**3GPP TSG-RAN WG4 Meeting # 104-bis-e R4-22xxxxx**

**Electronic Meeting, 10– 19 October 2022**

**Agenda item:** 6.11.3

**Source:** KDDI

**Title:** Email discussion summary for [104-bis-e] [134] NonCol\_intraB

**Document for:** Information

# Introduction

This part includes contributions in agenda 6.11.1 and 6.11.2.

Classify the contents into two topics:

1. Topic #1: "NR-CA Type-2 UE" for 2 layer MIMO case (intra-band non-collocated non-contiguous) as in 6.11.2
2. Topic #2: "New Type UE" for 4 layer MIMO case (non-collocated non-contiguous intra-band NR-CA and inter-band EN-DC) as in 6.11.2

Candidate target of email discussion are as below:

* 1st round:
	+ Reach consensus on UE RF architecture for NR-CA Type-2 UE (2 layer/2 Rx Chain per CC)
	+ Reach consensus on RF requirements for NR-CA Type-2 UE
	+ Reach consensus on guideline of RRM requirements for both NR-CA Type-2 UE and “New Type UE”
	+ Reach consensus on "New Type UE" for 4 layer MIMO case including but not limited to reference UE architecture
* 2nd round:
	+ Approve on the WF for NR-CA Type-2 UE
	+ Approve on the WF for NR-CA and EN-DC New Type UE

It is appreciated that the delegates for this topic put their contact information in the table below.

Contact information

|  |  |  |
| --- | --- | --- |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic 1: "NR-CA Type-2 UE" for 2 layer MIMO case (intra-band non-collocated non-contiguous)

## Companies’ contributions summary

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| **T-doc#** | **Company** | **Proposals / Observations** |
| R4-2215629 | Apple | Proposal 1: It is proposed to adopt the UE architecture for DC\_42\_n77/78 EN-DC type 2 for NR CA type 2 UE supporting 2 MIMO layer per CC.* i.e. 2 layer/2Rx Chain per CC, total 4 Rx Chain with separate FFT for each Rx chain

Observation 1: Based on the reference architecture in proposal 1, it is feasible to reuse 33us requirement. Proposal 2: The exact value (< =33us) for MRTD requirement can be further discussed and confirmed in RRM session.Proposal 3: “Async CA” is misleading concept. No further discussion should be pursued on this. |
| R4-2215736 | Samsung | Observation 5: The Type-2 non-collocated Intra-band NR CA architecture is reused from Type-2 non-collocated EN-DC deployment, in which the totally 4 Rx antenna and 2 Rx Path per cc is the assumption.Observation 6: In Rel-16, it proves that UE is already able to achieve 25dB power imbalance with 1dB REFSENS relaxation for Type-2 non-collocated EN-DC deployment.Observation 7: It could be deducted that UE is able to achieve 25dB power imbalance with 1dB REFSENS relaxation for Type-2 non-collocated intra-band NR-CA deployment.Observation 8: Too fragmental UE types has no benefit from network perspective.Proposal 5: No need to revisit 25dB power imbalance with 1dB REFSENS relaxation for Type-2 Intra-band non-collocated NR-CA, i.e., neither reduce the power imbalance nor define several power imbalance values is acceptable. |
| R4-2215790 | KDDI | Observation 1: The possible UE architecture for DC\_42\_n77/78 would be that for n77/78 intra-band non-contiguous NR-CA. Observation 2: The updated UE architectures were not shown in last RAN4 meeting Observation 3: The 2 Rx per band based on 2 Rx chain per CC is a baseline on UE architecture for Type-2 UE of n77/78 intra-band non-contiguous NR-CAObservation 4: Fragmentation of UE types doesn’t have any benefits from network configuration and operation perspective.Proposal: RAN4 conclude 25dB power imbalance with 1dB REFSENS relaxation for Type-2 Intra-band non-collocated NR-CA in this meeting. |
| R4-2215827 | Huawei, HiSilicon | Proposal 1: Consider one AGC setting per Rx chain. More than one AGC setting per Rx chain is not precluded.Proposal 2: Consider a shared BB for all RX chains. |
| R4-2215890 | ZTE | Proposal 1. For non-collocated type 2 UE supporting intra-band non-contiguous CA, 25dBc power imbalance of inter-band ENDC type 2 UE which corresponds to 1dB REFSEN degradation can be reused. |
| R4-2216425 | Ericsson | Observation 1: In NR up to and including release-17 intra-band non-contiguous EN-DC/NR-CA is collocated.Observation 2: In LTE up to and including release-17 intra-band non-contiguous is allowed to be non-colocated. A UE should cope with a relative propagation delay difference up to 30 µs among the component carriers to be aggregated in both intra-band non-contiguous and inter-band non-contiguous CA. Observation 3: NR DC has a total time budget. If TAE is larger it can be compensated with smaller $∆\_{RF\\_propagation}$ and vice versa.Observation 4: For a Type 2 UE with interBandMRDC-WithOverlapDL-Bands-r16 capability, 25 dB is used to derive minimum requirements, wilst keeping MRTD according to 7.6.2/7.6.5 in TS 38.133, ie 33 µs. Observation 5: For this WI, a 25 dB power imbalance can be used for derivation of minimum requirements, but MRTD of 500 meters would restrict deployment for operators.Proposal 1: Set MRTD for intra-band non-collocated EN-DC/NR-CA the same as for LTE, or NR CA inter band, or NR DC synchronous inter band, i.e., around 30 µs.Proposal 2: Let MRTD be the total budget to be managed freely. This means that there is no need to specify TAE for intra-band non-collocated EN-DC/NR-CA. |

## Open issues summary

### Sub-topic 1-1 : UE RF architecture baseline

*Sub-topic description:*

The agreement of WF R4-2214458 (KDDI) agreed in last meeting are as follows:

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| < Issue 2-2-1 (a): UE RF architecture>**Agreement:** * Total four RF antenna is assumed.
* Reuse UE RF architecture of inter-band non-contiguous DC\_42\_n77/78 EN-DC Type-2 (i.e. 2 layer/2 Rx Chain per CC, total 4 Rx Chain) as the baseline.

< Issue 2-2-1 (b): Meaning of number of Rx Chain>**Way forward:** * Clarify meaning of number of Rx Chain in the case of total 4 Rx Chain as follows
	+ Antenna/RF paths as baseline
	+ Further clarify in next meeting with consideration on other aspect, such as BB
 |

R4-2215629 (Apple) propose as P1 that 2 layer/2Rx Chain per CC, total 4 Rx Chain with separate FFT for each Rx chain. And also, R4-2215827 (Huawei) propose to consider one AGC setting per Rx chain. More than one AGC setting per Rx chain is not precluded as P1 and consider a shared BB for all RX chains as P2.

*Open issues and candidate options before e-meeting:*

**Issue 1-1-1: UE RF architecture**

* Proposals: with regard to following option 1, 2 and 3, companies can select more than one option.
	+ Option 1: 2layer/2Rx chain per CC, total 4Rx chain with separate FFT for each Rx chain
	+ Option 2: Consider one AGC setting per Rx chain. More than one AGC setting per Rx chain is not precluded
	+ Option 3: Consider a shared BB for all Rx chains
	+ Option 4: No need to add above option 1-3 to current agreement of last meeting
* Recommended WF
	+ TBA

### Sub-topic 1-2 : RF requirements

*Sub-topic description:*

The agreement of WF R4-2214458 (KDDI) agreed in last meeting are as follows:

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| < Issue 2-3-1: Power Imbalance and in-band blocking>**Agreement:*** 25dB power imbalance, 1dB REFSENS relaxation. RAN4 may revisit if there is technical concern.
 |

R4-2215736 (Samsung), R4-2215790 (KDDI) and R4-2215890 (ZTE) propose that RAN4 conclude 25dB power imbalance with 1dB REFSENS relaxation for Type-2 Intra-band non-collocated NR-CA in this meeting.

*Open issues and candidate options before e-meeting:*

**Issue 1-2-1: Power Imbalance and in-band blocking**

* Proposal
	+ Conclude 25dB power imbalance with 1dB REFSENS relaxation for Type-2 Intra-band non-collocated NR-CA in this meeting
* Recommended WF
	+ TBA

### Sub-topic 1-3 : Guidelines for RRM requirements

*Sub-topic description:*

The agreement of WF R4-2214458 (KDDI) agreed in last meeting are as follows:

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| < Issue 2-4-1: Guidelines for RRM requirements on MRTD>**Agreement:*** Agree to consider sync NR-CA scenario.
	+ No Tx-Rx simultaneous operation is assumed to be supported for sync NR-CA scenario.
* FFS async NR-CA scenario.
	+ Encourage operators to give their preference of async scenario.
 |

R4-2215629 (Apple) propose as P3 that “Async CA” is misleading concept and no further discussion should be pursued on this. On the other hand, there are no feedbacks from operators currently.

*Open issues and candidate options before e-meeting:*

**Issue 1-3-1: Guidelines for RRM requirements on MRTD**

* Proposal
	+ Encourage operators to give their preference of async scenario continuously.
* Recommended WF
	+ TBA

*Sub-topic description:*

And also, R4-2215629 (Apple) propose as P2 that the exact value (< =33us) for MRTD requirement can be further discussed and confirmed in RRM session. Additionally, R4-2216425 (Ericsson) propose as P1 to set MRTD for intra-band non-collocated EN-DC/NR-CA the same as for LTE, or NR CA inter band, or NR DC synchronous inter band, i.e., around 30 µs. And it propose as P2 to let MRTD be the total budget to be managed freely. This means that there is no need to specify TAE for intra-band non-collocated EN-DC/NR-CA.

*Open issues and candidate options before e-meeting:*

**Issue 1-3-2: Specific RRM requirements on MRTD**

* Proposal
	+ Discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan.
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Issue 1-1-1: UE RF architecture

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| **Company** | **Comments** |
| Qualcomm | Option 1 + Option 2. IF the UE has only 4 antennas than the RF front end is the same for all receivers(covering the entire band) and all the signals will go through the LNAs |
| Samsung | Option 4. Generally we think the agreement of RF architecture in last meeting is enough, “2 Rx/2 layer per CC” would be captured in 38.101-1, others more relevant to UE implementation would not, hence maybe we do not need to make agreements on Option 1-3.Regarding Option 2, not correct, should be **separated** AGC setting for different CCs, that is at least the 2Rx Chain of CC1 could share one AGC setting while the 2Rx Chain of CC2 could share one AGC setting.Regarding Option 3, separate BB could work.Regarding Option 1, does it has impact on RF requirement? |
| ZTE | For option 2, we share similar view with Samsung. Same AGC setting should be applied to CCx supporting 2Rx.Whether to use separate FFT (option 1) or share/separate BB impact on the RF requirements? |
| Ericsson | Option 1 + Option 2. |
| Murata | Option 1 + Option 2. The minimum requirement for Type 2 UE needs only to be met with 2RX/2 layer per CC. This should be the baseline. Architectural options and assumptions can be discussed if more > 2RX layers per CC are required. |
| Apple | Support Option 1 + Option 2. The FFT assumption will impact the MRTD/MTTD requirement. So, it should be part of the reference architecture discussion. |
| vivo | OK with option 1 + option2, but we think the detail information of UE implementation is not needed if the requirement is not impacted. |
| Meta | Support option 1,2. For option3, we think that same BB would be considered. But we are fine to consider the separate BB for each RF chain. |
| Skyworks | Option 1 + Option 2 is a more refined definition but it may not be so critical since we agree this is the same type2 UE that is already defined. |
| KDDI | Option 4: As vivo said, we think that the detail information of UE implementation is not needed if the RF requirement is not impacted. Actually, with regard to Rel-16/17 Type-2 EN-DC, the detail information of UE implementation is not specified in our understanding. |
| Samsung | I am little confused about comment on Option 2, companies are talking about AGC or AGC setting? Or both together? If we assume each chain possess one LNA(AGC) for simplicity. For collocated single band 4Rx case, 4 AGC(4LNA) could share one AGC setting due to the power imbalance is not large(4LNA could be set to one Gain mode); For Type-2, 2AGC(2LNA ) of CC1 could share one AGC setting and 2AGC(2LNA) of CC2 could share one AGC setting, but CC1 and CC2 could not share one AGC setting due to the large power imbalance, the Gain mode of CC1 and CC2 should be set separately.Anyway, maybe we do not need argue on Option1-3, as companies clarified that these options has no impact on RF requirement, and for Type-2 ENDC, we also do not have such kind of agreement but the requirement has been defined and works well. We do not think we need explicitly record them. |
| Huawei | We support option 2 and 3.@ Samsung, To have a full control on the gain of the received signals and avoid having the shared LNA dynamic range issues, we support having a separate AGC (including LNA) for every single RX path(4 AGCs in total in this case). The AGC settings could be identical between the two Rx chains of a single CC but it is not mandatory.@Vivo the Shared/Separated and AGC configurations were questions that were raised during the last meeting and are captured in the Email summary, hence they are addressed in this meeting |
| MediaTek | Option 1. Other options are UE implementation dependent, and UE shall not be restricted by. |

Issue 1-2-1: Power Imbalance and in-band blocking

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| **Company** | **Comments** |
| Qualcomm | We agree with the proposal. Is there a difference between this and the Rel.17 Type II UEs? |
| Samsung | We support moderator’s proposal.  |
| ZTE | We support moderator’s proposal. |
| Ericsson | WF is fine for us. |
| Murata | Agree with proposal |
| SoftBank | Support the proposal.  |
| Apple | Fine with moderator’s proposal. |
| Vivo | Support the proposal |
| Meta | Support the moderator’s proposal |
| Skyworks | Support the proposal |
| KDDI | Support the proposal |
| Huwaei | We support the proposal |
| NTT DOCOMO | We support this proposal. |
| MediaTek | We support the proposal |

Issue 1-3-1: Guidelines for RRM requirements on MRTD

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| **Company** | **Comments** |
| Qualcomm | We agree there shouldn’t be any simultaneous Rx-Tx within the band |
| Samsung | We welcome the feedback from operators, if no feedback or clear need of async operation from operators, we suggest to conclude sync operation for intra-band NRCA in this meeting as guideline for RRM discussion, note that it is for both Type-2 and New-Type UE. |
| ZTE | Similar view with QC, focus on sync operation. |
| Ericsson | Agree with Apple that Async CA is misleading concept. This should not be pursued. |
| Murata | This is an intra-band band combination, so there should not be any simultaneous RX/TX. |
| Apple | Async CA is misleading concept. It shall not be perused. It should also be noted that even for inter-band CA case in 38.133, only sync case is considered. |
| Meta | The asynchronous operation in intra-band CA shall be discussed in other new WI if RAN approve the intra-band simultaneous Rx-Tx capability WI. So, RAN4 only focus on the synchronous operation in this WI. |
| Skyworks | The main assumption is that simultaneous Tx/Rx is not supported and that the normal 33us MRTD timing is assumed. |
| Huawei | We support exclusion of simultaneous Rx-Tx. |
| CHTTL | In our understanding, the “asynchronous CA” discussed and support in Rel.16 NR spec means that the support for NR inter-band carrier aggregation with slot alignment, but with unaligned frame boundary and partial SFN alignment.So the term “async NR-CA” here could be confusing without further clarification. Also we would like to hear the feedback from other operators.In addition, we wonder if the term “sync NR CA” could also be confusing, as in the RRM spec we didn’t put synchronous/asynchronous in front of NR carrier aggregation. We wonder if it will be better to say: For NR-CA scenario - No Tx-Rx simultaneous operation is assumed to be supported.(Assuming this is for intra-band TDD-TDD CA) |
| NTT DOCOMO | “Async” may be confusing, so we would like to comment in terms of simultaneous TxRx and MRTD.Regarding simultaneous TxRx, our view is that we are OK to assume no-simultaneous TxRx for intra-band NR-CA in this WI since it has a large impact on RF architecture.Regarding MRTD, we generally have interests on larger MRTD values to increase deployment flexibility. We would like to further discuss if larger MRTD values than that of inter band NR CA is needed or not and feasible or not in RRM session considering the fact that, so far, there is no MRTD requirements for async inter-band NR CA specified in RRM spec. |
| MediaTek | We support to preclude simultaneous Rx-Tx within the n77 frequency range for the WI. |

Issue 1-3-2: Specific RRM requirements on MRTD

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| **Company** | **Comments** |
| Qualcomm | From our side MRTD can be discussed at any time. |
| Samsung | We support moderator’s proposal. MRTD discussion should be conducted in RRM session from next meeting. |
| ZTE | Fine with moderator’s proposal.  |
| Ericsson | MRTD = 33 µs, same as interband CA and interband EN-DC. |
| SoftBank | We are fine with the moderator’s proposal.  |
| Apple | We share similar view as Ericsson that reusing the MRTD requirement from inter-band CA should be fine based on architecture Option 1+ Option 2. Final decision can be done later in RRM session after we concluded the UE reference architecture. |
| Meta | The decision is up to RRM session for MRTD in intra-band non-contiguous CA with non-collocated scenarios.  |
| Skyworks | The main assumption is that the normal 33us MRTD timing is assumed as for already defined Type 2 UE. |
| KDDI | The decision is up to RRM session for MRTD in intra-band non-contiguous CA with non-collocated scenarios. Same issue was discussed in last meeting, so RAN4 doesn’t need to discuss it here again. |
| Huawei | We support Moderator’s proposal. |
| MediaTek | MRTD=3us for intra-band CA shall be applied for the WI since we only consider synchronized operation. This can be further discussed in RRM session.It is common understanding the UE does not support simultaneous Rx/Tx for the band combo in this WI, how can MRTD=33us fulfill the assumption? We are concerned whether simultaneous Rx/Tx happens with MRTD=33us since it allows uplink in n77. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary**  |
| **Sub-topic 1-1:****UE RF architecture baseline** | **Issue 1-1-1: UE RF architecture***Tentative agreements:* None5 companies (Samsung/Murata/vivo/Skyworks/KDDI) mention that the detail information of UE implementation is not needed if the RF requirement is not impacted and this topic is the same Type 2 UE already defined (almost same as Option.4). On the other hand, 5 companies (Ericsson/Murata/vivo/Meta/Skyworks/Huawei/MediaTek/Apple) support Option.1 and Option.2, and also Huawei support Option.3. Apple pointed out that the BB FFT assumption will impact the MRTD discussion.*Candidate options:*Proposals:* Option 1: Not to discuss the detail information of UE implementation furthermore if the RF requirement is not affected. “2 layer/2 Rx Chain per CC, total 4 Rx Chain” based on last meeting’s agreement is enough.

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| **Issue 2-2-1 (a): UE RF architecture**All five companies support the agreement in GTW.**Agreement:** * Total four RF antenna is assumed.
* Reuse UE RF architecture of inter-band non-contiguous DC\_42\_n77/78 EN-DC Type-2 (i.e. 2 layer/2 Rx Chain per CC, total 4 Rx Chain) as the baseline.
 |

* Option 2: Continue the detail information of UE implementation deeply with regard to the following aspects.
	+ Option 2-1: 2layer/2Rx chain per CC, total 4Rx chain with separate FFT for each Rx chain
	+ Option 2-2: Consider one AGC setting per Rx chain. More than one AGC setting per Rx chain is not precluded

*Recommendations for 2nd round:*Considering that 2 layer/2 Rx Chain per CC, total 4 Rx Chain is already defined in Rel-16/17 and currently there are no issues of RF requirements derived from the detail information of UE implementation, moderator propose to support Option 1. If companies support Option 2, moderator would like to encourage them to show some specific impacts for RF requirements and differences from Rel-16/17 Type 2 EN-DC case. |
| **Sub-topic 1-2:****RF requirements** | **Issue 1-2-1: Power Imbalance and in-band blocking****Agreements:**Conclude 25dB power imbalance with 1dB REFSENS relaxation for Type-2 Intra-band non-collocated NR-CA in this meeting*Recommendations for 2nd round:***RAN4 can close the issue 1-1-1 with above agreement.** |
| **Sub-topic 1-3:****Guidelines for RRM requirements** | **Issue 1-3-1: Guidelines for RRM requirements on MRTD***Tentative agreements:* None“Async” wording seems to be confusing. From SimultaneousRxTx point of view, companies agree to assume only non-simultaneousRxTx in this Rel-18 WI based on agreement of last meeting. On the other hand, from MRTD point of view (moderator intended this in 1st round), one operator show their interest in larger MRTD values to increase deployment flexibility. However, there is no MRTD requirements for async NR-CA scenario in current RRM spec. *Candidate options:*Proposals: (“Async” needs to be here considered from MRTD point of view)* Option 1: study async NR-CA scenario and requirements in Rel-18 study phase
* Option 2: consider async NR-CA scenario in later stage of Rel-18 or future release

*Recommendations for 2nd round:*Check preference on async NR-CA from MRTD requirements again. |
| **Issue 1-3-2: Specific RRM requirements on MRTD***Tentative agreements:* None7 companies (Samsung/ZTE/SoftBank/Meta/KDDI/Huawei/Apple) support to discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan. On the other hand, 4 companies (Qualcomm/Ericsson/ Skyworks) support to continuously discuss MRTD in this meeting.The moderator still propose the following agreement:* Discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan.

*Candidate options:* None*Recommendations for 2nd round:*Check the tentative agreement is accepted. |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

### Sub-topic 1-1 : UE RF architecture baseline

*Open issues and candidate options before 2nd round:*

**Issue 1-1-1: UE RF architecture**

Proposals:

* Option 1: Not to discuss the detail information of UE implementation furthermore if the RF requirement is not affected. “2 layer/2 Rx Chain per CC, total 4 Rx Chain” based on last meeting’s agreement is enough.

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| **Issue 2-2-1 (a): UE RF architecture****Agreement:** * Total four RF antenna is assumed.
* Reuse UE RF architecture of inter-band non-contiguous DC\_42\_n77/78 EN-DC Type-2 (i.e. 2 layer/2 Rx Chain per CC, total 4 Rx Chain) as the baseline.
 |

* Option 2: Continue the detail information of UE implementation deeply with regard to the following aspects.
	+ Option 2-1: 2layer/2Rx chain per CC, total 4Rx chain with separate FFT for each Rx chain
	+ Option 2-2: Consider one AGC setting per Rx chain. More than one AGC setting per Rx chain is not precluded

*Recommendations for 2nd round:*

Considering that 2 layer/2 Rx Chain per CC, total 4 Rx Chain is already defined in Rel-16/17 and currently there are no issues of RF requirements derived from the detail information of UE implementation, moderator propose to support Option 1. If companies support Option 2, moderator would like to encourage them to show some specific impacts for RF requirements.

### Sub-topic 1-3 : Guidelines for RRM requirements

*Open issues and candidate options before 2nd round:*

**Issue 1-3-1: Guidelines for RRM requirements on MRTD**

“Async” NR-CA here means scenario with MRTD requirement larger than 33us which is the maximum for CA in 38.133

Proposals:

* Option 1: study async NR-CA scenario and requirements in Rel-18 study phase
* Option 2: consider async NR-CA scenario in later stage of Rel-18 or future release

*Recommendations for 2nd round:*

Check preference on async NR-CA from MRTD requirements again. If there is only a little preferences from operators, the moderator propose to support Option 2.

**Issue 1-3-2: Specific RRM requirements on MRTD**

Proposal

* Discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan.

*Recommendations for 2nd round:*

* Check whether to accept the moderator’s proposal.

## Companies views’ collection for 2nd round

### Open issues

**Issue 1-1-1: UE RF architecture**

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| **Company** | **Comments** |
| Apple | **Issue 1-1-1: UE RF architecture**Option 1 is not enough for completing all the requirement. Option 2-1 is a key assumption for MRTD requirement development. Without this assumption, there is no foundation for MRTD larger than CP. Further we don’t see obvious objection for 2-1 in 1st round.Can the proponent for Option 1 clarify what is the baseline assumption for MRTD requirement if no further discussion beyond that agreed in the last meeting?*Note that in the WF agreed in the last meeting, Rx chain is still pending further check for BB part.* |
| KDDI | Option 1: According to work plan (R4-2211795) agreed in the last meeting, RAN4 needs to agree on the reference UE architecture for Type 2 NR-CA as follows.

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| --- |
| * RAN4 #104-bis-e (Oct. 2022)
	+ RF part (0.5TU)
		- Discuss reference UE architecture and RF impacts due to the power imbalance
			* Agree on the reference UE architecture at least for 2-layer MIMO case for NR-CA
			* Discuss both 2-layer MIMO case for NR-CA
			* Start initial discussion of 4-layer MIMO case for EN-DC and NR-CA
 |

Considering that “2 layer/2 Rx Chain per CC, total 4 Rx Chain” is already defined as EN-DC in Rel-16/17 and currently there are no issues of RF requirements derived from the detail information of UE implementation. If RAN4 doesn’t need the detail information of UE implementation for Type 2 EN-DC in Rel-16/17, RAN4 doesn’t need it for Type 2 NR-CA. We wonder if there are big differences between EN-DC and NR-CA. |
| Qualcomm | We think Option 1 and Option 2 should go together as this would be the typical implementation. If there is a desire to go beyond this then there should be a separate discussion which will likely result in some new UE capabilities. We do not see a need for this though because a different implementation seems very complicated. |
| Meta | In 1st round many companies are support option 1 and option 2 together. So RAN4 would consider option 1 and option 2 together to derive RF/RRM requirements for intra-band NC CA within non-collocated scenarios.  |
| MediaTek | Option 1 and option 2-1 is agreeable. Option 2-2 is UE implementation dependent that we do not think RAN4 need to further discussion on this. |
| Samsung | We support Option 1We feel that some experts may confuse AGC and AGC setting, they are two different things…..@Huawei, thanks for your clarification in 1st round, actually we have same understanding about AGC and AGC setting, but my concern is “Consider one AGC setting per Rx chain. More than one AGC setting per Rx chain is not precluded” this is just one kind of AGC setting implementation, we have point out another kind of AGC setting implementation in 1ST round, so my point is we do not need to explicitly record one kind of AGC setting implementation.Regarding Option 2-1, as companies clarified it more relevant to MRTD requirement, rather than RF requirement, hence we feel it might be better to be discussed and agreed in RRM session if necessary. |
| Huawei | Although the option 1 could be considered as a valid solution since REL16/17, the details proposed in option 2 were requested in the last RAN4 meeting (as mentioned in the first round). So we would like go with option 2-2 to have full control on the received signal gain and no limitations on the dynamic range. On the other hand, this option is aligned with 3a/3b architectures that are proposed for 4MIMO layers in the sense that 4AGC (LNAs) will be used.@Samsung thanks for the comment, we understand your point. However when the AGCs are considered as separated there is always a possibility to align them and use a commont AGC setting for the two RX chains of a single CC, hence we do not see an issue here. On the other hand we suggest to make the proposal more inclusive as follows:“Consider one AGC setting per Rx chain. Identical AGC settings for two Rx chains of a CC is not precluded. More than one AGC setting per Rx chain is not precluded”Regarding Option 2-2 we are not convinced by the time delay values that is provided (some calculations would be appreciated) in R4-2215629. Let’s discuss MRTD discussion on RRM session where more details could be covered |
| Apple 2 | To Huawei question on time delay value in R4-2215629.Using the following formula (which is used in Rel-17 EN-DC discussion in Huawei paper), 25dB power imbalance corresponds to 479m propagation difference in distance. then we get the propagation delay difference is 1.6us. PL=28.0+22log10(d3D)+20log10(fc)Further the network synchronization error is 3us. This leads to a totally 4.6us propagation delay difference corresponding to 25dB power imbalance. |
| Ericsson | Option 1, as per moderator’s recommendation is fine. |
| ZTE | Option 1. As commented in 1st round, we would like to know whether to use separate FFT (option 2-1) impact on the RF requirements? It seems it will impact RRM requirement but not RF requirement.For option 2-2, it seems different AGC setting implementation would impact the RF requirements, for ENDC, we think same AGC setting implementation should be applied for LTE carriers or NR carriers, otherwise, 6dB power imbalance between carriers for the same RAT may not guarantee. |

**Issue 1-3-1: Guidelines for RRM requirements on MRTD**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | If the intention is to define larger MRTD > 33us that defined in the current RRM spec. We think it’s premature to accept the scenario yet without clarification on the necessity. 33us MRTD has been in the spec for quite long time. We need to understand why it is not enough for this particular combination. If it is not enough, then it should be general discussion not specific to this WI. |
| KDDI | Option 2: From deployment flexibility point of view, async NR-CA might be kind of attractive for operators. On the other hand, there is actually not MRTD spec larger then 33us as companies pointed out so far. If RAN4 study new requirements on large MRTD for this non-collocated topic, this study seems to need a considerable time units. It would be better that RAN4 consider async NR-CA scenario in later stage of Rel-18 or future release. |
| Qualcomm | We do not agree with either option, we should not discuss anything beyond the MRTD currently agreed for CA. This would become a DC type of deployment, not CA. We are not aware of any async deployments in this band, it doesn’t seem feasible. We would like to point out that dynamic TDD or full duplex deployments are still sync. |
| Meta | Option2. This is expect huge effort to support the asynchronous NR CA operation. |
| SoftBank | Our understanding is that the difference between sync/async NR-CA is whether the frame boundary is aligned or not. For simplify the discussion, we are fine with focusing on sync NR-CA scenario at this timing. About the MRTD requirements larger than 33us (with sync NR-CA scenario), of course, as an operator, they are attractive considering the deployment flexibility. But we do not think we should discuss it in this WI because it may impact on inter-band NR-CA. |
| MediaTek | None of the options. The existing requirement for synchronized operation shall be maintained in this WI. Share view with Qualcomm on “We are not aware of any async deployments in this band” |
| Samsung | With clarification from companies in 1st round, we feel that better to adopt the term suggested by CHTTL for this issue as high lever agreement, then no misleading conception, right? For NR-CA scenario - No Tx-Rx simultaneous operation is assumed to be supported.Regarding the detailed MRTD requirement, should be discussed in RRM session. |
| Huawei | We echo the same comment as QC, moreover based on the operators’ comments, there is no urgent need of the Async NR-CA, and they do not have on such implementations soon.  |
| Ericsson | Option 2, as per moderator’s recommendation is fine. |
| NTT DOCOMO | We have a similar view with Samsung.RF session can agree No Tx-Rx simultaneous operation assumption, and RRM session will further discuss the value of MRTD based on the assumption. |

**Issue 1-3-2: Specific RRM requirements on MRTD**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | We supppor the moderator’s proposal to further discuss this in RRM session in RAN4#105 meeting. |
| KDDI | Support the moderator’s proposal. |
| Meta | Support the moderator’s proposal |
| SoftBank | We are fine with the moderator’s proposal.  |
| Samsung | Support the moderator’s proposal |
| Huawei | We support Moderator’s proposal |
| Ericsson | Proposal is fine: Discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan. |
| ZTE | Support the moderator’s proposal |
| NTT DOCOMO | Support the moderator Proposal. |

# Topic #2: ”New Type UE” for 4 layer MIMO case (non-collocated non-contiguous intra-band NR-CA and inter-band EN-DC)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc#** | **Company** | **Proposals / Observations** |
| R4-2215329 | Skyworks Solutions, Inc. | Table 1: NR Intra band CA configurationObservation on Type 4 UE: separate Antenna and LNA per band: * If the 25dB imbalance should be supported over the full signal dynamic range in each band, a fully independent path is required per total supported number of Rx including independent antennas
* Even at frequencies that exceed 3.3GHz, it is not definitive that a smartphone UE can support more than 4 good performance receive antennas.
* This approach may be more appropriate for FWA UE.

Observation on Type 3 UE: shared antenna and LNA between bands:* LNA AGC is shared for the two bands. Thus, the 25dB imbalance is supported without limitations only when the LNA is at maximum gain until non-linearity/blocker handling limitations appear:
	+ When LNA AGC is set for the largest signal, the sensitivity for the lowest signal will degrade
	+ When LNA AGC is set for the lowest signal, the sensitivity for the largest signal and/or resilience to blockers will degrade
* It uses the same number of antennas than for the baseline case (four).
* This approach may be more appropriate for smartphone UE for bands that exceed 3.3GHz and optionally for bands that exceed 1.8GHz.

Proposals:* Type 3 UE Architecture with 4 shared antennas and 4 shared LNAs (shared LNA AGC) is studied and specified for smartphone implementations, that includes:
	+ Necessary limitations or exceptions on dynamic range, REFSENS and blocking
	+ FFS if imbalance < 25dB would allow larger dynamic range
	+ Type 3a enabling 4Rx in one band and 2Rx in the other
	+ Type 3b enabling 4Rx in one both bands
* FFS if Type 4 architecture with 6 antennas (Type 4a enabling 4RX in one band and 2Rx in the other) or 8 antennas (Type 4b enabling 4RX in both bands) without dynamic range limitations is specified for FWA.
 |
| R4-2215629 | Apple | Proposal: 4MIMO layer per CC with 25dB power imbalance is not feasible for smart phone. |
| R4-2215673 | Qualcomm Incorporated | Observation 1: The RF architecture is with a shared antenna and LNA among all the aggregated CCs irrespective of the number of MIMO layers supported per CC.Observation 2: Handling of power imbalance and large MRTD(>CP) are the challenges in intra-band non-collocated deployments.Observation 3: the RF front end still has to handle the power imbalance irrespective of the number of receivers used for each CC.Observation 4: Splitting the receivers among different CCs enables handling of larger receive time difference at the UE.Observation 5: RTD should be within the CP to enable 4Rx on each CC.Observation 6: Performance degradation due to LNA signal distortion is difficult to characterize. RAN4 should not spend time on characterizing the performance degradation.Proposal: Enable 4Layer MIMO on each CC only with MRTD< CP. |
| R4-2215736 | Samsung | Observation 1: Generally speaking, Type-3 represents higher capability than Type-2, i.e., UE support 2+4 or 4+4 maximum MIMO layer for non-collocated inter-band EN-DC deployment, or 4+4 maximum MIMO layer for non-collocated intra-band NR-CA deployment, in terms of 2CC scenario.Proposal 1: Similar to “Type-2 UE”, the term “Type-3 UE” could be used in Rel-18 to indicate UE supporting non-collocated deployment with 2 or 4 maximum MIMO layer for LTE CC and 4 maximum MIMO layer for NR CC.Proposal 2: If Type-3 is indicated, Type-2 shall be considered as supported by default regardless of whether UE indicates Type-2 or not. Conclusion could be made after the feasibility of Type-3 is confirmed. Observation 2: The power imbalance (w/ or w/o more Rx performance relaxation) and UE architecture (Rx chain numbers, antenna numbers, separated/shared Lo/AGC) have mutual influence.Observation 3: UE architecture (limitation on Lo/LNA performance) has impact on frequency separation between 2 CC and maximum layer number per cc. Observation 4: Due to shared AGC/filter between CCs, the dynamic range is limited in theory, which has impact on blocking requirement and ACS requirement. Proposal 3: It is proposed to discuss the feasibility of following 4 possible UE architectures for New Type UE capable of supporting maximum 4 layer per cc (or LTE downgrade to 2 layer per cc) with consideration on power imbalance (w/ or w/o more Rx performance relaxation), frequency separation, dynamic range and UE implementation difficulty.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Architecture** | **Max Layer number (CC1+ CC2)** | **UE architecture (Rx Path number)** | **Antenna number** | **Frequency separation between 2 CC** | **Dynamic range** | **Smartphone implementation** | **Power imbalance (w/ or w/o Rx perf. Relaxation)** |
| 1 | 4+4 | Totally 8 (4Rx Path per CC) | 8 | No limitation or ≤ X MHz | Flexible (Separated AGC) | Challenging | 25 |
| 2 | 4+4 | Totally 4 (4Rx Path per CC) | 4(shared) | No limitation or ≤ X MHz | Restricted (Partially Shared AGC) | Friendly | 6＜P≤ 25 (w/ or w/o more Rx performance relaxation) |
| 3 Note 5 | 2+4 | Totally 6 (2Rx for b42, 4Rx for n77) | 6 | No limitation or ≤ X MHz | Flexible (Separated AGC) | Relative friendly | 25 |
| 4 | a | 4+4 | Totally 4 (Each Rx Path supports both CC1 and CC2) | 4(shared) | ≤X MHz | Very Restricted (Shared AGC) | Easy | Close or equal to 6 |
| b | 4+4 | Totally 4 (Each Rx Path supports both CC1 and CC2) | 4(shared) | ≤X MHz | Very Restricted (Shared AGC) | Easy | 6＜P＜25 (with more Rx performance relaxation) |
| Note 1: The assumption of this table is 2CC in total.Note 2: Common assumption for Lo is 200MHz, however different UE vendors have different implementation, hence X MHz is used here for indication of Frequency separation.Note 3: For Architecture-1/3, the assumption is totally separated AGC setting for CC1 and CC2.Note 4: Separated BB paths for each CC is assumed in this table.Note 5: Only applicable to EN-DC Scenario |

Proposal 4: Based on current situation, for New-Type non-collocated deployment, it is proposed:1. Architrecture-1: Could be considered for FWA type UE at late stage of Rel-18 or future releases.
2. Architrecture-2: Could be considered for both smart phone and FWA type UE in Rel-18.
3. Architrecture-3: Could be further checked in future meetings depending on the updated scope of Rel-18 or further considered in future releases.
4. Architrecture-4: Do not consider it for New-Type non-collocated deployment.

 |
| R4-2215890 | ZTE | Proposal 2. Same RF requirements with total 4Rx antennas should be applied for CA\_n77(2A)/n78(2A) and ENDC 42-n77/n78 type 3 UE supporting non-collocated scenario.Proposal 3. The RF architecture with total 4Rx antennas with 8Rx chain (4 layer/4Rx chain per CC, total 8Rx chain) can be seen as an alternative. Proposal 4: Whether or not supporting total 8Rx antennas is FFS. |
| R4-2216132 | vivo | Observation 1: Either 1 dB relaxation or 25 dB power imbalance is not affected by MIMO layer number.Proposal 1: For the “New Type UE” that support 4-layer MIMO, the 4Rx chain per CC can be the baseline for the reference architecture.Proposal 2: For NR CA 4-layer MIMO case, 1 dB relaxation with 25 dB power imbalance still can be reused.  |

## Open issues summary

### Sub-topic 2-1 : UE RF architecture on new Type UE

*Sub-topic description:*

R4-2215329 (Skyworks) propose the table on UE architecture for both EN-DC and Intra band NR-CA scenario and that “Type 3” UE Architecture with 4 shared antennas and 4 shared LNAs (shared LNA AGC) is studied and specified for smartphone implementations. And then, R4-2215736 (Samsung) propose as P3 to discuss the feasibility of 4 possible UE architectures for New Type UE capable of supporting maximum 4 layer per cc, and also propose as P4 that one architecture could be considered in Rel-18 and other two architectures could be considered in future release.

R4-2215890 (ZTE) propose as P3 that the RF architecture with total 4Rx antennas with 8Rx chain (4 layer/4Rx chain per CC, total 8Rx chain) can be seen as an alternative. Whether or not supporting total 8Rx antennas is FFS. Finally, R4-2216132 (vivo) propose as P1 that for the “New Type UE” supporting 4-layer MIMO, the 4Rx chain per CC can be the baseline for the reference architecture.

In moderator’s view, the above proposals from companies are somehow aligned and not contradict with each other. Considering the proposed architectures from Samsung, ZTE and vivo are all covered in the table proposed from Skyworks, moderator suggests to use Skyworks’ table for architecture and RF requirement discussion. In addition, considering the 8Rx (8 antenna) for FWA is still under discussion in FR1\_enh WI and 6Rx is not in scope of Rel-18 as of now, the group’s confirmation is required on whether the term “Type-3a/3b” could be used in Rel-18 to indicate UE supporting non-collocated deployment with maximum 2 or 4 MIMO layer for LTE CC and maximum 4 MIMO layer for NR CC, as well as whether “Type-4a/4b” could be considered in future releases. Alignments on other terminology may also be needed.

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: Possible UE RF architecture candidates on new Type UE**

* Proposal
	+ Discuss the following possible UE architecture candidates and name “3a/3b” and “4a/4b” for EN-DC/NR-CA New Type UE capable of supporting maximum 4 layer per CC for NR band and maximum 2 or 4 layer per CC for LTE band in study phase.
		- The UE Type 1 and 2 has been already defined in RAN4 specification, therefore they are not discussion point here.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UE****Type** | **Band** | **antenna/ LNA** | **Mixer** | **Analog****BB** | **#Rx** | **HW** | **power****imbalance** | **comment** |
| **1** | 1 | 4shared | 4shared | 4shared | 4Rx | 0.9x | 6dBfull range | Baseline architecture (i.e. legacy architecture) |
| 2 | 4Rx |
| **2** | 1 | 2 | 4total | 2 | 2 | 2Rx | 1x | 25dBfull range | Reuse of baseline architecture restricted to 2Rx/band but need 2LO frequencies |
| 2 | 2 | 2 | 2 | 2Rx |
| **3a** | 1 | 4shared | 4 | 4 | 4Rx | 1.2x | [25]dBpartial range | Reuse of baseline RFFE architecture adding RF split after 2 LNAs + 1BB/Rx => common AGC on LNA => 25dB only for some range |
| 2 | 2 | 2 | 2Rx |
| **3b** | 1 | 4shared | 4 | 4 | 4Rx | 1.4x | [25]dBpartial range | Reuse of baseline RFFE architecture adding RF split after 2 LNAs + 1BB/Rx => common AGC on LNA => 25dB only for some range |
| 2 | 4 | 4 | 4Rx |
| **4a** | 1 | 4 | 6total | 4 | 4 | 4Rx | 1.5x | 25dBfull range | Requires 6 antennas and LNA => is it compatible with smartphone? (for which frequency range) |
| 2 | 2 | 2 | 2 | 2Rx |
| **4b** | 1 | 4 | 8total | 4 | 4 | 4Rx | 2x | 25dBfull range | Requires 8 antennas and LNA => is it compatible with smartphone? (for which frequency range) |
| 2 | 4 | 4 | 4 | 4Rx |

* Recommended WF
	+ TBA

**Issue 2-1-2: UE RF architecture on new Type UE**

* Proposals :
	+ Option 1: Firstly discuss and confirm the feasibility of UE Type 3a/3b in Rel-18 and discuss Type 4a/4b in later release
		- Type 3 UE Architecture with 4 shared antennas and 4 shared LNAs (shared LNA AGC) is studied and specified for smartphone implementations, that includes:
			* Necessary limitations or exceptions on dynamic range, REFSENS and blocking
			* FFS if imbalance < 25dB would allow larger dynamic range
			* Type 3a enabling 4Rx in one band and 2Rx in the other
			* Type 3b enabling 4Rx in one both bands
	+ Option 2: Discuss the feasibility of UE both Type 3a/3b and Type 4a/4b at the same time in Rel-18
* Recommended WF
	+ TBA

### Sub-topic 2-2 : RF requirements on new Type UE

*Sub-topic description:*

R4-2216132 (vivo) propose as P2 that for NR CA 4-layer MIMO case, 1 dB relaxation with 25 dB power imbalance still can be reused. On the other hand, R4-2215629 (Apple) propose that 4MIMO layer per CC with 25dB power imbalance is not feasible. Moderator propose to firstly discuss the UE RF architecture, and then discuss specific RF requirements, because this meeting is a first time to discuss the UE RF architecture for New Type UE.

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: RF requirements on new Type UE**

* Proposals
	+ Option 1: For 4layer MIMO case, 1 dB relaxation with 25dB power imbalance still can be reused
	+ Option 2: For 4layer MIMO case, 25dB power imbalance can’t be reused
	+ Option 3: Discuss RF requirements after progressing the UE RF architecture discussion
* Recommended WF
	+ TBA

### Sub-topic 2-3 : RRM requirements on new Type UE

*Sub-topic description:*

R4-2215673 (Qualcomm) propose to enable 4Layer MIMO on each CC only with MRTD< CP. On the other hand, moderator propose to discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan.

*Open issues and candidate options before e-meeting:*

**Issue 2-3-1: RRM requirements on new Type UE**

* Proposals
	+ Option 1: Discuss RRM requirements to enable 4layer MIMO on each CC only with MRTD<CP in this meeting
	+ Option 2: Discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Issue 2-1-1: Possible UE RF architecture candidates on new Type UE

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We agree with the proposals to study Type 3a/b and Type 4a/b |
| Samsung | Generally we agree with the table proposed by Skyworks and we are fine with the term “Type-3a/b”, “Type-4a/b”. It is suggested to confirm the feasibility of Type-3a/b in this meeting and define the corresponding requirements in Rel-18, Type-4a/b could be considered in future releases for FWA and/or smart phone depending on the progress and scope of Rel-18.From our understanding, Type-3a/4a are proposed for EN-DC only and Type-3b/4b for both EN-DC and NR-CA. The assumption for Type-3a/3b is 4 antennas in total, and the Chain (Rx Path) is partially shared between CCs due to the signal is splitted after the main LNA, we may do not need to argue it belongs to totally 4 Chains or 8 Chains (it is totally different with the 8Rx+8 antenna case in which the diversity Gain of 8 antenna should be considered given that Sensitivity is calculated from the antenna connector, meanwhile the main contributor for NF is the front-end), just assume 4 antennas in total and 4Rx Chain per CC (the Chain is partially shared between CCs) is fine. With Skyworks’s table, I assume the reference architecture is clear. It is also very friendly for smart phone implementation, more justification and interpretation could be found in our paper. |
| ZTE | In general we are also fine with Type 3a/3b and Type 4a/4b. But currently, 6Rx(type 4a) antenna is not supported in RAN4, and 8Rx(type 4b)antenna is under discussing and it is for FWA. So we can consider type 4a/4b in future. To define the RF requirement based on Type 3a/3b at this stage is fine. |
| Ericsson | We are not against 4 layer MIMO but prefer to prioritize the non-colocation aspect of WI and do 4 layer MIMO as second priority in WI. |
| Murata | Feasibility for Type 3 for UE (smart phone) and Type 4 UE (FWA) can be discussed. |
| SoftBank | Thank you very much for the helpful analysis. For option 3a/3b, we would like to know if there are the restrictions other than the power imbalance. For example, R4-2215736 analyzes the frequency separation between 2 CCs is also limited in some UE architectures. |
| Apple | We would like to confirm that “4MIMO layer per CC with 25dB power imbalance is not feasible for smart phone”.However, we are open for further discussion on the feasibility of 3a/3b UE reference architecture with reduced power imbalance or performance degradation for REFSENS.  |
| Vivo | Ok to study Type-3 and Type-4 UE, but the power imbalance is also related to the deployment, we afraid whether it is feasible to further reduce it. |
| Meta | We can use these UE RF architectures in the WI. Specially, we prefer to define the RF requirement based on Type 1,2 and 3a/3b only in Rel-18 based on option 1 in issue 2-1-2.  |
| Skyworks | We suggest to focus on type3a/3b and postpone Type 4a/4b to later (at least after 8Rx is finalized in R18). For type3a/3b the key is that the LNA and its AGC is shared thus the AGC cannot be optimum for the two bands/CCs one the LNA AGC is activated thus dynamic range for one of the signal is affected. This is what we propose to study. |
| KDDI | We also would like to clarify the restrictions other than power imbalance including the frequency separation between 2cc. As moderator, we proposed to add the frequency separation to the table proposed in Issue 2-1-1 toward 2nd round discussion. |
| Samsung | Thanks for the comment from Softbank and KDDI, we also welcome the discussion on FS restriction in 2nd round. |
| Huawei | We support 3a/3b at this stage and wait for 8Rx discussions for agreement on 4a/4b.As it is shared. As the LNAs are shared, surely some dynamic range restrictions could happen; let’s discuss more about them in the second round  |
| CHTTL | Thanks for Skyworks for the good summary table, we wonder whether type 4a is preferable to the companies, as the cost is higher and with reduce support on the MIMO layers compared with 3b, not sure the gain on the power imbalance support can be more attractive than the cons. Would like to hear other companies’ view on this if possible. |
| MediaTek | Type 4a/4b is better to be discussed in R19 as stated by moderator. Type 3a/3b UE is only applicable if intra-band MRTD requirement applies (3us). It would not be feasible as Apple stated if not applying intra-band requirement. |

|  |  |
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| KDDI | We also would like to clarify the restrictions other than power imbalance including the frequency separation between 2cc. As moderator, we proposed to add the frequency separation to the table proposed in Issue 2-1-1 toward 2nd round discussion. |

Issue 2-1-2: UE RF architecture on new Type UE

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We prefer Option 1. We could also prioritize Type 3a/3b and discuss Type 4a/4b after concluding the Tpe 3 discussion if there will be time left |
| Samsung | Option 1. As commented in Issue 2-1-1.In addition, perhaps is it better to say “Type 3b enabling 4Rx in ~~one~~ both ~~bands~~ CCs”? Since Type-3b is also applicable to Intra-band NR CA. To be aligned, maybe we could also say “Type 3a enabling 4Rx in ~~one band~~NR CC and 2Rx in ~~the other~~LTE CC”? The head of the table could be modified to “CC”, instead of “Band”, making the whole table suitable for both EN-DC and NR-CA. |
| ZTE | Option 1.  |
| Ericsson | We are not against 4 layer MIMO but prefer to prioritize the non-colocation aspect of WI and do 4 layer MIMO as second priority in WI. |
| SoftBank | We think that whether type 4b can be discussed in Rel-18 or not depends on the progress of WI: NR\_ENDC\_ RF\_FR1\_enh2 because type 4b needs 8 antenna ports.  |
| Apple | We propose to focus on the discussion of 2-1-1 at first.  |
| Vivo | ok with option 1 |
| Meta | Support option 1 |
| Skyworks | Option 1. Type 4x should wait for R18 8Rx conclusions anyhow. |
| KDDI | Whether 4b can be discussed in R18 depends on the progress of other R18 WI, and also, at least RAN4 cannot discuss 4b for a while. Considering that, we think that it seems to be realistic to prioritize 3a/3b. |
| Huawei | Support option1. @Moderator, It would be great to ask Chairman about the status of 8Rx in Rel18, if Chairman’s estimation is that the 8Rx will be included in the late stages ofRel 18, then we might focus only on 4Rx case in this WID and better analyze it from different aspects  |
| CHTTL | ok with option 1. |
| NTT DOCOMO | Option 3, We agree to prioritize type 3x. But we think it is premature to decide to postpone type 4x in later release. FFS whether type 4x will be discussed in Rel-18 or later release. |
| MediaTek | Option 1 |

Issue 2-2-1: RF requirements on new Type UE

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Most likely Option 1 will be agreeable but it would be good to conclude Option 3 first. |
| Samsung | Option3. Further consideration and investigation on power imbalance and REFSENS/ACS/blocking requirements is needed based on the agreed reference architecture. We suggest to confirm the feasibility of UE architecture in this meeting and further discuss the RF requirements accordingly in next meeting. 1)If power imbalance=25dB, the dynamic range is restricted with Type-3 architecture, whether relaxed ACS requirement/blocking requirement is needed 2)Whether to define ＜25dB power imbalance to allow larger dynamic range. |
| ZTE | Option 3. Pending on the RF architecture. |
| Ericsson | Option 1. But we give prio to non colocation part of WI. |
| Murata | Option 3. The requirement depends on whether UE signals Type 3 or Type 4 as well as the feasibility of Type 3. |
| SoftBank | We support Option 3. We think that the requirements depend on the UE RF architecture.  |
| Apple | Option 3. Actually, power imbalance also have impact on the UE architecture. It may be discussed together with the architecture as well. |
| Vivo | Our proposal (option 1) is for Type 4 UE, and we think the requirement should be same if each CC has independent Rx chain regardless of the layer number. We are ok with option 3 for further discussion. |
| Meta | Option 3 is reasonable approach for the power imbalance for 4MIMO layer per CC.  |
| Skyworks | It is to early to conclude based on Type3a/b as we need to assess the whether the LNA AGC is activated for some of the REFSENS and blocking cases. Option 3 with using 25dB imbalance and finding the impact of LNA AGC on the different Rx requirements. |
| KDDI | Option 3 |
| Huawei | We support option 3 |
| MediaTek | Fine with option 1. |

Issue 2-3-1: RRM requirements on new Type UE

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We believe the MRTD discussion is directly related to the RF architecture and UE Type discussion so it could be useful to discuss in parallel. |
| Samsung | Option 2. RRM session is a much more suitable place to handle this. |
| ZTE | Option 2. |
| Ericsson | Option 2. |
| Murata | It may be too soon to discuss this meeting pending the feasibility of Type 3. The MRTD requirement depends on whether UE signals Type 3 or Type 4. |
| Apple | Option 2 |
| Meta | Option 2 |
| Skyworks | Too early to discuss RRM until we have a full understanding of Type3a/b LNA common AGC impact on timings |
| KDDI | Option 2 |
| Huawei | Option 2 for better analysis. However we agree that MRTD <CP duration |
| MediaTek | Option 2. We also agree MRTD(<=3us) <CP duration |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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| --- | --- |
|  | **Status summary**  |
| **Sub-topic 2-1:****UE RF architecture on new Type UE** | **Issue 2-1-1: Possible UE RF architecture candidates on new Type UE***Tentative agreements:* NoneAll companies seem to agree with moderator to discuss possible UE RF architecture candidates based on the table based on Skyworks’s proposal (R4-2215329). And also, 2 operators support to analyze whether there are the restrictions except for power imbalance, for example, frequency separation between 2 CCs proposed by Samsung (R4-2215736).With regard to prioritization New UE Type among 3a/3b (4 antenna, 4Rx) and 4a (6 antenna, 6 Rx)/4b (8 antenna, 8Rx), 7 companies support to prioritize Type 3a/3b in Rel-18 and consider Type 4a/4b in future releases for FWA and/or smart phone or wait for Rel-18 8Rx conclusions, because 4a is not supported in RAN4, and also 4b is under discussing for only FWA as Rel-18 in parallel. Huawei suggest to ask Chairman about the status of Rel-18 8Rx. In addition, Apple specifically ask to confirm that “4MIMO layer per CC with 25dB power imbalance is not feasible for smart phone”. And also, Ericsson prefer to prioritize the non-colocation aspect of WI and do 4 layer MIMO as second priority in WI.*Candidate options:**Recommendations for 2nd round:*The moderator propose to * Add frequency separation and NR-CA/EN-DC columns to the table of UE RF architecture candidates proposed in 1st round as follows
* Continuously discuss and agree the following table
	+ Check whether there are other restrictions except for power imbalance. If some other restrictions are found in 2nd round, Moderator will add them to the table immediately
* Prioritize Type 3a/3b discussion for 4MIMO layer in Rel-18.
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| **UE****Type** | **CC#** | **antenna/ LNA** | **Mixer** | **Analog****BB** | **#Rx** | **Frequency****Separation****between 2cc** | **NRCA/ENDC** | **power****imbalance** | **comment** |
| **1** | 1 | 4shared | 4shared | 4shared | 4Rx | ≤ X MHz | NRCA,ENDC | 6dBfull range | Baseline architecture (i.e. legacy architecture) |
| 2 | 4Rx |
| **2** | 1 | 2 | 4total | 2 | 2 | 2Rx | No limitation or ≤ X MHz | NRCA,ENDC | 25dBfull range | Reuse of baseline architecture restricted to 2Rx/band but need 2LO frequencies |
| 2 | 2 | 2 | 2 | 2Rx |
| **3a** | 1 | 4shared | 4 | 4 | 4Rx | No limitation or ≤ X MHz | ENDC | 6<P≤25dBpartial range | Reuse of baseline RFFE architecture adding RF split after 2 LNAs + 1BB/Rx => common AGC on LNA => 25dB only for some range |
| 2 | 2 | 2 | 2Rx |
| **3b** | 1 | 4shared | 4 | 4 | 4Rx | No limitation or ≤ X MHz | NRCA,ENDC | 6<P≤25dBpartial range | Reuse of baseline RFFE architecture adding RF split after 2 LNAs + 1BB/Rx => common AGC on LNA => 25dB only for some range |
| 2 | 4 | 4 | 4Rx |
| **4a** | 1 | 4 | 6total | 4 | 4 | 4Rx | No limitation or ≤ X MHz | ENDC | 25dBfull range | Requires 6 antennas and LNA => is it compatible with smartphone? (for which frequency range), FWA only |
| 2 | 2 | 2 | 2 | 2Rx |
| **4b** | 1 | 4 | 8total | 4 | 4 | 4Rx | No limitation or ≤ X MHz | NRCA,ENDC | 25dBfull range | Requires 8 antennas and LNA => is it compatible with smartphone? (for which frequency range), FWA only |
| 2 | 4 | 4 | 4 | 4Rx |

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| **Sub-topic 2-1:****UE RF architecture on new Type UE** | **Issue 2-1-2: UE RF architecture on new Type UE***Tentative agreements:* None9 companies (Qualcomm/Samsung/ZTE/vivo/Meta/Skyworks/KDDI/Huawei/CHTTL/MediaTek) support Option 1. And also, Samsung propose to modify the head of the table from “Band” to “CC”. On the other hand, Ericsson prefer to prioritize the non-colocation aspect of WI and do 4 layer MIMO as second priority in WI. 2 companies (SoftBank/Docomo) mention that whether Type 4a/4b can be considered in Rel-18 is FFS.The moderator propose to merge a topic on prioritization among UE Type 3a/3b and 4a/4b in Issue 2-1-1 and focus on specific topics in this Issue 2-1-2.*Candidate options:**Recommendations for 2nd round:*Moderator propose to discuss the following items in case of Type 3a/3b with 4 shared antennas and 4 shared LNAs (shared LNA AGC) for smartphone,* Necessary limitations or exceptions on dynamic range, REFSENS and blocking
* FFS if imbalance < 25dB would allow larger dynamic range
* Type 3a enabling 4Rx in one CC and 2Rx in the other CC for EN-DC
* Type 3b enabling 4Rx in one both CCs for NR-CA and EN-DC
 |
| **Sub-topic 2-2:****RF requirements on new Type UE** | **Issue 2-2-1: RF requirements on new Type UE***Tentative agreements:* Option 310 companies (Qualcomm/Samsung/ZTE/Murata/SoftBank/Apple/Meta/Skyworks/KDDI/Huawei) support Option 3, because they mention that further consideration and investigation on power imbalance and REFSENS/ACS/blocking requirements is needed based on the agreed reference architecture. On the other hand, 3 companies (Ericsson/vivo/MediaTek) support Option 1. Ericsson prefer to prioritize non-colocation part of WI, and also vivo can accept Option 3 for further discussion. *Candidate options:** Proposals
* Option 1: Discuss RF requirements after progressing the UE RF architecture discussion
* Option 2: For 4layer MIMO case, 1 dB relaxation with 25dB power imbalance still can be reused

*Recommendations for 2nd round:*Moderator propose to support Option 1. |
| **Sub-topic 2-3:****RRM requirements on new Type UE** | **Issue 2-3-1: RRM requirements on new Type UE***Tentative agreements:* Option 210 companies (Samsung/ZTE/Ericsson/Murata/Apple/Meta/Skyworks/KDDI/Huawei/MediaTek) support Option 2, because too early to discuss RRM until we have a full understanding of Type3a/b. On the other hand, Qualcomm support Option 1 and they mention that the MRTD discussion is directly related to the RF architecture and UE Type discussion so it could be useful to discuss in parallel. *Candidate options:** Proposals
* Option 1: Discuss RRM requirements to enable 4layer MIMO on each CC only with MRTD<CP in this meeting
* Option 2: Discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan

*Recommendations for 2nd round:*Moderator propose to support Option 2. |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provided recommendation on CRs/TPs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

### Sub-topic 2-1 : UE RF architecture on new Type UE

*Open issues and candidate options before 2nd round:*

**Issue 2-1-1: Possible UE RF architecture candidates on new Type UE**

Proposals:

* Add frequency separation and NR-CA/EN-DC columns to the table of UE RF architecture candidates proposed in 1st round as follows
* Continuously discuss and agree the following table
	+ Check whether there are other restrictions except for power imbalance. If some other restrictions are found in 2nd round, Moderator will add them to the table immediately
* Prioritize 3a/3b discussion for 4MIMO layer in Rel-18.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UE****Type** | **CC#** | **antenna/ LNA** | **Mixer** | **Analog****BB** | **#Rx** | **Frequency****Separation****between 2cc** | **NRCA/ENDC** | **power****imbalance** | **comment** |
| **1** | 1 | 4shared | 4shared | 4shared | 4Rx | ≤ X MHz | NRCA,ENDC | 6dBfull range | Baseline architecture (i.e. legacy architecture) |
| 2 | 4Rx |
| **2** | 1 | 2 | 4total | 2 | 2 | 2Rx | No limitation or ≤ X MHz | NRCA,ENDC | 25dBfull range | Reuse of baseline architecture restricted to 2Rx/band but need 2LO frequencies |
| 2 | 2 | 2 | 2 | 2Rx |
| **3a** | 1 | 4shared | 4 | 4 | 4Rx | No limitation or ≤ X MHz | ENDC | 6<P≤25dBpartial range | Reuse of baseline RFFE architecture adding RF split after 2 LNAs + 1BB/Rx => common AGC on LNA => 25dB only for some range |
| 2 | 2 | 2 | 2Rx |
| **3b** | 1 | 4shared | 4 | 4 | 4Rx | No limitation or ≤ X MHz | NRCA,ENDC | 6<P≤25dBpartial range | Reuse of baseline RFFE architecture adding RF split after 2 LNAs + 1BB/Rx => common AGC on LNA => 25dB only for some range |
| 2 | 4 | 4 | 4Rx |
| **4a** | 1 | 4 | 6total | 4 | 4 | 4Rx | No limitation or ≤ X MHz | ENDC | 25dBfull range | Requires 6 antennas and LNA => is it compatible with smartphone? (for which frequency range), FWA only |
| 2 | 2 | 2 | 2 | 2Rx |
| **4b** | 1 | 4 | 8total | 4 | 4 | 4Rx | No limitation or ≤ X MHz | NRCA,ENDC | 25dBfull range | Requires 8 antennas and LNA => is it compatible with smartphone? (for which frequency range), FWA only |
| 2 | 4 | 4 | 4 | 4Rx |

**Issue 2-1-2: UE RF architecture on new Type UE**

Proposals:

* Discuss the following items in case of Type 3a/3b with 4 shared antennas and 4 shared LNAs (shared LNA AGC) for smartphone,
	+ Necessary limitations or exceptions on dynamic range, REFSENS and blocking
	+ FFS if imbalance < 25dB would allow larger dynamic range
	+ Type 3a enabling 4Rx in one CC and 2Rx in the other CC for EN-DC
	+ Type 3b enabling 4Rx in one both CCs for NR-CA and EN-DC

### Sub-topic 2-2 : RF requirements on new Type UE

*Open issues and candidate options before 2nd round:*

**Issue 2-2-1: RF requirements on new Type UE**

Proposal

* Discuss RF requirements after progressing the UE RF architecture discussion

*Recommendations for 2nd round:*

Check whether to accept the moderator’s proposal.

### Sub-topic 2-3 : RRM requirements on new Type UE

*Open issues and candidate options before 2nd round:*

**Issue 2-3-1: RRM requirements on new Type UE**

Proposal

* Discuss RRM requirements in RRM session in RAN4#105 meeting according to work plan

*Recommendations for 2nd round:*

Check whether to accept the moderator’s proposal.

## Companies views’ collection for 2nd round

### Open issues

**Issue 2-1-1: Possible UE RF architecture candidates on new Type UE**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Open for feasibility discussion on for 3a/3b |
| KDDI | Support moderator’s proposals |
| Qualcomm | We are fine to prioritize 3a/3b |
| Meta | Support the moderator’s proposals |
| SoftBank | We are fine with the moderator’s proposals.  |
| Samsung | We support moderator’s proposal. And also thanks very much for moderator’s great efforts on merging the new Table. About the FS, we have some initial analysis but do not have explicit proposal in this meeting, we would like to have more input in next meeting, and we welcome other vendors feedback on FS as well. |
| Huawei | We are fine with the proposal with an emphasize on prioritizing 3a/3b architectures |
| Ericsson | Support moderator’s proposals |
| NTT DOCOMO | We support the moderato’s proposal. OK to prioritize 3a/3b. |
| Skyworks | Support to prioritize 3a/3b |

**Issue 2-1-2: UE RF architecture on new Type UE**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Open for feasibility discussion for 3a/3b |
| KDDI | Support moderator’s proposals |
| Qualcomm | We are mostly fine with the proposals but we are not sure about the 2nd bullet “FFS if imbalance <25dB would allow larger dynamic range”. This could lead to a long discussion and very complicated requirements. We should de-prioritize this part and only discuss it after settling on all the other requirements. |
| Meta | Support the moderator’s proposal |
| SoftBank | We are fine with the moderator’s proposals. |
| Samsung | We support moderator’s proposal. Question to Qualcomm: We would like to further understand why it leads to a long discussion and very complicated requirements? From RF aspect or RRM aspect? Further clarification is appreciated. |
| Huawei | Logically, if the power imbalance is reduced, the received power difference of the component carrier will be reduced, which means, more gains can be applied to the weakest CC (better dynamic range) however power imbalance of 25 dB was decided based on multiple studies including different aspects (REFSENS, and pathloss) on Rel17/18, so it is better to stick to it. |
| Ericsson | Support moderator’s proposals |
| Skyworks | Support moderator’s proposals. To Qualcomm: Agree to start with 25dB imbalance and see resulting limitations. Based on those we can further look is some relaxation would help later. |

**Issue 2-2-1: RF requirements on new Type UE**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Support moderator’s recommendation. |
| KDDI | Support moderator’s proposal |
| Qualcomm | We agree |
| Meta | Support the moderator’s proposal |
| SoftBank | We are fine with the moderator’s proposal. |
| Samsung | We support moderator’s proposal |
| Huawei | We support it |
| Ericsson | Support moderator’s proposals |
| Skyworks | Agree |

**Issue 2-3-1: RRM requirements on new Type UE**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Support moderator’s recommendation |
| KDDI | Support moderator’s proposal |
| Meta | Support the moderator’s proposal |
| SoftBank | We are fine with the moderator’s proposal. |
| Samsung | We support moderator’s proposal. |
| Huawei | We support it |
| Ericsson | Support moderator’s proposals |
| Skyworks | We think that it is important that before starting in RRM for this, we need to provide constraints on shared AGC in the LNA in RF session first |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
|  | WF on NonCol\_intraB\_ENDC\_NR\_CA for NR-CA Type-2 UE | KDDI | Capture all the agreements for NR-CA Type-2 UE |
|  | WF on NonCol\_intraB\_ENDC\_NR\_CA for NR-CA and EN-DC New Type UE | KDDI | Capture all the agreements for NR-CA and EN-DC New Type UE |

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2215329 |  | Architecture enabling 4Rx for non-collocated overlapping bands | Skyworks Solutions, Inc. | Noted |  |
| R4-2215629 |  | Further consideration on intra-band non-collocated CA/EN-DC | Apple | Noted |  |
| R4-2215673 |  | Issues for Non-collocated Deployments with 4Layers per CC | Qualcomm Incorporated | Noted |  |
| R4-2215736 |  | Views on UE RF aspect for non-collocated EN-DC, NR-CA deployment | Samsung | Noted |  |
| R4-2215790 |  | Discussion on the power imbalance requirement for Type-2 non-collocated intra-band NR-CA | KDDI | Noted |  |
| R4-2215827 |  | Clarifications on 2-Layer UE architecture Baseline | Huawei Technologies France | Noted |  |
| R4-2215890 |  | Further discussion on non-collocated EN-DC and NR-CA | ZTE Corporation | Noted |  |
| R4-2216132 |  | Discussion on feasibility of 4-layer MIMO under non-collocated deployment | vivo | Noted |  |
| R4-2216425 |  | On required arrival time difference between CCs | Ericsson | Noted |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents