**3GPP TSG-RAN WG4 Meeting #110bis R4-240xxxx**

**Changsha, China, 15th – 19th April, 2024**

**Source: China Telecom**

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

**Agenda Item: 6.11.4**

**Document for: Approval**

1. **Discussion**

**Issue 1-1-1: Test setting for when UE is indicated Modulation order (DCI index 1-5 is indicated)**

* Proposals for Rank 1+1 with 2T2R:
  + Option 1 (Case1): **Random precoding**, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE (China Telecom, Nokia, Ericsson)
    - CTC: For 2Tx tests with rank 1, there are totally only 4 candidate precoders to use, which is a strict restriction to require NW in reality to only schedule orthogonal precoding.
  + Option 2 (Case2): **Orthogonal precoding**, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE (Qualcomm, MTK, Apple, Samsung, Huawei)
  + Summary of performance gain for candidate cases:

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| Case Number | Duplex Mode and SCS | CHBW | Rank | MIMO | Precoder selection | 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/// |
| 1 | FDD 15kHz SCS | 10MHz | 1+1 | 2T2R | Random | TDLC300-100 | ULA medium | MCS 13 | QPSK | 9.7 | 11.5 | 5.9\* | 9.4 | 8.4 |  | 7.3 |
| 2 | Orthogonal | 7.1 | 7 |  | 7 | 6.4 |  | 5.1 |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | | | | | | | | | | |

* Proposals for Rank 2+2 with 4T4R:
  + Option 1 (Case6): Orthogonal precoding, TDLA30-10, XP medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE (MTK, Huawei)
  + Option 2 (Case7): Orthogonal precoding, TDLA30-10, ULA Low, MCS 17 (Table 1) for Target UE, 16QAM for co-UE. full FDRA for the co-UE (China Telecom, Qualcomm, Apple, Nokia, Samsung)
  + Option 3 (Case8): Orthogonal precoding, TDLA30-10, XP medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE. full FDRA for the co-UE (Samsung, Ericsson, Nokia)
  + Option 4 (Case9): Orthogonal precoding, TDLA30-10, XP medium, MCS 17 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE (MTK, Ericsson)
  + Summary of performance gain for candidate cases:

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| Case Number | Duplex Mode and SCS | CHBW | Rank | MIMO | Precoder selection | Channel Model | Antenna correlation | MCS for the target UE | Modulation order for the co-scheduled UE | MTK | Apple | CTC | Nokia | Huawei | ZTE | E/// |
| 5 | FDD 15kHz SCS | 10MHz | 2+2 | 4T4R | Orthogonal | TDLA30-10 | ULA Low | MCS13 | QPSK | 1.9 | 2.7 | 2.2 | 2.6 | 2.6 |  | 2.1 |
| 6 | XP medium | 2.4 | 3.1 | 3.3 | 3.5 | 3.4 |  | 2.9 |
| 7 | ULA Low | MCS 17 | 16QAM | 0.3 | 1.5 | 1 | 1.2 | 1.3 |  | 0.8 |
| 8 | XP medium | 0.7 | 1.8 | 0.3 | 1.6 | 1.6 |  | 1.3 |
| 9 | XP medium | QPSK | 2.1 | 4.4 | -0.2\* | 5 | 3.5 |  |  |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | | | | | | | | | | |

* Proposals for Rank 1+1 with 2T4R (if rank 2+2 with 4T4R is not covered)
  + Option 1: Random precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE (Nokia, Ericsson)
  + Option 2: Orthogonal precoding, TDLC300-100, ULA medium, MCS 13 (Table 1) for Target UE, QPSK for co-UE. full FDRA for the co-UE (MTK, Samsung)

**Issue 1-1-2: Test setting for when UE is not indicated Modulation order (DCI index 6 is indicated)**

* Proposals for Rank 1+1 with 2T2R:
  + Option 1 (Case27): Random precoding, TDLC300-100, ULA low, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE (China Telecom)
  + Option 2 (New case?): Orthogonal precoding, TDLC300-100, ULA low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE (Apple)
  + Option 3 (Case26): Orthogonal precoding, TDLC300-100, ULA medium, MCS 17 (Table 1) for Target UE, 16QAM for co-UE, full FDRA for the co-UE (Samsung, Huawei)
  + Option 4: Same configuration as tests without modulation order blind detection (Qualcomm, MTK, Nokia)
  + Summary of performance gain for candidate cases:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Case Number | Duplex Mode and SCS | CHBW | Rank for target + Co-UE | MIMO | Precoder selection | Channel Model | Antenna correlation | MCS for the target UE | Modulation order for the co-scheduled UE | MTK | Apple | CTC | Nokia | Huawei | ZTE | E/// |
| 19  (Same as Case 1) | FDD 15kHz SCS | 10MHz | 1+1 | 2T2R | Random | TDLC300-100 | ULA medium | MCS 13 | QPSK | 7.3 | 5.9\* | 5.8\* | 9.2 | 7.6 | 9.7\* | 7.1 |
| 20  (Same as Case 2) | Orthogonal | 5.2 | 2.6\* |  | 6.8 | 5.8 | 7.4 | 5 |
| 21 | Random | ULA Low | 3.6 | 0.9\* | 3.6 | 4.9 | 3.8 | 7.3\* | 3.3 |
| 25 | Random | ULA medium | MCS 17 | 16QAM | Inf | Inf | Inf | Inf | Inf | Inf | Inf |
| 26 | Orthogonal | 7.2 | Inf |  | 4.8 | 5.2 | 5.5 | Inf |
| 27 | Random | ULA Low | 2.2 | Inf | Inf | 4.1 | 6.6 | 3.2 | Inf |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | | | | | | | | | | |

* Proposals for Rank 2+2 with 4T4R:
  + Option 1: Introduce rank 2+2 4T4R requirements with modulation order blind detection (China Telecom, Qualcomm, MTK, Nokia, Samsung)
    - 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 (China Telecom, Nokia, Samsung)
    - Option 1B: Same configuration as tests without modulation order blind detection (Qualcomm, MTK)
  + Option 2: Do not introduce rank 2+2 4T4R requirements with modulation order blind detection (Apple, [Huawei])
  + Summary of performance gain for candidate cases:

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| Case Number | Duplex Mode and SCS | CHBW | Rank for target + Co-UE | MIMO | Precoder selection | Channel Model | Antenna correlation | MCS for the target UE | Modulation order for the co-scheduled UE | MTK | Apple | CTC | Nokia | Huawei | ZTE | E/// |
| 31  (Same as Case 5) | FDD 15kHz SCS | 10MHz | 2+2 | 4T4R | Orthogonal | TDLA30-10 | ULA Low | MCS 13 | QPSK | 1 | 0.6 | 2 |  | 1.5 |  | 1.1 |
| 32  (Same as Case 6) | XP medium | 1.2 | 0.6 | 2.5 |  | 3.2\* |  | 1.4 |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | | | | | | | | | | |

* Proposals for Rank 1+1 with 2T4R:
  + Option 1: Follow the same test scope for requirements without modulation order blind detection (China Telecom, MTK, Nokia)
  + Option 2 (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 (Samsung, Huawei)
  + Option 3 (New case?): Orthogonal precoding, TDLC300-100, ULA low, MCS 13 (Table 1) for Target UE, QPSK for co-UE, full FDRA for the co-UE (Apple)
  + Summary of performance gain for candidate cases:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| Case Number | Duplex Mode and SCS | CHBW | Rank for target + Co-UE | MIMO | Precoder selection | Channel Model | Antenna correlation | MCS for the target UE | Modulation order for the co-scheduled UE | MTK | Apple | CTC | Nokia | Huawei | ZTE | E/// |
| 22 | FDD 15kHz SCS | 10MHz | 1+1 | 2T4R | Random | TDLC300-100 | ULA medium | MCS 13 | QPSK | 11.9 | 5\* | 6.5\* | 10.5 | 10.4 |  | 8.1 |
| 23 | Orthogonal | 7.8 | 2.2\* |  | 7.9 | 7 | 8.9 | 6.2 |
| 24 | Random | TDLA30-10 | ULA Low | 1\* | 0 | 2.2 | 1.4 | 1.4 | 0.8 | 0.9 |
| 28 | 2T4R | Random | TDLC300-100 | ULA medium | MCS17 | 16QAM | 14.5 | Inf | Inf | 9\* | Inf | Inf | Inf |
| 29 | Orthogonal | 10.7 | Inf |  | 6.1 | 7 | 8\* | 5.2 |
| 30 | Random | TDLA30-10 | ULA Low | 0.5 | 0 | -0.3 | 2.5 | 0 | 0.1 | 0.2\* |
| Note: Results in (\*) are R-ML results outliers calculated based on 2.5dB SPAN metric. | | | | | | | | | | | | | | | | |

**Issue 1-1-3: Whether to tests UE not support BD-MO with R-ML with DCI index 6 is indicated**

* Proposals:
  + Option 1: Introduce test cases only applicable to the UE which can perform E-IRC receiver in that case (Qualcomm)
    - QC: Same test configuration as UE supporting modulation order blind detection.
  + Option 2: Do not introduce such test for UE not support BD-MO with R-ML (China Telecom, MTK, Apple, Nokia, Samsung, ZTE)
* Recommended WF
  + Option 2?

**Issue 1-2-1: For UE supporting MO BD, whether to introduce applicability rule to skip test(s) 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, Qualcomm, Huawei, ZTE, Nokia in case there is there is insignificant difference between with and without MO BD)
  + Option 2: Do not introduce applicable rule skip tests with modulation order indicated (MTK, Samsung)

**Issue 1-1-4: RRC assistant information configuration on the 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, Ericsson)
    - Option 2: Signalled regardless of whether the UE supports MO BD (China Telecom, Qualcomm, MTK, Apple)
    - Option 2A: 256QAM MCS Table (China Telecom, Qualcomm, MTK)
    - Option 2B: 64QAM MCS table (Apple)
  + For UEs supporting modulation order blind detection:
    - Option 1: 256QAM MCS Table (China Telecom, MTK, Nokia, Huawei, Ericsson)
    - Option 2: Align with the MCS Table configuration in the test, i.e., 64QAM MCS table (Apple, Samsung, ZTE)

**Issue 3-2: Whether new R-ML requirements should be captured in new clauses or in the existing clauses for MMSE-IRC under intra-cell inter-user scenario**

* Proposals:
  + In draft CR R4-2405475/5216/4239, new clauses are created in TS38.101-4 for advanced receivers for MU-MIMO.
  + In draft CR R4-2404295, R-ML new requirements are introduced in the existing clauses for MMSE-IRC under intra-cell inter-user scenario.
    - CTC: We will need to update 38.307 and may also need to update the existing test applicability rule.
    - QC: It might be cleaner if we have the test in the same clause but with letter suffix like A/B/C/D etc since it’s a different release from original clause.
* Release independent rule for R17 MMSE-IRC requirements in 38.307:

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| * Table 5.4-1: Additional requirements of other release independent features  |  |  |  |  | | --- | --- | --- | --- | | Feature | Release  independent from | Requirements to be fulfilled  (see 38.307 of the REL when the feature was introduced) | Further information | | … | … | … | … | | UE demodulation and CSI requirements for MMSE-IRC receiver for scenarios with inter cell and intra cell inter user interference | Rel-15 | Table B.3.3-1 | Rel-17 WI NR\_demod\_enh2-Perf: see Table B.3.3-1. These requirements are optional for Rel-15 and Rel-16 UEs and can be executed based on UE declaration. |   Table B.3.3-1: UE PDSCH demodulation and CSI requirements with MMSE-IRC receiver for scenarios with inter cell interference and intra cell inter user interference   |  |  | | --- | --- | | Section / Clause | Description | | 5.2.2.1.15 | PDSCH demodulation requirements with inter cell interference for 2RX FDD | | 5.2.3.1.15 | PDSCH demodulation requirements with inter cell interference for 4RX FDD | | 5.2.2.2.16 | PDSCH demodulation requirements with inter cell interference for 2RX TDD | | 5.2.3.2.16 | PDSCH demodulation requirements with inter cell interference for 4RX TDD | | 5.2.2.1.16 | PDSCH demodulation requirements with intra cell inter user interference for 2RX FDD | | 5.2.3.1.16 | PDSCH demodulation requirements with intra cell inter user interference for 4RX FDD | | 5.2.2.2.17 | PDSCH demodulation requirements with intra cell inter user interference for 2RX TDD | | 5.2.3.2.17 | PDSCH demodulation requirements with intra cell inter user interference for 4RX TDD | |

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

* *Status in the last meeting WF in R4-2321114*

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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* | |

* Proposals 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 (Qualcomm)
  + Proposal 2: Remove FG 36-2b and keep 36-2a from UE feature list (Apple)
* Proposals on 36-1:
  + Proposal 1: Update the feature 36-1 as following (Huawei)

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| 36. NR\_demod\_enh3 | 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 | UE not capable of advanced receiver to suppress inter-user inference in MU-MIMO;  UE not capable of decoding PDCCH with DCI bits of the co-scheduled UE information field in DCI format 1\_1. | Per UE  Note: 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 | No | FR1 only | N/A |  | Optional with capability signaling |