    - Option 2A: 256QAM MCS Table (China Telecom, Apple)
* Recommended WF
  + TBA

### Sub-topic 1-2 Test applicability

**Issue 1-2-1: For UE supporting MO BD, whether to introduce applicability rule to skip test(s) with modulation order indicated**

* *Status in the last meeting WF in R4-2406114*

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| * + *Option 1: Introduce applicability rule to skip tests with modulation order indicated for UEs capable of BD MO*   + *Option 2: Do not introduce applicable rule skip tests with modulation order indicated* |

* Proposals:
  + Option 1: Introduce applicability rule to skip tests with modulation order indicated for UEs capable of BD MO (China Telecom, Samsung, Huawei, ZTE, Nokia Qualcomm Apple Ericsson if the same test configuration with and without MO BD)
    - Nokia: There should be insignificant difference if SNR @ 70% TP (< 0.5dB) between the DCI index 1-5 test and the DCI index 6 test.
  + Option 2: Do not introduce applicable rule skip tests with modulation order indicated (MTK)
* Summary of performance difference between with and without MO BD (FDD 15kHz SCS with 10MHz):

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| Case Number | Performance difference between with and without MO BD | | | | | | |
| MTK | Apple | CTC | Nokia | Huawei | ZTE | E/// |
| Case1 and Case7 | 1.9 | 3.6\* | 0.2\* | 0.2 | 0.6 | 0.1 |  |
| Case2 and Case8 | 2.9 | 3.7\* | 0.2 | 1.5 | 1.4 | 0.2 |  |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | |

* Recommended WF
  + Discussion needed.

### Sub-topic 1-3 Test requirement value

**Issue 1-3-1: SNR requirement value definition rule**

* Proposals:
  + Proposal 1: RAN4 does not consider the farthest result(s) from the ideal AVERAGE value, until the span becomes **2.5 dB** or less. The final requirements are derived from AVERAGE impairment results with the corresponding ideal results whose span is within **2.5 dB** (China Telecom)
* Recommended WF
  + It is recommended to use the above proposal for requirement definition in this meeting.
  + The requirement value will be in [] and companies can still update results in the next meeting as a maintenance part.

# Topic #2: Receiver assumption and NWA signaling

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407006 | RAN1 | RAN1 thanks RAN4 for their LS (R1-2401954/R4-2403086) on RRC network assistant signalling for advanced receiver on MU-MIMO scenario.  Regardless of whether NW indicating “DMRS power boosting information of co-scheduled UEs” to target UE, UE may always assume the CDM groups without data are not used for data transmission for co-scheduled UEs.  There is no consensus to introduce RRC signalling indicating the “DMRS power boosting information of co-scheduled UEs” from RAN1’s perspective.  ACTION:  RAN1 respectfully asks RAN2 and RAN4 to take the above responses into account while designing the network assistant signalling for advanced receivers for MU-MIMO. |
| R4-2407112 | China Telecom | Proposal 1: Keep both 36-2a and 36-2b with removing the [] in the UE capability definition regardless of whether rank 2+2 test will be introduced for UE supporting modulation order blind detection. |
| R4-2407746 | Nokia | Observation 1: We see no need to specifically indicate if different power boosting is configured in the NW, and if RRC provided such a configuration, there will be no specification defining how the configuration were to be used by the UE. The phrase “the UE may assume” means from RAN1 perspective that ”the UE may always assume”, hence will most likely base its implementation on this assumption. Therefore, it is not expected the UE will have special capabilities to handle situations where the assumption does not apply.  Proposal 1: Do not introduce RRC signalling indicating the “DMRS power boosting information of co-scheduled UEs” |
| R4-2408743 | Ericsson | Proposal 1: Remove FG 36-2b and keep 36-2a only from the UE feature list if RAN4 agrees to not define 2+2 test under DCI 6  Proposal 2: Revise the texts in FG 36-2a as follows:  From: “… DCI index 6 or 7 in Table 7.3.1.2.2-12 of TS38.212 is signalled.”  To: “… The co-scheduled UE information index 6 or 7 in Table 7.3.1.2.2-12 of TS38.212 is signalled.” |

## Open issues summary

### Sub-topic 2-1 UE capability aspects

**Issue 2-1-1: Details for UE capability definition**

* *Agreed UE capability in RAN4#110:*

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| *The following feature has been captured in the R18 UE feature list LS to RAN2:*   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | ***Index*** | ***Feature group*** | ***Components*** | ***Prerequisite feature groups*** |  | ***Mandatory/Optional*** | | *36-1* | *MU-MIMO Interference Mitigation advanced receiver* | *R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression, for MU-MIMO up to maxNumberMIMO-LayersPDSCH layers across target and co-scheduled UEs with 2 RX and 4RX antennas, when co-scheduled UE(s)’ modulation order is signaled* | *3-4* | *…* | *Optional with capability signaling* | | *36-2a* | *MU-MIMO Interference Mitigation advanced receiver with modulation order detection* | *R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression for MU-MIMO* ***[for 2 layers across target and co-scheduled UEs with 2RX and 4RX]*** *when co-scheduled UE(s)’ modulation order is not signaled* | *36-1* | *…* | *Optional without capability signaling* | | *36-2b* | *MU-MIMO Interference Mitigation advanced receiver with modulation order detection* | *R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression for MU-MIMO* ***[for 2 layers across target and co-scheduled UEs with 2RX and maxNumberMIMO-LayersPDSCH layers across target and co-scheduled UEs with 4RX]*** *when co-scheduled UE(s)’ modulation order is not signaled* | *36-1* | *…* | *Optional without capability signaling* | |

* *Agreed UE capability updates in RAN4#110bis in WF R4-2406114:*

|  |
| --- |
| * + *For 36-1, update the note in capability granularity column as below:*   + *UE supports R-ML on MU-MIMO on single carrier operation. UE optionally supports R-ML on MU-MIMO on one or more carriers in CA,* ***NE-DC, EN-DC and NR-DC*** *operation*   + *Update the ‘Components’ column as below:*     - *For 36-1:*   + *R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression, for MU-MIMO up to maxNumberMIMO-LayersPDSCH layers across target and co-scheduled UEs with 2 RX and 4RX antennas, when co-scheduled UE(s)’ modulation order is* ***explicitly*** *signalled* ***by DCI index 1-5 in Table******7.3.1.2.2-12 of TS38.212****.*     - *For 36-2a:*   + *R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression for MU-MIMO [for 2 layers across target and co-scheduled UEs with 2RX and 4RX] when ~~co-scheduled UE(s)’ modulation order is not signalled~~* ***DCI index 6 or 7 in Table******7.3.1.2.2-12 of TS38.212 is signalled****.*     - *For 36-2b:*   + *R-ML (reduced complexity ML) receivers with enhanced inter-user interference suppression for MU-MIMO [for 2 layers across target and co-scheduled UEs with 2RX and maxNumberMIMO-LayersPDSCH layers across target and co-scheduled UEs with 4RX] when ~~co-scheduled UE(s)’ modulation order is not signalled~~* ***DCI index 6 in Table******7.3.1.2.2-12 of TS38.212 is signalled.*** |

* *Open issues in WF R4-2406114:*

|  |
| --- |
| *On 36-2a and 36-2b:*   * + *Proposal 1: Combine 36-2a and 36-2b and remove number of layer descriptions if RAN4 agrees to not define 2+2 test under DCI 6*   + *Proposal 2: Remove FG 36-2b and keep 36-2a from UE feature list* |

* Proposals on 36-2a and 36-2b:
  + Option 1: Combine 36-2a and 36-2b and remove number of layer descriptions if RAN4 agrees to not define 2+2 test under DCI 6 (Qualcomm, Samsung, MTK)
    - Option 1A: R-ML receivers with enhanced inter-user interference suppression for MU-MIMO when co-scheduled UE(s)’ modulation order is not signalled (Qualcomm)
    - Option 1B: R-ML receivers with enhanced inter-user interference suppression, for MU-MIMO up to maxNumberMIMO-LayersPDSCH layers across target and co-scheduled UEs with 2 RX and 4RX antennas, when DCI index 6 or 7 in Table 7.3.1.2.2-12 of TS38.212 is signalled (Samsung)
  + Option 2: Remove FG 36-2b and keep 36-2a from UE feature list (Ericsson, ZTE)
  + Option 3: Keep both 36-2a and 36-2b with removing the [] regardless of whether rank 2+2 test will be introduced for MO BD (China Telecom, Samsung)
* Proposals further update to 36-2a:
  + Proposal 1: (Ericsson)
    - From: “… **DCI** index 6 or 7 in Table 7.3.1.2.2-12 of TS38.212 is signalled.”
    - To: “… **The co-scheduled UE information** index 6 or 7 in Table 7.3.1.2.2-12 of TS38.212 is signalled.”
* Recommended WF
  + For 36-2a and 36-2b, discuss after test scope for modulation order blind detection is clear.

### Sub-topic 2-2 RRC signaling on DMRS Power Boosting configuration

**Issue 2-2-1: Assistant signalling on DMRS Power Boosting configuration**

* Proposals:
  + Proposal 1: Do not introduce RRC signalling to indicate different power boosting (Nokia)
* Recommended WF
  + RAN4 has provided our views in the LS R4-2403086 to RAN2. It is now RAN2’s decision based on their expertise as well as feedback from RAN4 and RAN1.
  + No discussion on this issue.

# Topic #4: Draft CR/CR

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2407245 | Apple | Clarification of release independence requirements for intra-cell inter-user interference cases (Cat F) |
| R4-2407246 | Apple | Clarification of release independence requirements for intra-cell inter-user interference cases (Cat A) |
| R4-2407117 | China Telecom | Correction on the required information analysis for advanced receiver for MU-MIMO |
| R4-2409007 | Huawei, HiSilicon | Draft CR for 38.101-4: Introduction of mandatory features without capability signalling for advanced receiver for MU-MIMO  Reason of change:  Some mandatory UE features with capability signalling for advanced receiver for MU-MIMO are missing.  All cases apply only in case the sum of MIMO layer for target UE and co-scheduled UE does not exceed target UE PDSCH MIMO layers capability.  4Tx is configured for Rank 2+2 tests, which means 4 CSI-RS port is configured, which may exceed the capability “maxConfigNumberPortsAcrossNZP-CSI-RS-PerCC” |
| R4-2409021 | Huawei, HiSilicon | CR for 38.101-4: Add applicability of requirements for PDSCH requirements with link Adapation. |
| R4-2409006 | Huawei, HiSilicon | Draft CR for 38.101-4: Introduction of definition for advanced receiver for MU-MIMO |
| R4-2408497 | Samsung | Draft CR on applicability rule of advanced receiver for MU-MIMO |
| R4-2408741 | Ericsson | draft CR to 38.101-4: Introduction of FDD 2Rx PDSCH requirements for advanced receiver for MU-MIMO |
| R4-2407247 | Apple | DraftCR to 38.101-4 on FDD 4Rx requirements for advanced receiver for MU-MIMO |
| R4-2409454 | MediaTek | Draft CR to 38.101-4: PDSCH requirements of MU-MIMO advanced receiver in 4Rx TDD |
| R4-2407749 | Nokia | DraftCR on RMC for Advanced Receivers |
| R4-2407115 | China Telecom | Big CR for UE advanced receiver performance requirements for MU-MIMO  For post meeting agreement. |

## Open issues

**Issue 3-1: Definition for advanced receiver for MU-MIMO**

* Proposal:
  + R4-2409006 and R4-2407247 proposes to use ‘Enhanced Receiver Type 2’ as a definition for MU-MIMO interference mitigation advanced receiver in TS38.101-4
* Recommended WF
  + Encourage feedback on the above proposal.

**Issue 3-2: CR on release independent requirements for Rel-17 MMSE-IRC cases**

* *Agreements in the last meeting WF in R4-2406114*

|  |
| --- |
| * + *R-ML new requirements are introduced in the existing clauses for MMSE-IRC under intra-cell inter-user scenario.*      - *R-ML receiver not intended to be release independent.*   + ***Update 38.307 Rel-17 and Rel-18 in Table B.3.3-1 state which tests are release independent from Rel-15.*** |

* Recommended WF
  + There is another CR R4-2407403 in thread [316] update further information for R17 IRC test requirements in Table 5.4-1 of TS38.307.
  + Encourage feedback on R4-2407245.

**Issue 3-3: Updates to the required information analysis in TR38.878**

* Proposed changes in R4-2407117:
  + R4-2407117 removes the required RAN4 default assumption and RRC signalling for ‘DMRS power boosting for the co-scheduled UE’, if RAN2#126 agrees not to introduce RRC assistant signalling on ‘DMRS power boosting for the co-scheduled UE’.
* Recommended WF
  + Encourage feedback on R4-2407117.
  + Check RAN2 conclusion on Friday.

**Issue 3-4: Impact on mandatory UE features with capability signalling**

* *UE feature list description for the impacted capabilities in TR38.822:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| *CSI-RS and CSI-IM reception for CSI feedback* | *…*  *2) Supported max # of ports across all configured NZP-CSI-RS resources per CC*  *…* | *csi-RS-IM-ReceptionForFeedback {*  *…*  *2. maxConfigNumberPortsAcrossNZP-CSI-RS-PerCC*  *…*  *}* | *…* | *Component-2 candidate values: {2, 4, 8, 12, 16, 24, 32, 40, 48 … ,256}* |
| *…* | *…* | *…* | *…* | *…* |
| *PDSCH MIMO layers* | *Supported maximal number of MIMO layers* | *maxNumberMIMO-LayersPDSCH* |  | *For single CC standalone NR, it is mandatory with capability signalling to support at least 4 MIMO layers in the bands where 4Rx is specified as mandatory for the given UE and at least 2 MIMO layers in FR2.*  *Some relaxations to this requirement may be applicable in the future (including in Rel-15).*  *Mandatory in all cases means mandatory with capability signalling.*  *It is not expected that there is a signalling change (i.e. signalling remains to be defined as {1, 2, 4, 8} in every band and every band combination, including FR1 and FR2 in all cases.* |

* Proposed changes in R4-2409007 and R4-2409021

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Supported maximum number of ports across all configured NZP-CSI-RS resources per CC (*maxConfigNumberPortsAcrossNZP-CSI-RS-PerCC*) | FR1 FDD | PDSCH | Clause 5.2.2.1.4 (Tests 1-1, 1-2)  Clause 5.2.3.1.1 (Tests 3-1, 4-1, 5-1)  Clause 5.2.3.1.4 (Tests 1-1, 1-2)  Clause 5.2.3.1.16(Tests 4-1,[4-2]) | The requirements apply only in case the number of NZP-CSI-RS ports in the test case satisfies UE capability on maximum number of NZP-CSI-RS ports |
|  | FR1 TDD | PDSCH | Clause 5.2.3.2.1 (Test 3-1, 4-1, 5-1)  Clause 5.2.3.2.17(Tests 4-1,[4-2]) |  |
| Supported maximum number of PDSCH MIMO layers (*maxNumberMIMO-LayersPDSCH*) | FR1 FDD | PDSCH | Clause 5.2.2.1.1 (Tests 2-1, 2-2, 3-1)  Clause 5.2.2.1.2  Clause 5.2.3.1.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1)  Clause 5.2.3.1.2  Clause 5.6.2.1.1  Clause 5.6.3.1.1  Clause 5.2.2.1.16(Tests 2-1, 2-2)  Clause 5.2.3.1.16(Tests 3-1,3-2,4-1,[4-2]) | The requirements apply only in case the PDSCH MIMO rank in the test case does not exceed UE PDSCH MIMO layers capability |
|  | FR1 TDD | PDSCH | Clause 5.2.2.2.1 (Tests 2-1, 2-2, 3-1)  Clause 5.2.2.2.2  Clause 5.2.3.2.1 (Tests 2-1, 2-2, 3-1, 4-1, 5-1)  Clause 5.2.3.2.2  Clause 5.6.2.2.1  Clause 5.6.3.2.1  Clause 5.2.2.2.17(Tests 2-1, 2-2)  Clause 5.2.3.2.17(3-1,3-2,4-1,[4-2]) | The requirements specified in Clause 5.2.2.1.16, 5.2.3.1.16, 5.2.2.2.17 and 5.2.3.2.17 apply only in case the sum of MIMO layer for target UE and co-scheduled UE does not exceed target UE PDSCH MIMO layers capability. |

* Recommended WF
  + There is another CR R4-2409019 in thread [316] with similar applicability rule updates for R17 CRS-IM and MMSE-IRC requirements.
  + The idea of the proposed changes seems to be applicable for all test requirements in TS38.101-4 that configure >2 NZP CSI-RS ports and/or >1 MIMO layers across different releases and different WIs.
  + If this CR is agreed, may require attention of all threads that impact 38.101-4.

**Draft CR/CR review**

* Companies to provide comments and response under e-mail thread [111][324] NR\_demod\_enh3\_Part1 –CR review.