**3GPP TSG-RAN WG4 Meeting #1101 R4-240xxxx**

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

**Source: China Telecom**

**Title: Ad-hoc minutes for Performance evolution WI**

**Agenda Item: 7.11.4**

**Document for: Approval**

1. **Discussion**

**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 1-2-1: 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.

**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.

**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:*

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| * + *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:*

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| *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.

**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 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