**3GPP TSG-RAN WG4 Meeting # 109 R4-2318211**

**Chicago, USA, November 13 – November 17, 2023**

**Agenda item:** 8.11.5

**Source:** Moderator (Ericsson)

**Title:** Topic summary for [109][319] NonCol\_intraB\_ENDC\_NR\_CA\_Demod

**Document for:** Information

# Introduction

This topic summary lists open issues on UE demodulation performance part for Rel-18 WI support of intra-band non-colocated EN-DC/NR-CA deployment.

# Topic #1: Type 2 UE NR-CA PDSCH demodulation requirements

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318350 | Nokia, Nokia Shanghai Bell | **Proposal 1:** RAN 4 to use the MCS pair: MCS4 (table 1, carrier with lower power) and MCS24 (table 2, carrier with higher power).  **Observation 1:** The TxEVM performance of practical TEs is below 1.5% in FR1, and independent of modulation order. Using overly conservative TxEVM values in impaired simulations to derive performance requirements, means the DUT will be subjected to a much better effective SNR in the test than in the simulations (at the baseband receiver and for upper SNR limits).  **Observation 2:** For 3% TxEVM at 25dB SNR operating point, the DUT requirement relaxation is about 1.1dB. Below 20dB there is virtually no relaxation.  **Proposal 2:** RAN4 shall not consider TE TxEVM for the derivation of final requirement SNR values. A value of 2% TE TxEVM shall be considered in FR1 and independently of the modulation order, to limit the MCS choice to stay below 1dB degradation (when assuming testing using a TE with such an innate TxEVM value).  **Proposal 3:** RAN4 shall add the following note to the final agreements concerning TxEVM:  Note: Since Rel-15 is has been common practice to assume TE TxEVM in impaired simulations, with values commonly chosen as 6% at QPSK, 6% at 16QAM, 6% at 64QAM, 3% at 256QAM, and 2.5% at 1024QAM.  The intent was to allow requirements to be testable with any TE that meets or exceeds the TxEVM assumption, as TxEVM results in a SNR dependent degradation and limitation of the effective baseband SNR at the receiver.  Additionally, the TE TxEVM assumptions are used to limit the SNR, and therefore MCS, usable during tests by self-imposing a 1dB SNR degradation/relaxation limit when adding TxEVM.  RAN5 does not require a specific TxEVM in the test configuration and the TE does not add additional TxEVM on top of its innate TxEVM performance. RAN5 does set a Maximum Test System Uncertainty, which is chosen such that the noise from the Test system is sufficiently below that required for the UE to demodulate the signal with the required success rate.  Adding TE TxEVM in RAN4 requirement derivation leads to a SNR relaxation for the DUT at the higher end of the SNR range, when using a TE with better than the assumed TxEVM performance.  In the meantime, experience with TE's on the market has shown that the Rel-15 TE TxEVM assumptions were too conservative. The TEs' actual TxEVM limits are much lower than the commonly chosen values, and it is not needed to add TE TxEVM in the requirement derivation.  Additionally, unlike for transmissions from UEs/BSs, the TE TxEVM is independent from the used modulation order (assuming same power), as no crest factor reduction is employed. |
| R4-2318351 | Nokia, Nokia Shanghai Bell | Simulation results  Moderator: Results to be captured in the summary R4-2319740. |
| R4-2318556 | MediaTek inc. | **Proposal 1:** We propose 2 following test case configurations as possible test candidates   * PCell: Rank 2, MCS Table 2, MCS 22 / SCell: Rank 1, MCS Table 1, MCS 4 * PCell: Rank 2, MCS Table 2, MCS 23 / SCell: Rank 1, MCS Table 1, MCS 5 |
| R4-2318557 | MediaTek inc. | Simulation results  Moderator: Results to be captured in the summary R4-2319740. |
| R4-2318679 | Apple | **Observation 1:** The scenario in question is Intra-band non-collocated non-contiguous NR CA, which special emphasis in the non-contiguous aspect, as very early decided by the RAN4 RF session.  **Observation 2:** In RAN4-108 the RF session has been agreed to introduce a minimum frequency separation of 80MHz+BWanother/2 between 2 CCs as a side condition for the test cases using the requirements specified in this WI. An LS to RAN5 has been submitted, with tdoc number R4-2314750.  **Observation 3:** In RAN4-108bis the Demod session has been agreed to support this minimum frequency separation of 80MHz+BWanother/2 between 2 CCs as a side condition. A new LS to RAN5 has been submitted, this time with tdoc number R4-2314750.  **Proposal 1:** RAN4 follow up on discussing how to capture this side condition for Intra-band Non-contiguous Non-collocated NR-CA scenarios such that the requirement will only be applicable to bands that are separated by 80MHz+BWanother/2.  **Observation 4:** During RAN4-108bis it was agreed that the weaker carrier should use Rank1, and the stronger carrier should use Rank2, given the existing power imbalance requirement of <=25dB.  **Observation 5:** Since the SNR distance between the lowest MCS and the higher MCS in the 64QAM is not enough to cover the 25dB power imbalance range, the weaker carrier will consider the 64QAM table while the stronger carrier uses the 256QAM table.  **Proposal 2:** During RAN4#109, align results submitted by interested companies and decide the best MCS pair to guarantee a SNR difference of no more than 25dB, considering the confidence interval given by the computed spans. |
| R4-2319531 | ZTE Corporation | **Proposal 1:** To consider the following MCS combination as alternatives for demodulation requirement.   * MCS4(table1) and MCS22(table2) * MCS5(table1) and MCS22(table2) * MCS5(table1) and MCS23(table2) |
| R4-2319532 | ZTE Corporation | Simulation results  Moderator: Results to be captured in the summary R4-2319740. |
| R4-2319739 | Ericsson | **Observation:** The following MCS pair does not exceed 25dB.   * MCS table 1, MCS4 * MCS table 2, MCS22   **Proposal:** Consider our simulation results to decide the requirements for Type 2 UE PDSCH demodulation requirements. |
| R4-2320192 | Huawei, HiSilicon | **Proposal 1:** Choose one MCS pair from following candidate options:   * Option1: MCS4 (Weaker CC), MCS22 (Stronger CC) * Option2: MCS5 (Weaker CC), MCS22 (Stronger CC)   **Proposal 2:** Following applicability rules and test setup should be considered:   * The requirements are only applicable for UE supporting TDD-TDD intra-band Non-Collocated NR-CA [intraBandNonColocatedCA-r18]. * The requirements apply only in case modulation order configured for each CC doesn’t exceed UE per CC capability on supported maximum modulation order * During the demod test, the new RRC signaling to be introduced by RAN2 should be configured to guarantee the tested UE is operating on type2 architecture. |
| R4-2320193 | Huawei, HiSilicon | Simulation results  Moderator: Results to be captured in the summary R4-2319740. |
| R4-2320795 | Qualcomm Inc. | **Proposal 1:** According to the simulation results in [2], RAN4 should select MCS4 for the Lower Power Rank 1 carrier.  **Proposal 2:** For the Higher Power Rank 2 Carrier, RAN4 should choose the highest MCS among the choices (MCS 22-25, MCS Table 2) such that the final SNR requirement (based on averaged impairment results collected and including margins) does not exceed 25dB difference with respect to the Lower Power carrier.  **Proposal 3:** According to the simulation results provided, if MCS 4 is selected, the choices for Higher Power carrier should not consider MCS higher than 22 (MCS Table 2). We propose to consider MCS [19, 20, 21, 22]. |
| R4-2320796 | Qualcomm Inc. | Simulation results  Moderator: Results to be captured in the summary R4-2319740. |
| R4-2319740 | Ericsson | Simulation results summary |

## Open issues summary

RAN4#109 agreed to decide the MCS and requirements according to the impairment results [R4-2317948].

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|  | **Rank** | **MCS table** | **MCS index** |
| Carrier with lower power | Rank 1 | MCS table 1 | Option 1: MCS4 (QPSK, 0.30)  Option 2: MCS5 (QPSK, 0.37) |
| Carrier with higher power | Rank 2 | MCS table 2 | Option 1: MCS22 (256QAM, 0.74)  Option 2: MCS23 (256QAM, 0.78)  Option 3: MCS24 (256QAM, 0.82)  Option 4: MCS25 (256QAM, 0.86) |

### Sub-topic 1-1 Final demodulation requirements

**Issue 1-1-1: Tx EVM assumption**

* Proposals (Nokia):
  + RAN4 shall not consider TE TxEVM for the derivation of final requirement SNR values. A value of 2% TE TxEVM shall be considered in FR1 and independently of the modulation order, to limit the MCS choice to stay below 1dB degradation (when assuming testing using a TE with such an innate TxEVM value).
  + Add the following note to the final agreements concerning TxEVM:

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| Since Rel-15 is has been common practice to assume TE TxEVM in impaired simulations, with values commonly chosen as 6% at QPSK, 6% at 16QAM, 6% at 64QAM, 3% at 256QAM, and 2.5% at 1024QAM. The intent was to allow requirements to be testable with any TE that meets or exceeds the TxEVM assumption, as TxEVM results in a SNR dependent degradation and limitation of the effective baseband SNR at the receiver. Additionally, the TE TxEVM assumptions are used to limit the SNR, and therefore MCS, usable during tests by self-imposing a 1dB SNR degradation/relaxation limit when adding TxEVM.  RAN5 does not require a specific TxEVM in the test configuration and the TE does not add additional TxEVM on top of its innate TxEVM performance. RAN5 does set a Maximum Test System Uncertainty, which is chosen such that the noise from the Test system is sufficiently below that required for the UE to demodulate the signal with the required success rate. Adding TE TxEVM in RAN4 requirement derivation leads to a SNR relaxation for the DUT at the higher end of the SNR range, when using a TE with better than the assumed TxEVM performance.  In the meantime, experience with TE's on the market has shown that the Rel-15 TE TxEVM assumptions were too conservative. The TEs' actual TxEVM limits are much lower than the commonly chosen values, and it is not needed to add TE TxEVM in the requirement derivation. Additionally, unlike for transmissions from UEs/BSs, the TE TxEVM is independent from the used modulation order (assuming same power), as no crest factor reduction is employed. |

* Recommended WF
  + Discuss the proposal.
  + Moderator: For information, RAN4 has been setting the NR UE demodulation requirements with the following methodology from Rel-15.
    - Confirm the span of companies’ alignment results are small enough (e.g., 2.5dB). Alignment results are derived from the simulation without UE Rx impairments, however RAN4 had agreed to add gNB Tx EVM (e.g., 6% up to 64QAM, 3% of 256QAM, and 2.5% for 1024QAM) to derive alignment results.
    - If the span is small enough, set the final requirement by adding the common margin (e.g., 0.5dB for QPSK/16QAM, 0.8dB for 64QAM/256QAM, 1dB for 1024QAM) to the average of impairment results. Impairment results are provided by companies adding UE Rx impairment margin, where added margin is up to companies.

**Issue 1-1-2: MCS pair**

* Proposals:
  + (Apple): Align results submitted by interested companies and decide the best MCS pair to guarantee a SNR difference of no more than 25dB, considering the confidence interval given by the computed spans.
  + Companies’ proposals on MCS pair (Nokia, MediaTek, ZTE, Ericsson, Huawei):

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| **MCS for SCell (Lower SNR)** | **MCS for PCell (Higher SNR)** | **Supporting companies** |
| Table 1, MCS4 | Table 2, MCS22 | MediaTek, ZTE, Ericsson, Huawei, Qualcomm |
| Table 1, MCS4 | Table 2, MCS23 |  |
| Table 1, MCS4 | Table 2, MCS24 | Nokia |
| Table 1, MCS4 | Table 2, MCS25 |  |
| Table 1, MCS5 | Table 2, MCS22 | ZTE, Huawei |
| Table 1, MCS5 | Table 2, MCS23 | MediaTek, ZTE |
| Table 1, MCS5 | Table 2, MCS24 |  |
| Table 1, MCS5 | Table 2, MCS25 |  |

* Recommended WF
  + Collect impairment results first in R4-2319740.
  + Decide MCS pair based on the average of impairment results so that the SNR difference of PScell and SCell does not exceed 25dB.

**Issue 1-1-3: Applicability**

* Proposals: The following applicability rule should be considered.
  + Proposal 1 (Huawei): The requirements are only applicable for UE supporting TDD-TDD intra-band Non-Collocated NR-CA [*intraBandNonColocatedCA-r18*].
  + Proposal 2 (Huawei): The requirements apply only in case modulation order configured for each CC doesn’t exceed UE per CC capability on supported maximum modulation order.
    - The requirements apply on in case the UE indicates support of 256QAM modulation scheme for PDSCH for FR1 (*pdsch-256QAM-FR1*)
  + Proposal 3 (Apple): Discuss how to capture this side condition such that the requirement will only be applicable to bands that are separated by 80MHz+BWanother/2.
* Recommended WF
  + Discuss these proposals.
  + Moderator: For proposal 3, RAN4 has already sent LS to RAN5 (R4-2316951) in RAN4#109bis to inform RF conformance test should consider the frequency separation 80MHz+BWanother/2.

**Issue 1-1-4: Configuration parameters**

* Proposal (Huawei): The following test setup should be considered.
  + During the demod test, the new RRC signaling to be introduced by RAN2 should be configured to guarantee the tested UE is operating on type2 architecture.
* Recommended WF
  + Discuss whether this proposal is agreed.
  + Note RAN2 will implement new RRC signaling in RAN2#124 (November 2023) meeting.

**Issue 1-1-5: CA combinations**

Moderator: Draft CR R4-2319525 specifies the CA combinations TDD 30 kHz + TDD 30 kHz, TDD 15 kHz + TDD 30 kHz, and TDD 15 kHz + TDD 30 kHz. RAN4 has agreed to specify with CBW=40MHz only, but not discussed the SCS.

* Proposals:
  + Option 1: Specify TDD 30 kHz + TDD 30 kHz, TDD 15 kHz + TDD 30 kHz, and TDD 15 kHz + TDD 30 kHz.
  + Option 2: Specify TDD 30kHz + TDD 30kHz only.
  + Option 3: Others
* Recommended WF
  + This WI limits to 2 CC intra-band CA with n77/n78. Considering the carrier frequency around 4.0GHz and intra-band CA, the moderator thinks Option 2 is the reasonable option.

# Topic #2: draft CRs for UE demodulation requirements

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2320194 | Huawei, HiSilicon | Draft CR on Applicability rurle |
| R4-2319525 | ZTE Corporation | Draft CR on PDSCH demodulation requirements |
| R4-2320797 | Qualcomm Inc. | Draft CR on FRC  Moderator: Contents are empty. |
| R4-2318352 | Nokia, Nokia Shanghai Bell | Big CR for UE demodulation requirements for Non-colocated NR-CA deployment scenario |

## Open issues summary

### Sub-topic 2-1 Review draft CRs

**Issue 2-1-1: Draft CRs**

* Recommended WF
  + Revise the draft CRs during the meeting.
  + Set the final requirements according to the simulation results summary R4-2319740.
  + Big CR R4-2318352 to be email approval.