**3GPP TSG-RAN WG4 Meeting # 100-e R4-2114712**

**Electronic Meeting, 16th – 27th August, 2021**

**Agenda item:** 8.33

**Source:** Dominique Brunel (Skyworks)

**Title:** Email discussion summary for [100-e][112] NR\_Baskets\_Part\_1 Round 1

**Document for:** Information

# Introduction

Email discussion for contributions submitted under agenda item 8.6 Issues arising from basket WIs but not subject to block approval, and additional documents submitted to NR band combination baskets that require discussion.

List of candidate target of email discussion for 1st round and 2nd round

* 1st round: Discussion and potential and approval of CRs. Proposals for way forward.
* 2nd round: Finalization of CRs and way forwards.

Topics:

1. LB-LB-LB and LB-LB combinations
2. Improved MSD study
3. Band combinations corrections for FR1 and FR2
4. NR-U contiguous UL CA
5. NR intra-band UL CA

V02: addition of n5B MSD paper, addition of one “low MSD” paper

# Topic #1: LB-LB-LB and LB-LB combinations and IMD due to intra-band UL CA

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2111731**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111731.zip)DC\_8A\_20A\_n28A MSD | Qualcomm Incorporated | based on 3LB antenna architecture. **Proposal 1: Use 23.5dB MSD as shown in Table 1.** |
| [**R4-2112018**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112018.zip)Further discussion on MSD due to UL IMD for DC\_8A-20A\_n28A | MediaTek Inc | based on 3LB antenna architecture, **MSD (5MHz BW) 23.7 dB"** |
| [**R4-2113404**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113404.zip)Discussion on DC\_8A-20A\_n28A | Huawei, HiSilicon | based on 3LB antenna architecture, **MSD B8 (5MHz BW) 14.8 dB** |
| [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip) TP for TR 37.717-21-11: DC\_8A-20A\_n28A | Huawei, HiSilicon | Moderator comment: can revise and co-author the TP based on agreements between companies |
| [**R4-2114582**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114582.zip) DC\_8-20\_n28 and other LB-LB-LB RF-FE challenges | Skyworks Solutions Inc. | **Proposal: Consider restriction of DC\_8-20\_n28 operation to FWA form factor devices only. FFS which of architecture #1 or architecture #2 provides the best complexity / performance trade-off and completion of B8 MSD due to IMD3.**Observation 4: Further clarification is needed for requested operation of CA\_n5-n8-n28, in particular how n5 Rx band overlap with n8 Tx band can be resolved. |
| [**R4-2113344**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113344.zip)Discussion on UE RF requirements for DC\_20-38\_n8 | VODAFONE Group Plc | **No additional MSD required for 2nd order harmonic hit on band 38 compared to CA\_8A-20A-38A in 36101.**Need input on IMD3 hit on band 38 from DC\_20\_n8 UL. IMD5 hits on bands 8 and n38 require no additional MSD compared to DC\_8\_n41.Need input on band 20 IMD3 hit from DC\_38\_n8 UL. |
| [**R4-2112017**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112017.zip) Further discussion on MSD due to IMD5 for CA\_n41C-n66A | MediaTek Inc. | **Moderator: adding missed contribution****Propose to revise MSD for separate antenna at [32.5]** |

## Open issues summary

### Sub-topic 1-1

**Issue 1-1a: DC\_8A-20A\_n28A IMD3 related B8 MSD**

* Proposals
	+ Qualcomm (R4-2111731) and MediaTek (R4-2112018): 23.5/23.7dB respectively
	+ Huawei (R4-2113404): 14.8dB
* Recommended WF
	+ Two companies have very close values
	+ Agree on assumptions and MSD value

**Issue 1-1b: DC\_8A-20A\_n28A restriction to FWA and valid architectures (R4-2114582)**

* Proposals:
	+ Consider restriction of DC\_8-20\_n28 operation to FWA form factor devices only
	+ Which architecture to specify: 3 low band antenna only or 2 LB antenna also?
* Recommended WF
	+ Agree on how to capture restriction to FWA and/or architecture assumptions

### Sub-topic 1-2

**Issue 1-2: CA\_n5-n8-n28 (R4-2114582)**

* Proposals: Clarify operation of CA\_n5-n8-n28, in particular how n5 Rx band overlap with n8 Tx
* Recommended WF
	+ Proponent to provide input

### Sub-topic 1-3

**Issue 1-3: CA\_DC\_20-38\_n8 (R4-2113344)**

* Proposals:
	+ No additional MSD required for 2nd order harmonic hit on band 38 compared to CA\_8A-20A-38A in 36101.
* Recommended WF
	+ Agree on H2 MSD
	+ Encourage companies to provide input on IMD3 MSD to B38 and B20 for WF/TP

### Sub-topic 1-4

**Issue 1-4: CA\_n41C-n66A (R4-2112017)**

* Proposals:
	+ Change IMD5 MSD to [32.5] dB
	+ Keep existing value
* Recommended WF
	+ Companies to provide input on proposal

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | **Issue 1-a**: MSD values are very close, could agree to either. R4-2112018: question for clarification: Is block diagram meant to represent quadplexing of B8 and B20?R4-2113404: question for clarification: in Table 3, is -73.47 dBm the combined REFSENS due to IMD3 ? In which case, the level is very close to R4-2111731 and to R4-2112018 and so the MSD should also be very close to 23.5dB.**Issue 1-b:*** Restriction to FWA-like large form factor for DC\_8-20\_n28 operation
* For FWA large form factor, penta-plexer may be realizable and should be further studied to evaluate the performance of each architecture.
 |
| Huawei | **Issue 1-a**: To Skyworks, -73.47 dBm is the total interference for main path or diversity path. Considering MRC gain, 20dB MSD can be considered.Issue 1-b: Not sure whether it’s meaningful to restrict the FWA-like large form factor for DC\_8-20\_n28 in RAN4’s spec since all the band combination can be reported by UE capability without implementation restriction. |
| MediaTek | **Issue 1-a**: To Skyworks, yes, the block diagram was using Quadplexer of B8 and B20.**Issue 1-b:** Not sure the restriction for FWA device is needed. Three LB antennas is possible for larger form factor devices such as > 6-inch screen smart phone. For < 6-inch screen devices, agree with observations in R4-2114582. |
| Qualcomm | Issue 1-a: R4-2113404 MSD should be ~23dB according to analysis that was presented. In which case we can agree on the MSD as ~23.5dB.Issue 1-b: We are open to analyze MSD for alternative architecture with pentaplexer and investigate the performance delta if any |

 Sub topic 1-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | If no further input from proponent on how to deal with n5 and n8 overlap, that combination should be removed from the basket. |
| Qualcomm | We need some time to analyse this combination. Suggest WF. We agree with concern addressed by Skyworks. |

Sub topic 1-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | **Issue 1-3: CA\_****DC\_20-38\_n8 (R4-2113344)**For B38 MSD due to B20 Tx harmonics. There is a typo in TP as the harmonic order is not H2 but H3. The B38 MSD due to B20 H3 is already captured for DC\_20\_n38 in 38.101-3. So, this MSD does not need to be specified.MSD analysis can be presented at next meeting for IMD3 related MSDs of B38 and B20. |
| Huawei | **Issue 1-3: CA\_DC\_20-38\_n8 (R4-2113344)**The MSD due to IMD for DC\_7A-20A\_n8A in Table 7.3B.2.3.5.2-1 can be reused for DC\_20-38\_n8. |
| Qualcomm | IMD3 in B20 and 2 IMD3's in Band 38. Need to analyse IMD3 due to reverse IMD of B20 and n8 TX. Consider 20\_8 Quadplexer on single LB antenna. Next meeting. Cobine in WF. |

Sub topic 1-4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MediaTek | As discussion in our contribution, RAN4 spec need to accommodate different implementation. We suggest change IMD5 MSD to [32.5] dB |
| Skyworks | We are fine to accommodate different implementation and change to [32.5] and keep brackets for now |
| Qualcomm | Our preference is to change value to 32.5dB based on dual antenna. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip) TP for TR 37.717-21-11: DC\_8A-20A\_n28A | Moderator input: review in round 1 for structure/text, will be used in Rd2 to collect agreements on MSD and FWA/architecture restrictions |
| Skyworks: In addition to REFSENS proposals of sub-topic 1-1, restriction of operation to FWA-like large form factor needs to be captured in TP for TR. |
| MediaTek: Antenna design and device form factor are implementation dependent. Agree with Skyworks that such consideration need to be captured in the TP for TR. |

## 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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1.1** | *Issue 1-1a: DC\_8A-20A\_n28A IMD3 related B8 MSD* There is consensus to use 23.5dB MSD for the 3 antenna case*Issue 1-1b: DC\_8A-20A\_n28A restriction to FWA and valid architectures* 2 antenna architecture with pentaplexer is also welcome for analysis and there is split views on FWA restriction but agreement that form factor has an influence to be able to fit 3LB antennas*Tentative agreements:*MSD is 23.5dB for the 3 antenna case. Pentaplexer case can be further analysed. Moderator suggests that the 3 antenna MSD is used in the spec and may be revised only if needed from pentaplexer study which can anyhow be captured in TR later*Candidate options:*For FWA limitation: can be discussed further but at least some form factor limitation may be recognized in a note for the 3 LB antenna aspects.*Recommendations for 2nd round:* TP from Huawei can capture agreed MSD value in [] and co-sourcing if any. Any Note associated to form factor limitation in TS or TR can be captured there based on 2nd round discussion |
|  | **Status summary**  |
| **Sub-topic #1.2** | Issue 1-2: CA\_n5-n8-n28 (R4-2114582)No input from proponents and more time needed. Suggest to close in this meeting and come back next meeting if any new input but n5 and n8 overlap is an issue that seems unsolvable*Tentative agreements:**Candidate options:**Recommendations for 2nd round:* close the discussion and come back next meeting |
|  | **Status summary**  |
| **Sub-topic #1.3** | Issue 1-3: CA\_DC\_20-38\_n8 (R4-2113344)Consensus that work is needed for next meeting but it could be useful to have a WF. Note that higher order combination are stalled due to this one *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* create WF to align architecture assumptions |
|  | **Status summary**  |
| **Sub-topic #1.4** | Issue 1-4: CA\_n41C-n66AThere is consensus amongst experts that the spec can capture the MSD based on dual antenna architecture at 32.5dB*Tentative agreements:**Candidate options:**Recommendations for 2nd round:* CR to modify MSD value to 32.5dB |

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip) TP for TR 37.717-21-11: DC\_8A-20A\_n28A | To be revised: TP from Huawei can capture agreed MSD value in [] and co-sourcing if any. Any Note associated to form factor limitation in TS or TR can be captured there based on 2nd round discussion |
| New Tdoc | Request CR to R17 38.101-1 to capture IMD5 MSD for CA\_n41C-n66A for MediaTek |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on REFSENS assumptions for DC\_20-38\_n8 | Vodafone |

## Discussion on 2nd round (if applicable)

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| Revision of [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip) TP for TR 37.717-21-11: DC\_8A-20A\_n28A | Company XXX |
|  |
|  |
| CR to R17 38.101-1 to capture IMD5 MSD for CA\_n41C-n66A | Company XXX |
|  |
|  |

### WF comments collection

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

|  |  |
| --- | --- |
| **WF** | **Comments collection** |
| WF on REFSENS assumptions for DC\_20-38\_n8 | Company XXX |
|  |
|  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Improved MSD Study

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2112381**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112381.zip)Views on defining “low MSD” for CA and DC | Apple | Observation 1: It would not be uncommon to observe a randomly selected phone to have a substantially better performance than the specified MSD requirement under typical condition as the 3GPP MSD requirement would be at the tail end of the statistical distribution.Observation 2: To reduce MSD caused by Tx 2nd order harmonic to below 10 dB, the antenna isolation needs to be better than 20 dB in conjunction with PCB isolation higher than 85 dB.Observation 3: MSD in the range of 20 to 30 dB does not only appear in certain CA or DC combinations. In some FDD bands, such as n8 and n71, the desensitization level can very well be above 20 dB for wider channel BW.Observation 4: With defining two sets of MSD requirements and only a subset of UEs is expected to support the optional set, the performance gain for the network is uncertain.Observation 5: Maintaining one set of requirements with practical MSD improvement would motivate UE vendors to tighten but not outstretch their device performance which could potentially provide better overall link performance and shall benefit the entire cellular network ecosystem in the long run.**Proposal 1: Further clarifications are needed on how network would handle UE differently before the consideration of UE capability introduction.****Proposal 2: Keep one set of MSD requirements and specify MSD with practical device performance improvement for the new combinations going forward.** |
| [**R4-2112572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112572.zip)Discussion on low MSD feasibility | Samsung | Observation 1: CA and DC between band 2/3 (1.8/1.9GHz) and 77/78 (3.5GHz) is a possible candidate as example band combinations which addresses MSD due to both harmonic and IMD.**Proposal 1: low MSD feasibility should be confirmed by both conductive measurement and radiative measurement.** |
| [**R4-2112587**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112587.zip)Views on Low MSD indicator for IMD | SoftBank Corp. | [Observation-1] A NodeB is expected to utilize the low MSD indicator for scheduling RB combination under high MSD, with controlling Tx powers of 2UL. Otherwise, the low MSD indicator would be meaningless.[Observation-2] Better coupling loss could be archived for some combos.[Observation-3] The impedance matching/PA gain at an aggressor frequency would be worse.[Observation-4] The MSD fluctuations discussed here might differ implementation by implementation and hard to estimate during standardization process or minimum requirement context.[Observation-5] It looks pragmatic to define “low MSD” as a UE capability.[Observation-6] Having said that, as an operator, we will highly appreciate any efforts seeking for MSD improvement.  |
| [**R4-2113015**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113015.zip) Discussion on "Low MSD" for CA and DC | vivo | **Proposal: Though already feasible to have significant MSD improvement for some type of interference in certain band combination, it is still not that feasible to specify general “low MSD” requirements for large number of CA and DC band combinations.** |
| [**R4-2114223**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114223.zip)Signaling low MSD for CA and DC combinations | Qualcomm Incorporated | **Proposal: “Low MSD” is specified as [6] dB for those band combinations where the current MSD is 10 dB or higher and [0] dB for those band combinations where the current MSD is below 10 dB.Proposal: Low MSD capability signaling is per band combination.** |
| [**R4-2114567**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114567.zip)Discussion on the feasibility of MSD improvement | Huawei, HiSilicon | **Proposal 1: RAN4 needs to further clarify and agree on the scope and methodology of the study.** |
| [**R4-2114570**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114570.zip) Discussion on defining ”low MSD” for NR CA and DC band combinations | CHTTL | In general, based on the discussion above, we think **defining “low MSD” with an additional optional per band combination capability is feasible, and whether per MSD type is also needed under per band combination can be further discussed.** |
| [**R4-2114578**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114578.zip)Selection Criteria for CA/DC candidates eligible to improved MSD | Skyworks Solutions Inc. | **Proposal: To reduce workload associated with possible MSD improvements studies, CA or DC combinations should at least fulfil the following conditions. Only consider CA/DC combinations for which:- MSD exceeds 20dB and impacts an operator real-world deployment configuration,- MSD is dominated by PCB isolation or harmonic rejection.Any text proposal that proposes an improved MSD should not be subject to the automatic basket approval process.**Observation 2: A technical report capturing the improved MSD levels for eligible CA/DC candidates may be sufficient to address the concerns raised on the topic “low MSD” for CA and DC. |
| [**R4-2113906**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113906.zip)R17 MSD improvement | OPPO | Observation 1: MSD reporting is meaningful only if the improvement is large, otherwise, doesn’t change status in the field.Observation 2: No officially defined component values in MSD calculation, and improve the MSD by review the component performance might not be easy.Observation 3: If 1:1 gain can be derived from PCB isolation improvement, then the discussion can focus on how much PCB isolation can be achieve in commercial UE design.**Proposal 1: It is proposed to review the PCB isolation that commercial UEs can achieve by measurements or other justifications.****Proposal 2: It is proposed to agree on how much MSD improvements could be considered as meaningful improvement and deserve the MSD reporting.** |

## Open issues summary

Moderator input: In general it seems that better common understanding about the scope, the definition and operation of ”low MSD” and/or its associated capability is needed to progress in the topic before entering in the ”low MSD” numbers.

In round one these needs to be clarified and agreed. Only after that need and definition of capability is discussed

### Sub-topic 2-1

**Issue 2-1: Scope of “low/improved” MSD**

* Proposals (moderator input, based on the different proposals but enlarged to look at the entire scope)
	+ Only CA/DC
	+ PC3 and/or PC2
	+ “low MSD” should be applicable/confirmed for both conducted and radiated measurements
	+ Harmonics, harmonic mixing, IMD, triple beat, cross band related
	+ Only MSD above 20dB corresponding to real world deployment dominated by PCB isolation or harmonic rejection
	+ Only large (meaningful) MSD improvement should be considered based on improved PCB isolation assessment
	+ Only new combinations
	+ Any combination with a default “low MSD” value depending on the reference MSD
	+ Any other input on scope
* Recommended WF
	+ Companies provide their view on their preferred approach in round1 in view of a WF in round 2
	+ Specific feedback on values and/or threshold proposed is welcomed but can be captured in 2-5

### Sub-topic 2-2

**Issue 2-1: Specification of “low/improved” MSD**

* Proposals (moderator input, list based on the different proposals)
	+ Keep one set of MSD requirements and specify MSD with practical device performance improvement for the new combinations going forward.
	+ Technical report capturing the improved MSD levels for eligible CA/DC candidates
	+ A default “low MSD” is defined versus an MSD threshold
	+ Any other input on how to specify
* Recommended WF
	+ Companies provide their view on their preferred approach in round1 in view of a WF in round 2

### Sub-topic 2-3

**Issue 2-3a: Network use of “low MSD”**

* Aspects to be clarified (moderator input, list based on the different documents)
	+ Will the network use the indication to enabled scheduler restrictions
		- For allocations for “reference MSD” UEs
		- To restrict the use of combinations to For allocations for “reference MSD” UEs
		- Any other input on how “reference MSD” and “low MSD” UEs will be treated by the network
	+ Is the indication useful if only a limited set of UEs support the improved MSD
	+ Is the indication useful if only a majority of UEs support the improved MSD
	+ NodeB is expected to utilize the low MSD indicator for scheduling RB combination under high MSD, with controlling Tx powers of 2UL
	+ Any other input on how the network will operate the two types of UEs
* Recommended WF
	+ Companies provide their view on how the network deals with “low MSD” and “reference MSD” UEs in round1 in view of a WF in round 2

**Issue 2-3b: Signalling of “low MSD”**

* Proposals (moderator input, list based on the different proposals)
	+ Signalling is not needed:
		- Good UEs will perform well in network
		- Risk of excluding “nominal” UEs even below max power or any allocations
	+ If defined, signalling is:
		- per band combination
		- if needed also per MSD type
	+ Signalling is based on:
		- Default MSD value versus reference MSD threshold
	+ Any other signalling related input
* Recommended WF
	+ Companies provide their view on need and definition of signalling including specific criteria in round1 in view of a WF in round 2

### Sub-topic 2-4

**Issue 2-4: Candidates for study**

* Proposals (moderator input, list based on the different proposals)
	+ CA and DC between band 2/3 (1.8/1.9GHz) and 77/78 (3.5GHz)
	+ Any other
* Recommended WF
	+ Companies provide their view but it may be better to have fully agreed on the scope before picking one (or more) example case for the study

### Sub-topic 2-5

**Issue 2-4: Comments to documents**

* Recommended WF
	+ Companies can provide their comments to documents in this topic by adding document number as headline

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-1: Scope of “low/improved” MSD**Below can be considered.* Only CA/DC
* PC3 and/or PC2
* “low MSD” should be applicable/confirmed for both conducted and radiated measurements
* Harmonics, harmonic mixing, IMD, triple beat, cross band related
* Only MSD above 20dB corresponding to real world deployment dominated by PCB isolation or harmonic rejection
* Only large (meaningful) MSD improvement should be considered based on improved PCB isolation assessment
* Only new combinations
 |
| Skyworks | **Issue 2-1: Scope of “low/improved” MSD*** Only MSD above 20dB corresponding to real world deployment dominated by PCB isolation or harmonic rejection
* Only large (meaningful) MSD improvement should be considered based on improved PCB isolation assessment.
 |
| Nokia | * “low MSD” should be applicable/confirmed for both conducted and radiated measurements

🡪”radiated measurements” should be out of scope unless 3gpp has the MSD requirements for NOT low MSD based on radiated measurements.* Only MSD above 20dB corresponding to real world deployment dominated by PCB isolation or harmonic rejection

🡪we don’t think that we need to limit the scope of MSD > 20 dB. As far as we can establish the mechanism of signalling lower MSD values, the information shall be allowed to be reported. For instance, if a band combination with current specified MSD of 10dB can has 0 MSD, it must be allowed to be reported to a network. * Only large (meaningful) MSD improvement should be considered based on improved PCB isolation assessment

🡪we don’t think this limitation is necessary. We have not proposed to re-evaluate MSD, rather to introduce signalling mechanism to allow UE to different MSD values better than the specified ones.* Only new combinations

🡪No need this limitation.* Any combination with a default “low MSD” value depending on the reference MSD

🡪again, we have not proposed to re-valuate MSD for every band combination, but rather introduce signalling mechanism so that if a band combination has better MSD than the specified one, it is up to UE vendors if the UE reports lower MSD values to be considered by NW. UE can choose not to signal as capability, if it wants to do so. |
| Samsung | **Issue 2-1: Scope of “low/improved” MSD**Following could be considered for “low/improved” MSD study:* Only CA/DC
* PC3 and/or PC2
* “low MSD” should be applicable/confirmed for both conducted and radiated measurements
* Harmonics, harmonic mixing, IMD, triple beat, cross band related
* Only MSD above 20dB corresponding to real world deployment dominated by PCB isolation or harmonic rejection
* Only large (meaningful) MSD improvement should be considered

But first of all, we would like low MSD proponents clarify on the practical measurement results. It was claimed only several dB MSD is observed in practical measurement for some practical UE, did those measurements performed in conductive or radiative way?If radiated measurements is out of scope, how could we define a new capability to only indicate its conductive performance applying to radiative real network? so we think low MSD feasibility should also be based on radiative measurement, other than low MSD only observed in conductive test. |
| MediaTek | **Issue 2-1: Scope of “low/improved” MSD*** Only CA/DC
* PC3 and/or PC2
* Harmonics, harmonic mixing, IMD, triple beat, cross band related

For one CA/DC combination, all MSD mechanisms need to be considered together when characterizing MSD improvement.Radiated measurement is out of scope since RAN4 only specify conductive MSD requirements |
| SoftBank | We share the similar views as Nokia, while we do not stop UE vendors’s re-evaluating some MSDs if they think feasible. |
| Xiaomi | **Issue 2-1: Scope of “low/improved” MSD*** “low MSD” should be applicable/confirmed for both conducted and radiated measurements
* Harmonics, harmonic mixing, IMD, triple beat, cross band related
* Only MSD above 20dB corresponding to real world deployment dominated by PCB isolation or harmonic rejection
* Only large (meaningful) MSD improvement should be considered based on improved PCB isolation assessment
 |
| vivo | First of all, we were not fully convinced the capability signalling, and the following is only views for every listed scope of “Low MSD”:* Only CA/DC

--This should be enough;* PC3 and/or PC2

--“and” is more reasonable* “low MSD” should be applicable/confirmed for both conducted and radiated measurements

--This is Theoretically attractive, since antenna coupling is also an important factor. However, considering the difficulties of testing and current situation, only conductive test seems possible;* Harmonics, harmonic mixing, IMD, triple beat, cross band related

--Since they are quite different, we do not suppose all of them can be covered. * Only MSD above 20dB corresponding to real world deployment dominated by PCB isolation or harmonic rejection

--This is the most typical scenario and we suppose it can be considered in the first stage, if we decide to consider.* Only large (meaningful) MSD improvement should be considered based on improved PCB isolation assessment

--This is similar to previous one, and can be considered in the first stage, if we decide to consider.* Only new combinations

--Only consider improved MSD for all new combinations may also be a way.* Any combination with a default “low MSD” value depending on the reference MSD

--Not clear the meaning of this. |
| CHTTL | We share the similar views as Nokia. |
| Huawei (Jin Wang) | **Issue 2-1: Scope of “low/improved” MSD**In order to limit the workload in RAN4, we prefer to define a generic threshold for “low MSD”. As long as the UE can achieve a MSD below the threshold for a given band combination, it can indicate “low MSD” to the network. How the UE achieve this is totally up to implementation. In this way, RAN4 does not have to revisit large number of band combinations.However, we need to select a small set of band combinations for study in order to determine the generic threshold. We should consider it from both feasibility of UE implementation and benefit for the network.From UE point of view, we may use the conventional MSD analysis. As indicated in Apple’s paper, we may study the relationship of MSD and PCB isolation, antenna isolation, and figure out how low a MSD is practically achievable.From the network perspective, the UE self-interference doesn’t have to be low enough to yield 0 dB MSD. As we know, the UE performance in the field is typically limited by external interference rather than internal noise. UEs away from the cell edge usually don’t need to transmit at max power. The effective power back-off will also reduce the MSD, most evidently for high order MSDs. In other words, the threshold for low MSD may depends on IMD order.In summary, by limiting the scope to define the generic threshold for “low MSD”, the potential RAN4 workload is reduced. |
| Apple | **Issue 2-1: Scope of “low/improved” MSD*** Only CA/DC (inter-band only)
* PC3 and/or PC2 (to maintain consistent MSD relation between PC2 and PC3 for the same combination)
* “low MSD” should be applicable/confirmed for both conducted and radiated measurements
	+ The definition of “low” MSD value needs to be clarified.
	+ Radiated part has been considered in antenna isolation assumption for MSD evaluation.
* Harmonics, harmonic mixing, 2UL IMD, triple beat, cross band related
* Only new combinations
 |
| Qualcomm | Issue 2-1: Scope of “low/improved” MSDWe are ok to discuss the aspects proposed by the moderator, however, we would like to point out that there is an agreement from RAN #92e that RAN4 should study feasibility and capability signaling and report back to RAN #93e. So the moderator’s suggestion to “look at the big picture” is fine, but we need to ensure that we are able to complete the work assigned to RAN4 by this meeting. The agreement includes both CA and DC, but limits to MSD caused by H2/IM2/IM3 where one example band combination can be taken to study feasibility. There was no restriction from RAN about only large (meaningful) MSD improvement should be considered, nor about limiting the study to any particular mechanism such as PCB isolation. Rather, RAN simply asked RAN4 to study feasiblity of “low MSD”; that’s all.  |
| NTT DOCOMO, INC | **Issue 2-1: Scope of “low/improved” MSD**>PC3 and/or PC2PC3 and PC2 should be considered because large MSD values are specified not only for PC2 but also for PC3 while the values for PC2 may be larger. |
| AT&T | Issue 2-1: We support the views of Qualcomm. |

Sub topic 2-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-1: Specification of “low/improved” MSD**Below can be considered. And in our understanding the MSD specified in spec should be the minimum requirements which is the target of RAN4 specification. Opening the door of specifying the requirements for better performance UE may have the risk of burdening RAN4 by more and more “better requirements” people claiming with the intention of classify good and bad UE even both can met RAN4 requirements which is not within RAN4 scope.* Keep one set of MSD requirements and specify MSD with practical device performance improvement for the new combinations going forward.
* Technical report capturing the improved MSD levels for eligible CA/DC candidates
 |
| Skyworks | **Issue 2-1: Specification of “low/improved” MSD**As pointed out in our brief survey of the high number of CA MSD test points specified, and the hundreds of new MSDs introduced in basket approval process at every meeting, it is essential that before any discussion takes place, RAN 4 agrees on clear set of selection criteria to evaluate/re-evaluate “low MSD”. WF resulting from issue 2-1 is key to achieve this goal. Then eligible CA/DC candidates with improved/low MSD could be captured in a Technical report.* Technical report capturing the improved MSD levels for eligible CA/DC candidates
* Considering the high number of MSD test points, any text proposal that proposes an improved MSD should not be subject to the automatic basket approval process.
 |
| Nokia | None of the proposals. NW does not care how UE meets low MSD and/or what the practical device performance is and/or if new band combo or old band combo. We just specify MSD in a conventional manner for each band combination if any and that becomes reference. And we allow UE to indicate the delta between the specified MSD and the MSD the UE can meet. The granularity is FFS.  |
| Samsung | **Issue 2-2: Specification of “low/improved” MSD**If RAN4 confirms the feasibility of “low/improved” MSD, the following proposal is doable.* Technical report capturing the improved MSD levels for eligible CA/DC candidates

About “default MSD value versus reference MSD threshold”, RAN4 need firstly achieves consensus on whether introducing low MSD capability. |
| MediaTek | **Issue 2-1: Specification of “low/improved” MSD*** Proposals (moderator input, list based on the different proposals)
* Keep one set of MSD requirements and specify MSD with practical device performance improvement for the new combinations going forward.
* Technical report capturing the improved MSD levels for eligible CA/DC candidates

RAN4 specify MSD in a conventional manner for each band combination. Any improved MSD requirements shall be optional. |
| SoftBank | We share the similar views as Nokia, while we do not stop UE vendors’s re-evaluating some MSDs if they think feasible. |
| Xiaomi | **Issue 2-1: Specification of “low/improved” MSD*** + Technical report capturing the improved MSD levels for eligible CA/DC candidates

If RAN4 confirms the feasibility of “low/improved” MSD, the improved MSD shall be optional requirements |
| vivo | Our preferences are:* Keep one set of MSD requirements and specify MSD with practical device performance improvement for the new combinations going forward.
* Technical report capturing the improved MSD levels for eligible CA/DC candidates

As we have discussed, our first preference is keeping one set of MSD. If really consider the specification of “Low MSD”, the different types of interference scenario have to be considered to have a reasonable level of improvement. A single threshold for all cases seems simple and attractive, but things may not easy for different interference type. |
| CHTTL | We share the similar views as Nokia. |
| Huawei (Jin Wang) | **Issue 2-1: Specification of “low/improved” MSD**The “low MSD” should be an optional UE capability. As commented in Issue 2-1, RAN4 may choose to just define the generic threshold(s) for “low MSD”. After that, RAN4 doesn’t have to touch it for new/existing band combinations.  |
| Apple | **Issue 2-2: Specification of “low/improved” MSD*** Keep one set of MSD requirements and specify MSD with practical device performance improvement for the new combinations going forward.
* Technical report capturing the improved MSD levels for eligible CA/DC candidates
 |
| Qualcomm | Agree with Nokia. An alternative to a “delta MSD” is to specify an “absolute MSD” that is not necessarily or entirely based on what the worst case UE can meet, because it doesn’t need to be nor is it intended to be. We do not propose to perform a detailed MSD analysis for the thousands of combinations because it is not needed nor is it appropriate since the MSD here is an optional value that the UE may or may not be able to meet and is indicated by UE capability signaling. |
| Sony | In general, we prefer to keep only one set of requirements rather than defining a capability for improved MSD. If an MSD requirement leads to a CA/DC configuration problem in the field, we think all UE should be required to meet an improved performance rather than just some “good” UEs. Therefore, the following approaches are the feasible based on our understanding:* Keep one set of MSD requirements and specify MSD with practical device performance improvement for the new combinations going forward.
* Technical report capturing the improved MSD levels for eligible CA/DC candidates
 |
| AT&T | We agree with the proposal from Nokia to simplify the work in RAN4. |

Sub topic 2-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-3a: Network use of “low MSD”**MSD is only specified under the worst case in terms of Tx power, RB allocation, etc. And in the NW actually most of the time UE is under better conditions in which the MSD is much less than the RAN4 requirements. Current NW handling of MSD better to be clarified from NW vendors to better understand the situation in the real NW. And in our view the MSD should not be the only condition to determine a band combination could not be applied in the NW.Besides, whether the introduction low MSD indication means large MSD UE will not be even scheduled in the NW also need to be clarified from the proponent of low MSD.**Issue 2-3b: Signalling of “low MSD”**MSD signalling is rely on the above issues, and how NW to use this low MSD indication. And the concern of excluding “nominal” UEs even below max power or any allocations is shared with the introduction of signalling here. If defined, per band combination is ok. |
| Skyworks | **Issue 2-3b: Signalling of “low MSD”**Signalling is not needed:* Good UEs will perform well in network even without the signalling capability.
* Risk of excluding “nominal” UEs even below max power or any allocations – in particular how would network handle UEs that do not report the capability is unclear.
 |
| Nokia | Issue 2.3a: How network uses the indication is implementation issue and not sure the intention of the questions. Why is the handling of band combinations with large MSD changed by the introduction of the capability? And a question of “Is the indication useful if only a limited set of UEs support the improved MSD” and “Is the indication useful if only a majority of UEs support the improved MSD” are not worth discussing. This is a chicken-and-egg debate. If we do this discussion, we have to do this for every single option for any features to be introduced in 3GPP.Issue 2.3bNot sure “Risk of excluding “nominal” UEs even below max power or any allocations”. This is not related to the discussion. We don’t know what reference MSD threshold mean in “Default MSD value versus reference MSD threshold”, but if it means delta from the default MSD, that is the way to signal. And the delta for harmonic/cross band isolation and IMD due to 2UL must be handled separately. |
| Samsung | **Issue 2-3a: Network use of “low MSD”**All the aspects listed by moderator are meaningful to be clarified for further proceeding.**Issue 2-3b: Signalling of “low MSD”**Agree with OPPO that necessity of signalling rely on above issue. And if RAN4 confirms the low MSD feasibility and a low MSD would be anyway be derived, it is preferred to maintain reference MSD as minimum requirement unchanged. Low MSD should not replace previous minimum requirement on MSD, if so, signalling could be considered. |
| SoftBank | **For “Signalling is not needed”:**We cannot understand the notion that “Good UEs will perform well in network” since, to identify a good UE in terms of 2UL IMD, it seems a gNB should attempt to schedule RBs causing IMD intentionally and see what’s happens. It turns out be a waste of network resource. Without the flag, is there a way to find the good UEs in terms of MSD from IMD or Hn? |
| Xiaomi | **Issue 2-3a: Network use of “low MSD”**Besides the listed aspects shall be clarified, it is better to have a clarification on whether the UE not indicating the “low MSD” can be able to use CA/DC or not when the Tx power is not large (e.g. UEs in cell center or small cell) or DL power is large enough.**Issue 2-3b: Signalling of “low MSD”**If the improved MSD requirement is specified, it shall as optional feature to signal to NW. |
| vivo | **Issue 2-3a: Network use of “low MSD”**It is helpful for those questions to be clarified, since this may have major impact on the meaning of the entire scope, or it might be possible that the whole work is not useful.**Issue 2-3b: Signalling of “low MSD”**Prefer: Signalling is not needed;If really defined, signalling need to be per band combination, and per-MSD type. If the latter is not considered, then reasonable threshold do not seem possible. |
| CHTTL | **Issue 2-3b: Signalling of “low MSD”**We share the same view as Softbank. Though ”Good UEs will perform well in network” but the network will not know unless the BS attempt the scheduling that cause IMD to the UE. |
| Huawei (Jin Wang) | **Issue 2-3a: Network use of “low MSD”**We share similar concerns with Oppo. How the network use the “low MSD” is complicated. The network needs to predict the UE performance and schedule the UE based on multiple factors, such as CSI, CQI, interference level, PHR etc. A single “low MSD” indicator cannot be the deciding factor.**Issue 2-3b: Signalling of “low MSD”**We share similar concerns with Skyworks. Signalling is not always necessary and helpful. It might help in some cases, e.g. when dual UL may cause large MSD. We could further study if signalling is necessary.If defined, signalling per band combination may not be enough. For example, a band combination consisting of 3 bands may have 3 different dual-UL combinations and three different single UL. The band combination may suffer from multiple MSDs. Each of them may need one indication. |
| Apple | Issue 2.3a: We support moderator’s input on the aspects to be clarified.Issue 2.3b: Signalling is not needed:* Good UEs will perform well in network
* Risk of excluding “nominal” UEs even below max power or any allocations
 |
| Qualcomm | Issues 2-3a: Network use of “low MSD”According to the agreement at RAN and the guidance that RAN provided to RAN4, there was no question or concern about how the network might use the “low MSD”. RAN4’s task is to “Discuss the capability signaling for network to distinguish UE with different MSD performance if RAN4 conclude specifying “low MSD” is feasible”, so our understanding is that the attributes and parameters of this capability signaling should be discussed, not whether it is useful, under what conditions it is useful, or guessing how it might best be used (other than as needed to define signaling attributes and parameters).Issues 2-3b: Signalling of “low MSD”Our view is that signaling is beneficial. We propose the signaling is per combination. Further fine-tuning to signal according to MSD type is not justified in our opinion, but could be considered as a future enhancement if there is motivation. |
| Sony | **Issue 2-3a: Network use of “low MSD”**We think the network side should clarify all the listed questions about how this “low MSD” indication can be used. We think the MSD value in the specification is merely an indication of the worst-case scenario, but it is not a sole condition for a network to configure the CA/DC operation. Moreover, “low MSD” is a static capability that can not reflect the UE real time MSD performance with different Tx power, and it may require a lot of work in RAN4 to identify all scenarios where a UE can set this capability. Therefore, we don’t see a clear benefit for a network to use the “low MSD” indication at this moment. **Issue 2-3b: Signalling of “low MSD”**Based on our current understanding (see above), there is no clear benefit for signalling of “low MSD” so we don’t think it would be needed. |
| NTT DOCOMO, INC | **Issue 2-3a: Network use of “low MSD”**It is implementation matter how to utilize this capability and we don’t have a clear answer. What we can say at this time is that, the work on improving MSD may be helpful for following cases: In general, in our understanding, operators need to select which band combinations should be operated in their NW among all possible band combinations which are consisting with their assigned spectrum. Then, they may deprioritize band combinations with high MSD specified in 3GPP, since 3GPP compliant-UE may follow the high MSD. So, if low MSD is introduced to some band combinations which originally have high MSD, it is good information for operators to decide to introduce such band combinations in their NW, while they may need to investigate how many UEs can support low MSD. In addition to this, NW may utilize the indication of low MSD in its operation, but it is up to implementation. So, working on improving MSD is good at least in our view. |

Sub topic 2-4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | **Issue 2-4: Candidates for study**CA and DC between band 2/3 (1.8/1.9GHz) and 77/78 (3.5GHz) is ok. |
| Skyworks | Candidate(s) for study should allow evaluation of the different types of MSD that are considered eligible for MSD improvement. The types of MSD (harmonic, IMD etc..) should be part of selection criteria and should captured in a WF based on sub topic 2.1 inputs. We propose to study only MSD due to harmonics or driven by PCB isolation. |
| Samsung | **Issue 2-4: Candidates for study**We think CA and DC between band 2/3 (1.8/1.9GHz) and 77/78 (3.5GHz) is a good example for low MSD study which is well aligned with RAN plenary guidance. |
| Xiaomi | **Issue 2-4: Candidates for study**CA and DC between band 2/3 (1.8/1.9GHz) and 77/78 (3.5GHz) |
| vivo | It is doubtful whether one example band combination can help to define the whole scheme and setting new requirements. If really one example selected, we support Skyworks’ proposal to study only MSD due to harmonics or driven by PCB isolation, for CA and DC between band 2/3 (1.8/1.9GHz) and 77/78 (3.5GHz). |
| Apple | **Issue 2-4: Candidates for study**Any new inter-band CA/DC combinations with 2nd or 3rd order harmonic interference, 3rd order harmonic mixing, IMD2 or IMD3 issue can be considered as candidates for study. |

Sub topic 2-5

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | R4-2112381 has a text saying that “Furthermore, if the “low” MSD requirement is defined as 5 dB, wouldn’t it unfair for UEs with 5.5dB MSD to be excluded from using the combination?”. At a first glance, we understand it but even now, this situation exits for instance some requirements for switching time have three options for ULTxSwitchingBandPair-r16 where 35, 140 or 210us is allowed. If the UE’s switching time is 145us, the UE report 210us. The issue is not specific to this discussion. The UE vendors have a choice to do extra efforts to shorten it by 5us and signal 140us OR leave it as it is and signal 210us. |

## 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.*

Moderator: a lot of companies expressed their view in contributions and comments but view are still divided amongst companies on the meaning, use, signaling and definition of “low MSD” in round 2 we will try to reorganize the discussion to crystalize the views on the most critical aspects so that we have a clear picture of the positions and extract a few cases for a potential slot in GTW (but this is first meeting of this SI, not sure that GTW time can be granted). The focus is to be able to provide feedback to RAN#93e but I cannot guarantee that there will be a common view in RAN4.

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#2.1** | **Issue 2-1: Scope of “low/improved” MSD**There are split view on whether:* “Low MSD” should only be achieved for conducted only or at least have some meaning for radiated performance
* “Low MSD” should apply to any case or whether it should tackle cases with large MSD that can be improved by front end integration, PCB isolation…
* Which types are “improved/low” amongst harmonic, harmonic mixing, IMD, cross band, triple beat and thus what signalling complexity is involved if any
* Whether MSD needs re-evaluation and agreement in RAN4 of a better value or is only advertised as a threshold (MSD below XdB which may depend on current MSD value) or improvement vs specification by UEs
* Whether this applies to combinations in the spec or only to new combinations

*Tentative agreements:*Only applicable to CA/DC in PC3 and PC2 combinations*Candidate options:**Recommendations for 2nd round:* further discuss the principle of low MSD whether this is aRAN4 agreed value or a UE declared improvement(of XdB to a default value of YdB) and based on this, try to agree the MSD types and examples to study |
|  | **Status summary**  |
| **Sub-topic#2.2** | **Issue 2-1: Specification of “low/improved” MSD**There seems to be a consensus that either way we go there is no need to capture an improved MSD in the TS and that only the minimum requirement is captured there. Still, whatever way, if signalling applies there is need to clarify which agree value/ threshold/improvement is advertised. Some companies expressed that if a minimum requirement is with very large MSD that hampers it use can be improved it is better to revisit the minimum requirement that create different categories of UE.*Tentative agreements:*TS only has minimum requirement*Candidate options:**Recommendations for 2nd round:* Clarify first which “low MSD” principle is used then agree what would be captured and where |
|  | **Status summary**  |
| **Sub-topic#2.3** | **Issue 2-3a: Network use of “low MSD”**There is little input as to how the “low MSD” indication might be used by the networks and if it may be used to discriminate UEs that meet 3GPP minimum requirements. If any there is some recognition that in real NW the link performance may not be only limited by REFSENS+MSD. It is also unclear what happens when the UE is not at max power/other allocation where the MSD may not an issue.Also it is unclear what are the gains with only a few “low MSD” UEs or only a few “minimum requirement” UEsAlso if the signalling is a generic way for UE to signal they are “better” it is unclear how it helps operators/NW vendors on how to deal with problematic combinations by tuning (or not) schedulers around problematic cases.**Issue 2-3b: Signalling of “low MSD”**There are still companies that are not convinced about the benefit of signalling low MSD, given it is unclear if it changes anything in the NW performance and how UEs are handled*Tentative agreements:*If any signalling, “low MSD” is an optional capability and it should be per band combination and it is FFS how the different MSD types are tackled but also the different UL configurations within a band combination*Candidate options:**Recommendations for 2nd round:* Clarify first which “low MSD” principle is used then see if signalling is needed and with which granularity/complexity vs types |
|  | **Status summary**  |
| **Sub-topic#2.4** | **Issue 2-4: Candidates for study**There is some consensus that CA/DC between band 2/3 and n77/78 for harmonic issues is a good start but there is also the view that example(s) should be chosen to encompass all or a number of MSD types (at least Harmonics, harmonic mixing, IMD2/3) *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* try extent the list of examples to add harmonic mixing and IMD2/3 cases |
|  | **Status summary**  |
| **Sub-topic#2.5** | **Issue 2-5: Comments to documents**Only one comment to one document was given. documents will be noted*Tentative agreements:**Candidate options:**Recommendations for 2nd round:* close this issue |

At this moment the positions are too far apart to seek a WF and even less elaborate LS to RAN. Moderator suggests to focus round 2 in mapping the different options for the “feasibility study” and their potential implications in terms of signaling. Still clarification are needed for the use/usefulness of the capability and how the way to handle operator specific problematic cases in NW is changed. Issues from round 1 will be revisited/re-arranged to focus on the few options derived from round 1 comments.

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
|  |  |  |

## Discussion on 2nd round (if applicable)

*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

**Issue 2-1: feasibility study options for “low/improved” MSD**

* Options
	+ Option 1: Critical MSD that require operator/network specific handling are re-evaluated by RAN4 for a “low/improved MSD” value
		- Associated selection criteria of MSDs to be improved?
		- Which types?
		- Associated capability or not?
	+ Option 2: MSD is not re-evaluated and UE vendors advertise a low MSD value/improvement
		- Which types?
		- Value advertised is WC of all types?
		- Which granularity/values?
		- How low makes sense
	+ Improvement of radiated performance versus improvement conducted REFSENS need to part of the study or not
	+ other
* Recommended WF
	+ Companies provide their view on their preferred approach in round2 and possibly narrow down options,

### Sub-topic 2-2

**Issue 2-1: Specification of “low/improved” MSD**

* Otpions
	+ No evaluation of low MSD
	+ Evaluation of MSD improvement of critical cases and value captured in TR
	+ Other
* Recommended WF
	+ Companies provide their view on their preferred approach in round2

### Sub-topic 2-3

**Issue 2-3: Network use of “low MSD”**

* Aspects to be clarified
	+ How a generic low/improved MSD capability can be used by the network if it is not related to a real critical use case?
	+ How much improvement/threshold value is useful for the scheduler compared to other factors
		- At which granularity?
		- For which distribution of low MSD/minimum requirement MSD UEs
		- For which power range
	+ What “treatment” UEs will get
		- Vs reported low MSD/minimum requirement MSD
		- Vs power range
		- Vs allocation
	+ Any other
* Recommended WF
	+ Companies provide their view on how the network should deals with “low MSD” and “minimum requirement MSD” UEs in round 2

### Sub-topic 2-4

**Issue 2-4: Signalling of “low MSD”**

* Options
	+ Signalling is not needed:
	+ Signalling that UE meets an improved MSD value captured in TR
		- per band combination
		- if needed also per MSD type
	+ Default MSD value is signalled (<XXdB)
		- MSD default value(s) may depend on minimum requirement MSD value
		- per band combination
		- if needed also per MSD type
	+ MSD improvement value is signalled (improved by XXdB vs minimum requirement MSD value)
		- what granularity
		- per band combination
		- if needed also per MSD type
	+ Any other signalling related input
* Recommended WF
	+ Companies provide their view on need and definition of signalling including specific criteria in round 2

### Sub-topic 2-5

**Issue 2-5: Band combinations candidates for study**

* Options
	+ On top CA and DC between band 2/3 (1.8/1.9GHz) and 77/78 (3.5GHz) to harmonic issue
	+ Example band combinations for harmonic mixing suggestion (if needed)
	+ Example band(s) combinations for IMD3/2 suggestion (if needed)
	+ Example band combinations for cross band isolation (if needed)
	+ Any other
* Recommended WF
	+ Candidates are welcome for the study phase regardless of “low MSD” principles/signalling chosen.

### Companies views’ collection for 2nd round

Sub topic 2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. |
|  |  |
|  |  |

Sub topic 2-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Evaluation of MSD improvement of critical cases and value captured in TR |
|  |  |
|  |  |

Sub topic 2-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |
|  |  |

Sub topic 2-4

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | It depends on the conclusion in above issues like how much can be improved and how NW to utilize the signalling, etc. Without clear conclusion on these issues, it is premature to discuss the signalling. |
|  |  |
|  |  |

Sub topic 2-5

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |
|  |  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: Band combinations corrections for FR1 and FR2

Moderator input: CR are commented directly

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2112904**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112904.zip) | ZTE Corporation | Discussion on inter-band CA Tx RF requirementsObservation 1. Different types of UL CA configurations are supported for inter-band NR CA band combination in different releases of TS38.101-1. Observation 2. Some of the Tx requirements are only defined for ‘nXA-nYA’ type of UL CA configurations, which means for inter-band NR CA Tx requirements in TS38.101-1:* Requirements for ‘-’ type of UL CA configurations are missing in Rel-15 /Rel-16/Rel-17 specs.
* Requirements for ‘nXC’ type of UL CA configurations are missing in Rel-16/Rel-17 specs.
* Requirements for ‘nX(2A)’ and ‘nXA-nYB’ types of UL CA configurations are missing in Rel-17 spec.

**Proposal 1. To agree the companion CRs provided in [2~7].** |
| [**R4-2112910**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112910.zip) | ZTE Corporation | CR to TS38.101-1: Inter-band NR CA Tx requirement including intra-band non-contiguous CA and combinations of intra-band and inter-band CA UL configuration corresponding to [**R4-2112910**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112910.zip) |
| [**R4-2112723**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112723.zip) | ZTE Corporation | On configurations for SUL band combination with inter-band CAObservation 1: In the configuration table for SUL band combination *with inter-band CA*, the supported channel bandwidth is redundant with the configuration tables for SUL band combination with single carrier, intra-band contiguous CA or intra-band non-contiguous CA.**Proposal 1: It is proposed that for SUL band combination with inter-band CA (Table 5.5C-4), the channel bandwidth for NR band in SUL band combination should directly refer to the configuration tables for SUL band combination with single carrier (Table 5.5C-1), intra-band contiguous CA (Table 5.5C-3) or intra-band non-contiguous CA (Table 5.5C-2).** |
| [**R4-2112724**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112724.zip) | ZTE Corporation | CR to TS 38.101-1 on corrections to configuration for SUL bands corresponding to [**R4-2112723**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112723.zip) |
| [**R4-2113573**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113573.zip) | Ericsson | Rel-17 draft CR 38.101-1, band combination corrections**Corrections:*** **UL rows to be merged into just one row for CA\_n41A-n71(2A), CA\_n41A-n71B, CA\_n41(2A)-n71 and Band CA\_n41C-n71B**
* **Add missing C in UL for CA\_n2A-n30A-n66(2A)**
* **Add missing A in UL for CA\_n25A-n29A-n66A**
* **Add missing A in UL for CA\_n25(2A)-n66(2A)-n77A**
* **Remove not defined 5 MHz in band n77 from CA\_n25A-n77A**
* **Remove not defined 5 MHz in band n78 from CA\_n25(2A)-n78A**
* **Remove not defined 70 MHz in band n40 from CA\_n34A-n40A**
* **Remove emply rows after CA\_n38A-n78(2A)**
* **Remove not defined 25 MHz in band n41 from CA\_n41A-n77(2A)**
* **Merge the two rows in the first column for CA\_n46N-n48B**
* **Remove not defined 25, 30 and 40 MHz in band n5 from CA\_n5A-n25A-n66(2A)**
* **Correct the 20 MHz channel BW for CA\_n5A-n25A-n77A**
* **Remove not defined 50, 60, 80, 90 and 100 MHz in band n66 from CA\_n25A-n48A-n66A**
* **Remove not defined 70 and 90 MHz in band n79 from CA\_n1A-n8A-n78A-n79A and CA\_n1A-n8A-n78(2A)-n79A**
 |
| [**R4-2113574**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113574.zip) | Ericsson | Rel-17 draft CR 38.101-2, band combination corrections**Correcting n262 channel BW definition to BW instead of Yes** |
| [**R4-2113575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113575.zip) | Ericsson | Rel-17 draft CR 38.101-3, band combination corrections**Corrections:*** **Adding missing band combinations in Table 5.2A.1-1 and Table 5.2A.1-2**
* **Adding missing UL for CA\_n28A-n77A-n257D**
* **Adding missing A in definition of DC\_29A-30-66A\_n260A**
 |
| [**R4-2112721**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112721.zip) | ZTE Corporation | Optimization to NR FR2 configurations for intra-band non-contiguous CAObservation 1: Too many columns of sub-block are redundant in the configuration table for intra-band non-contiguous CA which contain no additional information.**Proposal 1: To optimize the configuration table for intra-band non-contiguous CA in FR2, Option 2 of no column for sub-blocks is suggested. Take CA\_n260(2G-3O) as an example, the suggested optimization for the configuration can be as follows.** |
| [**R4-2112722**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112722.zip) | ZTE Corporation | CR to TS 38.101-2 on corrections to intra-band non-contiguous CA corresponding to [**R4-2112721**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112721.zip) |
| [**R4-2112352**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112352.zip) | Apple | CR for TS 38.101-1: Correcting CA frequency setup for 2UL interband reference sensitivity**The frequency setup for CA\_n71-n77 and CA\_n71-n78 to check for IMD5 are false. UL and DL frequency are not matching for n78 and UL/DL frequency need to be adjusted so that IMD5 falls into n71 downlink** |
| [**R4-2112353**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112353.zip) | Apple | CR for TS 38.101-3: Correcting DC frequency setup for 2UL interband reference sensitivity**The frequency setup for CA\_n71A-n78A to check for IMD5 is false. UL and DL frequency are not matching for n78** |
| [**R4-2112358**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112358.zip) | Apple | CR for TS 38.101-1 Rel-17: Applying n40 and n41 spurious emissions on CA**With the recent agreement on n40 and n41 single band emission requirements, the emission limits for CA combinations require an update to match new conditions.** |

## Open issues summary

Moderator input: CR are commented directly in 3.3.2

### Sub-topic 3-1

**Issue 3-1: SUL band combination with inter-band CA**

* Proposals
	+ **Proposal 1: It is proposed that for SUL band combination with inter-band CA (Table 5.5C-4), the channel bandwidth for NR band in SUL band combination should directly refer to the configuration tables for SUL band combination with single carrier (Table 5.5C-1), intra-band contiguous CA (Table 5.5C-3) or intra-band non-contiguous CA (Table 5.5C-2).**
* Recommended WF
	+ Discuss proposal in the review of associated [**R4-2112724**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112724.zip)CR

### Sub-topic 3-2

**Issue 3-2: Optimization to NR FR2 configurations**

* Proposals
	+ **Proposal 1: It is proposed that for SUL band combination with inter-band CA (Table 5.5C-4), the channel bandwidth for NR band in SUL band combination should directly refer to the configuration tables for SUL band combination with single carrier (Table 5.5C-1), intra-band contiguous CA (Table 5.5C-3) or intra-band non-contiguous CA (Table 5.5C-2).**
* Recommended WF
	+ Discuss proposal in the review of associated [**R4-2112722**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112722.zip)CR

### Sub-topic 3-3

**Issue 3-3: inter-band CA Tx RF requirements**

* Proposals
	+ **Proposal on missing Tx configurations**
* Recommended WF
	+ Discuss proposal in the review of associated [**R4-2112910**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112910.zip)CR

## Companies views’ collection for 1st round

### Open issues

### 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** |
| [**R4-2112910**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112910.zip) | Skyworks: given the implications and amount of change across many CR we would need time in Round2 to verify. Also it is no clear in which agenda the 05-09 CRs are to be treated. |
| Company B |
|  |
| [**R4-2112722**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112722.zip) | Company A |
| Company B |
|  |
| [**R4-2112724**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112724.zip) | Huawei: For table 5.5C-4, it's unnecessary to make such changes. It's clearer to specify the channel bandwidth for each band instead of using reference.  |
| ZTE: Reply to Huawei: Thanks for the comments. The information of supported channel bandwidths with inter-band CA in Table 5.5C-4 is duplicated with the information for SUL band combination in Table 5.5C-1, Table 5.5C-2 and Table 5.5C-3. In addition to the duplicated content among the CA configuration tables, what is more important is that the duplication will increase the risk of inconsistency among these tables. If in case a combination with inter-band CA in Table 5.5C-4 uses the channel bandwidth which is not defined in Table 5.5C-1, Table 5.5C-2 or Table 5.5C-3 for the certain SUL band combination, is this a legal case for the channel bandwidth in Table 5.5C-4? Furthermore, if the duplication of channel bandwidth in Table 5.5C-4 is for the purpose of clearer specification, why we also use CA\_n41C, CA\_n78C, etc. as reference? |
| Huawei: To ZTE, Thanks for your clarification. The reason why we use CA\_n41C, CA\_n78C, as reference is related to the RAN2 signaling structure (FSPC is used). For SUL band combination, NUL and SUL are two UL carriers even if they belong to one cell. There are lots of capabilities (supportedBandwidthUL) related to each carrier. |
| [**R4-2113573**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113573.zip) | Company A |
| Company B |
|  |
| [**R4-2113574**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113574.zip) | Company A |
| Company B |
|  |
| [**R4-2113575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113575.zip) | Company A |
| Company B |
|  |
| [**R4-2112352**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112352.zip) | Company A |
| Company B |
|  |
| [**R4-2112353**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112353.zip) | Company A |
| Company B |
|  |
| [**R4-2112358**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112358.zip) | Huawei: 90/100MHz haven’t be introduced into spec for these CA combinations CA\_n1-n40, CA\_n3-40, CA\_n8-n40, CA\_n28-n40, CA\_n39-n40, CA\_n40-n78, CA\_n40-n79. There is no need to list n41 in separate row. |
| Xiaomi: in the cover page, it says apply note 20 to n41, actually, it should be note 22.To Huawei, the exceptions for 90 and 100 MHz channel bandwidth are for n41 to protect 90MHz and 100Mhz of n41 when 2UL CA are configured. It is no matter with the channel bandwidth of CA combinationsApple: Thanks for the comments. Similar changes are made to Rel-16 and are discussed in [104]. DOCOMO drafted similar CRs and proposed to merge those. Therefore, the revision also features the changes of the CR from DOCOMO. The revision changes the note description and refers to band n40: “As exceptions, when channel bandwidth of n40 is 90 and 100 MHz, -40 dBm/MHz is applicable in the frequency range of 2496 – 2505 MHz.”. Hope this is acceptable. The revision can be found in the revision folder located in Round 1. Huawei: To Xiaomi, the 90 and 100MHz is only for aggressor band n40.To Apple, thanks for your revision. The wording is OK for me, but the core requirements must be consistency and accurate. Given there is no channel bandwidth 90/100MHz for aggressor band n40 for any BCS of CA\_n1-n40, CA\_n3-40, CA\_n8-n40, CA\_n28-n40, CA\_n39-n40, CA\_n40-n78, CA\_n40-n79 currently. These requirements are not needed. We can’t presuppose that channel bandwidth 90/100MHz for aggressor band n40 must be supported by these CA band combinations. It violate the basic principle for the specification. |
|  |

## Summary for 1st round

### Open issues

### 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**  |
| [**R4-2112910**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112910.zip)And mirror CRs | Companies requested more time to check => review in Rd2 |
| [**R4-2112722**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112722.zip) | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112724**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112724.zip) | Further discussion needed in RD2 may need to revise |
| [**R4-2113573**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113573.zip) | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2113574**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113574.zip) | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2113575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113575.zip) | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112352**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112352.zip) | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112353**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112353.zip) | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112358**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112358.zip) | Revision needed because of R16 discussion, this revision needs to address comments in this thread. |

## Discussion on 2nd round (if applicable)

### 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** |
| [**R4-2112910**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112910.zip) | Company A |
|  |
|  |
| [**R4-2112722**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112722.zip) |  |
|  |
|  |
| [**R4-2112724**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112724.zip) |  |
|  |
|  |
| [**R4-2113573**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113573.zip) |  |
|  |
|  |
| [**R4-2113574**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113574.zip) |  |
|  |
|  |
| [**R4-2113575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113575.zip) |  |
|  |
|  |
| [**R4-2112352**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112352.zip) |  |
|  |
|  |
| [**R4-2112353**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112353.zip) |  |
|  |
|  |
| Revision of [**R4-2112358**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112358.zip) | Apple: A revision is uploaded to the server and can be found in the “Revision” folder of Round 2. |
|  |
|  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: NR-U contiguous UL CA

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2112304**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112304.zip)NRU ULCA including wideband operation | Skyworks Solutions Inc. | **Proposal on NR-U ULCA cases:*** **#1 Wideband operation in each CC is restricted to cases where transmitted sub-bands are contiguous across the two CCs**
* **#2 Same waveform type is used in each CC: CP-OFDM+CP-OFDM or DFT-s-OFDM+DFT-s-OFDM**
* **#3 Same allocation type is used in each CC:**
	+ **#3a Full+Full or Interlace+Interlace with same number of RB per 10RB in each CC, furthermore, RB start positions are chosen such that the lower edge of the highest allocated RBs in lower CC and the lower edge of the lowest allocated RBs in upper CC is ≥ 1.8MHz**
	+ **#3b For MPR/A-MP evaluation purpose, it is further restricted to RB start positions are chosen such that the lower edge of the highest allocated RBs in lower CC and the lower edge of the lowest allocated RBs in upper CC is the closest to 1.8MHz**
* **#4 All channel bandwidth combination should be considered but it should meet the channel bonding rule such that the aggregated channel BW is contained with the WIFI channel of same or higher channel BW.**
	+ **Low priority on >160MHz aggregated bandwidth aligning with 320MHz 802.11be half-overlapping channels in n96 (not applicable in n46)**
	+ **Consider limitations for 60+60 and 100+100 cases and potential limitations for 40+100/100+40/60+100/100+60 cases**
* **#5 Prioritize the study of the general case and NS-28/29/30/31 in n46 and NS-53/54 for the introduction of NR-U contiguous ULCA feature**
	+ **Other NS can be studied within the already agreed spectrum specific NR-U WIs or as a second priority once the single CC related work is finalized**
 |

## Open issues summary

### Sub-topic 4-1

**Issue 4-1: NR-U contiguous UL CA configurations**

* Proposals
* #1 Wideband operation in each CC is restricted to cases where transmitted sub-bands are contiguous across the two CCs
* #2 Same waveform type is used in each CC: CP-OFDM+CP-OFDM or DFT-s-OFDM+DFT-s-OFDM
* #3 Same allocation type is used in each CC:
	+ #3a Full+Full or Interlace+Interlace with same number of RB per 10RB in each CC, furthermore, RB start positions are chosen such that the lower edge of the highest allocated RBs in lower CC and the lower edge of the lowest allocated RBs in upper CC is ≥ 1.8MHz
	+ #3b For MPR/A-MP evaluation purpose, it is further restricted to RB start positions are chosen such that the lower edge of the highest allocated RBs in lower CC and the lower edge of the lowest allocated RBs in upper CC is the closest to 1.8MHz
* #4 All channel bandwidth combination should be considered but it should meet the channel bonding rule such that the aggregated channel BW is contained with the WIFI channel of same or higher channel BW.
	+ Low priority on >160MHz aggregated bandwidth aligning with 320MHz 802.11be half-overlapping channels in n96 (not applicable in n46)
	+ Consider limitations for 60+60 and 100+100 cases and potential limitations for 40+100/100+40/60+100/100+60 cases
* #5 Prioritize the study of the general case and NS-28/29/30/31 in n46 and NS-53/54 for the introduction of NR-U contiguous ULCA feature
	+ Other NS can be studied within the already agreed spectrum specific NR-U WIs or as a second priority once the single CC related work is finalized
* Recommended WF
	+ Each proposal are commented with proposal number as header

## Companies views’ collection for 1st round

### Open issues

Sub topic 4-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | Feedback from companies is welcomed as the aim is to refine the WID in next RAN plenary so that the workload and goals are clear. |
| Charter Communications Inc. | #1 agree with #1 proposal#2 agree with #2 proposal#3a agree with #3a proposal#3b agree with #3b proposal#4 we agree on 60 + 60, with regards to 100 MHz decision is pending the outcome of 100 Mhz nr-U channel raster discussion#5 agree with #5In general we agree with the proposal except for #4, especially how to treat 100 Mhz channel raster configurations pending further iscussions |
| Apple | #1: Agree with the general principle. What we need to clarify whether potential outcome of the LBT procedure should be accounted for because the LBT process is independent for each UL carrier. #4: Since the resulting number of combinations can be quite big and/or some of them are not even possible due to WIFI bonding rules, we can consider a limited set of combinations for “phase1”, for instance only 20+20 and 80+80, before we understand better how many combinations we need to tackle if we consider other channel bandwidths.#5: We can indeed focus on the existing NS values we have for band n46 and n96.  |
| Qualcomm | #1: ok#2: checking the implication, is this restriction also imposed for NR UL CA? I didn’t find any such restriction in my quick check.#3: checking the implication#4: since there is no requirement for WiFi channel bonding alignment in the DL, there should not be in the UL either or else there will be mismatch in channel configuration when CA is configured by the network #5: okWe noticed there were other proposals in R4-2112304 on baseline architecture, LO exceptions, and SEM, but these weren’t included in first round discussion topics. Is the intention to discuss these in second round, or defer to next meeting to enable focus on the first set of proposals? |

### CRs/TPs comments collection

## 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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#4.1** | *Status:*Proposal2: Needs further check on implicationsProposal3a/b: Needs further check on implicationsProposal4: agreement on 60+60, and priority to 20+20, 80+80. Need to discuss 100MHz UL CA based on potential agreements on 100MHz channelization*Tentative agreements:*Proposal1: consensus to agreeProposal5: consensus to agree*Candidate options:**Recommendations for 2nd round:* Further discuss the restrictions and generate a way forward that can be used as input to WI revision/further definition in RAN if needed. WF may also capture further inputs on RAN4 assumptions |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on NRU ULCA cases and evaluation assumptions | Skyworks Solutions Inc. (+others if candidates) |

### CRs/TPs

## Discussion on 2nd round (if applicable)

### WF comments collection

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

|  |  |
| --- | --- |
| **WF** | **Comments collection** |
| WF on NRU ULCA cases and evaluation assumptions | Company XXX |
|  |
|  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #5: n5B UL CA

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2114579**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114579.zip)CA\_n5B MSD Measurements | Skyworks Solutions Inc. | **Proposal: Adopt CA\_n5B MSD Levels proposed in Table 3 for Table 7.3A.2.1-1 (subclause 7.3A).**Table 3: Proposed changes to Table 7.3A.2.1-1 to capture CA\_n5B MSD.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| CA configuration | SCS(PCC/SCC)(kHz) | Aggregated channel bandwidth (PCC+SCC) | UL PCC allocation(LCRB) | UL SCC allocation(LCRB) | PCC ΔRIBNC (dB) | SCC ΔRIBNC (dB) | Duplex mode |
| CA\_n5B | 15/15 | 15MHz + 10MHz | 12 (RBstart = 67)  | 8 (RBstart = 0) | [27] | [42.5] | FDD |
| 15MHz + 10MHz | 20 (RBstart = 58)  | N/A | 0 | [5.2] |
| 15MHz + 5MHz | 15 (RBstart = 64)  | 5 (RBstart = 0) | [29.5] | [25.5] |
| 15MHz + 5MHz | 20 (RBstart = 58) | N/A | 0 | [5.2] |
| NOTE 1: All combinations of channel bandwidths defined in Table 5.5A.1-1.NOTE 2: The carrier centre frequency of PCC in the UL operating band is configured closer to the DL operating band.NOTE 3: The transmitted power over both PCC and SCC shall be set to PUMAX as defined in subclause 6.2A.4. |

**The single uplink MSD test points are copied from DC\_(n)5AA Table 7.3B.2.1-1.** |

## Open issues summary

### Sub-topic 5-1

**Issue 5-1: n5B MSD proposal**

* **Proposal: Adopt CA\_n5B MSD Levels proposed in Table 3 for Table 7.3A.2.1-1 (subclause 7.3A).**

Table 3: Proposed changes to Table 7.3A.2.1-1 to capture CA\_n5B MSD.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| CA configuration | SCS(PCC/SCC)(kHz) | Aggregated channel bandwidth (PCC+SCC) | UL PCC allocation(LCRB) | UL SCC allocation(LCRB) | PCC ΔRIBNC (dB) | SCC ΔRIBNC (dB) | Duplex mode |
| CA\_n5B | 15/15 | 15MHz + 10MHz | 12 (RBstart = 67)  | 8 (RBstart = 0) | [27] | [42.5] | FDD |
| 15MHz + 10MHz | 20 (RBstart = 58)  | N/A | 0 | [5.2] |
| 15MHz + 5MHz | 15 (RBstart = 64)  | 5 (RBstart = 0) | [29.5] | [25.5] |
| 15MHz + 5MHz | 20 (RBstart = 58) | N/A | 0 | [5.2] |
| NOTE 1: All combinations of channel bandwidths defined in Table 5.5A.1-1.NOTE 2: The carrier centre frequency of PCC in the UL operating band is configured closer to the DL operating band.NOTE 3: The transmitted power over both PCC and SCC shall be set to PUMAX as defined in subclause 6.2A.4. |

**The single uplink MSD test points are copied from DC\_(n)5AA Table 7.3B.2.1-1.**

* Recommended WF
	+ Companies to verify test points and proposed MSD
	+ If acceptable discuss if a CR can be generated and if brackets are necessary.

## Companies views’ collection for 1st round

### Open issues

Sub topic 5-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Thank you Skyworks for providing the contribution and details. Can you please give the WID document reference outlining the operator request for this band combination? We are concerned that the maximum aggregated BW is 25MHz (BCS1) and the maximum single carrier BW is only 20MHz. We are not opposed to the alternate BCS as long as requirements are defined. Perhaps a WF and possibly agree on the test points this meeting as well as investigate potential coexistence issues. We can contribute data based on agreed testpoints for the next meeting. |

### CRs/TPs comments collection

## 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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#5.1** | *Tentative agreements:*Good agreement on technical analysis, need to agree on channel configuration and test points for next meeting TP. If more progress in round 2 tentative agreement may be captured in CR based on WF*Candidate options:**Recommendations for 2nd round:* Discuss test points and configuration in a WF. If agreement a CR may capture tentative agreement |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on n5B 25MHz aggregated BW MSD | Skyworks Solutions Inc., Qualcomm |

### CRs/TPs

## Discussion on 2nd round (if applicable)

### WF comments collection

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

|  |  |
| --- | --- |
| **WF** | **Comments collection** |
| WF on n5B 25MHz aggregated BW MSD | Company XXX |
|  |
|  |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on REFSENS assumptions for DC\_20-38\_n8 | Vodafone | Capture REFSENS assumptions for contributions by interested companies next meeting |
| CR to R17 38.101-1 to capture IMD5 MSD for CA\_n41C-n66A | MediaTek Inc. | CR to modify MSD value to 32.5dB |
|  |  |  |
| WF on NRU ULCA cases and evaluation assumptions | Skyworks Solutions Inc., […] | Capture agreements on cases restrictions and prioritization. Capture evaluation assumptions for next meetings |
| WF on n5B 25MHz aggregated BW MSD | Skyworks Solutions Inc., Qualcomm | Capture agreements on test points and channel configurations for n5B MSD. may result in CR to capture tentative agreement |
|  |  |  |
|  |  |  |
|  |  |  |

**xExisting tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| *LB-LB-LB and LB-LB combinations* |
| [**R4-2111731**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111731.zip) | DC\_8A\_20A\_n28A MSD | Qualcomm Incorporated | noted | Consensus on MSD value captured in [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip) |
| [**R4-2112018**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112018.zip) | Further discussion on MSD due to UL IMD for DC\_8A-20A\_n28A | MediaTek Inc | noted | Consensus on MSD value captured in [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip) |
| [**R4-2113404**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113404.zip) | Discussion on DC\_8A-20A\_n28A | Huawei, HiSilicon | noted | Consensus on MSD value captured in [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip) |
| [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip)  | TP for TR 37.717-21-11: DC\_8A-20A\_n28A | Huawei, HiSilicon | revised | Capture consensus on MSD and agreements in Rd2 about form factor restrictions. |
| [**R4-2114582**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114582.zip)  | DC\_8-20\_n28 and other LB-LB-LB RF-FE challenges | Skyworks Solutions Inc. | noted | Consensus on MSD value captured in [**R4-2113405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113405.zip)revision |
| [**R4-2113344**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113344.zip) | Discussion on UE RF requirements for DC\_20-38\_n8 | VODAFONE Group Plc | noted | WF on REFSENS assumptions for DC\_20-38\_n8 to capture inputs for next meeting |
| [**R4-2112017**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112017.zip)  | Further discussion on MSD due to IMD5 for CA\_n41C-n66A | MediaTek Inc. | noted | CR to modify MSD value to 32.5dB |
| *Improved MSD Study* |
| [**R4-2112381**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112381.zip) | Views on defining “low MSD” for CA and DC | Apple | noted | Further discussion needed in round 2 to derive few feasibility study options to at least crystalize the different views within RAN4.Depending on the progress how to capture positions is FFSAlso if limited options are on the table, CTW time may be needed to try to provide RAN4 feedback to RAN |
| [**R4-2112572**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112572.zip) | Discussion on low MSD feasibility | Samsung | noted |
| [**R4-2112587**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112587.zip) | Views on Low MSD indicator for IMD | SoftBank Corp. | noted |
| [**R4-2113015**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113015.zip) | Discussion on "Low MSD" for CA and DC | vivo | noted |
| [**R4-2114223**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114223.zip) | Signaling low MSD for CA and DC combinations | Qualcomm Incorporated | noted |
| [**R4-2114567**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114567.zip) | Discussion on the feasibility of MSD improvement | Huawei, HiSilicon | noted |
| [**R4-2114570**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114570.zip) | Discussion on defining ”low MSD” for NR CA and DC band combinations | CHTTL | noted |
| [**R4-2114578**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114578.zip) | Selection Criteria for CA/DC candidates eligible to improved MSD | Skyworks Solutions Inc. | noted |
| [**R4-2113906**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113906.zip) | R17 MSD improvement | OPPO | noted |
| *Band combinations corrections for FR1 and FR2* |
| [**R4-2112904**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112904.zip) | Discussion on inter-band CA Tx RF requirements | ZTE Corporation | Noted |  |
| [**R4-2112910**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112910.zip) | CR to TS38.101-1: Inter-band NR CA Tx requirement including intra-band non-contiguous CA and combinations of intra-band and inter-band CA UL configuration | ZTE Corporation | Stays Return to | Companies requested more time to check => review in Rd2 |
| [**R4-2112723**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112723.zip) | On configurations for SUL band combination with inter-band CA | ZTE Corporation | Noted |  |
| [**R4-2112724**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112724.zip) | CR to TS 38.101-1 on corrections to configuration for SUL bands | ZTE Corporation | Stays Return to, may need revision in Rd2 | Further discussion needed in RD2 may need to revise  |
| [**R4-2113573**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113573.zip) | Rel-17 draft CR 38.101-1, band combination corrections | Ericsson | Stays Return to | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2113574**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113574.zip) | Rel-17 draft CR 38.101-2, band combination corrections | Ericsson | Stays Return to | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2113575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113575.zip) | Rel-17 draft CR 38.101-3, band combination corrections | Ericsson | Stays Return to | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112721**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112721.zip) | Optimization to NR FR2 configurations for intra-band non-contiguous CA | ZTE Corporation | Noted |  |
| [**R4-2112722**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112722.zip) | CR to TS 38.101-2 on corrections to intra-band non-contiguous CA | ZTE Corporation | Stays Return to | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112352**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112352.zip) | CR for TS 38.101-1: Correcting CA frequency setup for 2UL interband reference sensitivity | Apple | Stays Return to | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112353**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112353.zip) | CR for TS 38.101-3: Correcting DC frequency setup for 2UL interband reference sensitivity | Apple | Stays Return to | No comment should be agreeable but better to leave time in Rd2 for review |
| [**R4-2112358**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112358.zip) | CR for TS 38.101-1 Rel-17: Applying n40 and n41 spurious emissions on CA | Apple | To be revised | Revision needed because of R16 discussion, this revision needs to address comments in this thread. |
| *NR-U contiguous UL CA* |
| [**R4-2112304**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112304.zip) | NRU ULCA including wideband operation | Skyworks Solutions Inc. | Noted | WF on NR-U UL CA cases and evaluation assumptions to capture agreements |
| *n5B UL CA* |
| [**R4-2114579**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114579.zip) | CA\_n5B MSD Measurements | Skyworks Solutions Inc. | 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** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | 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

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| Skyworks Solutions Inc. | Dominique Brunel | Dominique.brunel@skyworksinc.com |
| Skyworks Solutions Inc. | Laurent Noel | laurent.noel@skyworksinc.com |
| Samsung | Bozhi Li | Bozhi.li@samsung.com |
| ZTE | Zhifeng Ma | ma.zhifeng@zte.com.cn |
| Sony | Kun Zhao | kun.1.zhao@sony.com |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

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)