**3GPP TSG-RAN WG4 Meeting # 107 R4-230XXXX**

**Incheon, Korea (Republic of), May 22nd – May 26th, 2023**

**Agenda item: 8.12.5**

**Source:** Moderator (Ericsson)

**Title:** Topic summary for [107][323] NonCol\_intraB\_ENDC\_NR\_CA\_Demod

**Document for:** Information

# Introduction

This topic summary list the open issues on the UE demodulation performance part in Rel-18 WI support of intra-band non-collocated EN-DC/NR-CA deployment.

# Topic #1: Test scope

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2307033 | Nokia, Nokia Shanghai Bell | **Observation 1:** Type 3 and 4 UEs are postponed in RF. Type 2 UEs, which use 2 Rx per band/LNA and have 2 mixers/LOs, are focus of Rel-18.  **Observation 2:** BLER for each CC increases quickly once residual FOE exceeds DM-RS density related BB FOC range, and once residual TOE exceeds CP. BLER is different for demodulator implementations and FO/TO difference scenarios between CCs.  **Observation 3:** Mostly type 2 (and type 4) UEs are expected to be served in non-collocated environments.  **Proposal 1:** We propose for RAN4 to define UE demod requirements based on type-2 UEs.  **Observation 4:** Type-2 (and type-4) UEs are able to compensate for RTDs and power imbalance, with maximum values agreed at RAN4#106-bis-e.  **Proposal 2:** RAN4 shall define PDSCH UE demodulation requirements for type-2 based upon maximum received time difference value (33us) and maximum power imbalance assumption (25dB). |
| R4-2307854 | MediaTek inc. | **Observation 1:** There exist RF tests for Type2 UE of EN-DC where data throughput is measured 1dB above reference sensitivity level with another carrier having 25dB higher power.  **Observation 2:** There does not exist RF tests for Type2 UE of NR-CA.  **Proposal 1:** Do not define demodulation requirements to Type 3a/3b and Type 4a/4b UEs.  **Proposal 1:** We support not to define new UE demodulation requirements for Type 2 UE for intra-band non-contiguous EN-DC deployment scenario. There already exist RF tests for Type2 UE of EN-DC with data throughput test metric.  **Proposal 2:** We support to define new UE demodulation requirements for Type 2 UE for intra-band non-contiguous NR-CA deployment scenario. |
| R4-2308404 | ZTE Corporation | **Proposal 1:** The demodulation requirements of Type 2 UE need to be reflected in the specification. |
| R4-2308430 | Ericsson | **Observation 1:** RAN4 core part does not introduce UE capabilities for Type 3a/3b and Type 4a/4b for 4-layer MIMO case in Rel-18.  **Proposal 1:** RAN4 only discuss Type 2 UE for the PDSCH demodulation requirements in Rel-18 intra-band non-contiguous EN-DC/NR-CA deployment WI.  **Observation 2:** For Type 2 UE, the maximum received power difference of 25dB in intra-band non-contiguous EN-DC is verified with the existing UE RF in-band blocking test specified in TS38.101-3 7.6B.2.6.  **Observation 3:** For Type 2 UE, the maximum received timing difference of 33us in intra-band non-contiguous EN-DC is verified with the existing RRM interruption test specified in TS38.133 (e.g., A.4.5.2.1).  **Proposal 2:** RAN4 do not define the dedicated Type 2 UE demodulation requirements for intra-band non-contiguous EN-DC scenario in Rel-18.  **Observation 4:** For Type 2 UE, the maximum received power difference of 25dB in intra-band non-contiguous NR-CA can be verified with UE RF in-band blocking test to be specified in Rel-18 TS38.101-1.  **Observation 5:** For Type 2 UE, the maximum received timing difference of 33us in intra-band non-contiguous NR-CA can be verified with UE RRM interruption test specified in TS38.133 (e.g., A.6.5.3.4).  **Proposal 3:** RAN4 do not define the dedicated Type 2 UE demodulation requirements for intra-band non-contiguous NR-CA scenario in Rel-18.  **Proposal 4:** Add the following sentence in TS38.101-4 clause 9.1.1 to clarify the intra-band non-contiguous EN-DC power imbalanced test is not applicable for Type 2 UE.   * For FR1 intra-band non-contiguous EN-DC, this requirement does not apply for the EN-DC configurations if UE indicates interBandMRDC-WithOverlapDL-Bands-r16. |
| R4-2308862 | Huawei, HiSilicon | **Proposal 1:** Preclude type 3a/3b and type 4a/4b UE in performance requirements definition and only focus on type 2 UE.  **Observation 1:** Type 2 UE has no updates to the baseband processing compared to baseline architecture.  **Proposal 2:** Don’t define requirements for type 2 UE |
| R4-2309297 | Qualcomm Incorporated | **Observation 1:** A demod test would be needed to check that the UE correctly handles both CCs at the same time.  **Observation 2:** A static channel (AWGN) should be used for this test.  **Observation 3:** Artificial noise should be added in this test, the SNR of the weaker CC should be set below or around 0dB while the stronger CC should be set 25dB higher. Actual signal levels should be further discussed.  **Observation 4:** RTD between the CCs in the test should be set to 33us. |
| R4-2309372 | Apple | **Proposal 1:** RAN4 should discuss the need for demodulation requirements only for Type-2 UEs  **Observation 1:** Existing test cases in 38.101-4 with 6dB power imbalance between SCell and PCell are only meant for Type-1 UEs.  **Observation 2:** Type-2 UE performance should be measured as any EN-DC NR-CA tests case, with the only difference of the extra requirements of MRDT and Power Imbalance.  **Propose 2:** For Type-2 UE, set the received time difference between two carriers to MRTD = 33 us for PDSCH demodulation requirements.  **Proposal 3:** For Type-2 UE, choose a set of MCSs such that the difference of required SNR to achieve XX% of the maximum throughput is equal or less than 25dB.  **Proposal 4:** For Type-2 UE, consider 70% of the maximum throughput as the figure of merit  **Observation 3:** Previous EN-DC NR-CA tests will always measure the per-carrier throughput, measuring only one carrier at a time.  **Proposal 5:** Extend the same assumptions for the EN-DC case. Here, current practice is only to measure throughput from the NR carrier.  **Proposal 6:** RAN4 to discuss how much of the overall goal can be achieved via REFSENS tests, whether we really need to consider dedicated demodulation tests, and how to properly incorporate the 33us MRTD aspect. |

## Open issues summary

### Sub-topic 1-1 Test scope

*Sub-topic description: Test scope in the UE demodulation performance part*

Open issues and candidate options before meeting [R4-2305891]:

|  |
| --- |
| **Agreement**:   * Discuss the UE demodulation requirements for Type 2 UE first.   + Test scope covers both EN-DC and NR-CA * Not define the UE demodulation requirements for Type 3 UE. * For UE demodulation requirements for Type 4 UE, depending on the progress of RF discussion. |

**Issue 1-1-1: UE type assumption**

* Proposals
  + Option 1 (Nokia, MediaTek, Ericsson, Huawei, Apple): RAN4 should discuss the need for demodulation requirements only for Type-2 UEs
    - Preclude Type-3a/3b and Type-4a/4b UE from the UE demodulation performance requirements discussion.
* Recommended WF
  + Agree with the option 1.

# Topic #2: Type 2 UE demodulation requirements

## Companies’ contributions summary

See 1.1

## Open issues summary

Open issues and candidate options before meeting [R4-2305891]:

|  |
| --- |
| **Way forward:**   * Option 1: Define new UE demodulation requirements for Type 2 UE for intra-band non-contiguous EN-DC/NR-CA deployment scenario.   + Interested companies assume the maximum received time difference value (33us) and maximum power imbalance assumption (25dB). * Option 2: Not define new UE demodulation requirements for Type 2 UE for intra-band non-contiguous EN-DC/NR-CA deployment scenario. |

### Sub-topic 2-1 Test case for Type 2 UE demodulation requirements

*Sub-topic description: Whether to define Type 2 UE demodulation requirements for EN-DC and/or NR-CA scenario. If agreed to define the dedicated Type 2 UE demodulation requirements, what is the test setup.*

**Issue 2-1-1: Whether to define new Type 2 UE demodulation requirements in TS38.101-4**

* Observations
  + (MediaTek): There exist RF tests for Type2 UE of EN-DC where data throughput is measured 1dB above reference sensitivity level with another carrier having 25dB higher power. There does not exist RF tests for Type2 UE of NR-CA.
  + (Ericsson): For Type 2 UE, the maximum received timing difference of 33us in intra-band non-contiguous EN-DC is verified with the existing RRM interruption test specified in TS38.133.
  + (Huawei): Type 2 UE has no updates to the baseband processing compared to baseline architecture.
  + (Qualcomm): A demod test would be needed to check that the UE correctly handles both CCs at the same time.
  + (Nokia): BLER for each CC increases quickly once residual FOE exceeds DM-RS density related BB FOC range, and once residual TOE exceeds CP. BLER is different for demodulator implementations and FO/TO difference scenarios between CCs. Mostly type 2 (and type 4) UEs are expected to be served in non-collocated environments.
* Proposals
  + Option 1 (Nokia, ZTE, Qualcomm, Apple): Define new Type 2 UE demodulation requirements for both EN-DC and NR-CA scenario
    - Option 1a (MediaTek): Define with NR-CA scenario only.
  + Option 2 (Ericsson, Huawei): Not define the dedicated UE demodulation requirements for Type 2 UE
* Recommended WF
  + First discuss whether to define new Type 2 UE demodulation requirements or not, based on the observations.
  + If agreed to define the requirements, discuss further whether to define for NR-CA scenario only or both NR-DC and NR-CA scenarios.

**Issue 2-1-2: Test setup for Type 2 UE demodulation requirements (if agreed to define the requirements)**

* Proposals
  + Option 1 (Nokia, Qualcomm, Apple): Assume the power difference of 25dB and received time difference of 33us.
* Recommended WF
  + Agree with Option 1 if it is agreed to define Type 2 UE demodulation requirements.

**Issue 2-1-4: Test method for Type 2 UE demodulation requirements (if agreed to define the requirements)**

* Proposals
  + Option 1 (Apple):
    - Choose a set of MCSs such that the difference of required SNR to achieve XX% of the maximum throughput is equal or less than 25dB.
    - Consider 70% of the maximum throughput as the figure of merit.
  + Option 2 (Qualcomm):
    - A static channel (AWGN) should be used for this test.
    - Artificial noise should be added in this test, the SNR of the weaker CC should be set below or around 0dB while the stronger CC should be set 25dB higher. Actual signal levels should be further discussed
* Recommended WF
  + Discuss the following points:
    - For EN-DC, measure NR carrier only. For NR-CA measure both PCell and SCell at same time.
    - Channel model: AWGN or Fading channel model?
    - Test criteria: Reuse X% of the maximum throughput?
    - How to select MCS for each carrier?

### Sub-topic 2-2 Test applicability of Type 2 UE for existing power imbalance test

**Issue 2-2-1: Whether to clarify the test applicability of the existing power imbalance test**

* Observations (Apple)
  + Existing test cases in 38.101-4 with 6dB power imbalance between SCell and PCell are only meant for Type-1 UEs.
* Proposals (Ericsson)
  + Add the following sentence in TS38.101-4 clause 9.1.1 to clarify the intra-band non-contiguous EN-DC power imbalanced test is not applicable for Type 2 UE.
    - *For FR1 intra-band non-contiguous EN-DC, this requirement does not apply for the EN-DC configurations if UE indicates interBandMRDC-WithOverlapDL-Bands-r16.*
* Recommended WF
  + Discuss the proposal.

# Appendix (for information): UE type options for non-colocated deployment scenario

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UE Type | CC# | antenna / LNA | Mixer | Analog BB | #Rx | NRCA / ENDC | power imbalance | Comments |
| 1 | 1 (NR) | 4 shared | 4 shared | 4 shared | 4Rx | NR-CA  EN-DC | 6dB  full range | Baseline architecture (i.e. legacy architecture) |
| 2 (LTE/NR) | 4Rx |
| 2 | 1 (NR) | 2 | 2 | 2 | 2Rx | NR-CA  EN-DC | 25dB  full range | Reuse of baseline architecture restricted to 2Rx/band but need 2LO frequencies |
| 2 (LTE/NR) | 2 | 2 | 2 | 2Rx |
| 3a | 1 (NR) | 4 shared | 4 | 4 | 4Rx | EN-DC | 6<P≤25dB  partial range | Reuse of baseline RFFE architecture adding 2LO/BB/Rx and RF split after 2 LNAs out of 4 => common AGC on LNA => 25dB partial range |
| 2 (LTE) | 2 | 2 | 2Rx |
| 3b | 1 (NR) | 4 shared | 4 | 4 | 4Rx | NR-CA  EN-DC | 6<P≤25dB  partial range | Reuse of baseline RFFE architecture adding 2LO/BB/Rx and RF split after all 4 LNAs => common AGC on LNA => 25dB partial range |
| 2 (LTE/NR) | 4 | 4 | 4Rx |
| 4a | 1 (NR) | 4 | 4 | 4 | 4Rx | EN-DC | 25dB  full range | Requires 6 antennas and LNA => FWA only |
| 2 (LTE) | 2 | 2 | 2 | 2Rx |
| 4b | 1 (NR) | 4 | 4 | 4 | 4Rx | NR-DC  EN-DC | 25dB  full range | Requires 8 antennas and LNA => FWA only |
| 2 (LTE/NR) | 4 | 4 | 4 | 4Rx |