**3GPP TSG-RAN WG4 Meeting #98-e R4-20XXXX**

**Electronic Meeting, Jan .25 – Feb. 5 2020**

**Agenda item:** 7.11.1

**Source:** Huawei, HiSilicon

**Title:** Email discussion summary for RAN4#98\_#109\_NR\_RF\_FR1

**Document for:** Information

# Introduction

This part includes contributions in agenda 7.11.1.

Classify the contents into 5 topics:

1. Topic #1: intra-band CA requirement in Rel-16
2. Topic #2: Switching period between case1 and case2

candidate target of email discussion are as below:

* 1st round:
	+ Reach consensus on the left issue for intra-band UL CA
	+ Agree on the CRs if possible
* 2nd round:
	+ Anything not completed in 1st round

#  Topic #1: intra-band CA Rel-16

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100160 | Interdigital | **Rel-16 CR:****Introduction of Pcmax requirements for inter-band CA category A-B combos in sub-clause 6.2A.4.1.3 is required for inter-band CA category A-B since the current specification supports only one UL serving cell per band, while A-B category requires intra-band CA in one of the bands, which is the case for the proposed CA\_n46A-n48B combination.** |
| R4-2100162 | Qualcomm | **Rel-16 CR:**1. **Allocate RBs in PCC and make PCC closest to downlink.**
2. **Make it clear that reference applies to 1UL/2DL or 2UL/2DL**
3. **Correct RB allocation in the 160RB + 79RB case.**
 |
| R4-2101178 | Qualcomm | • **Observation 1:** **pcmax\_L,f,c(i),i(p) and pcmax,L,f,c(i),j(q) are the single CC pcmax which references MPR, AMPR from the single CC tables, but the Pcmax for intra-band CA must reference the CA MPR and AMPR tables as was shown when the CCs have the same slot patterns.****• Observation 2:****Does TAG apply to intra-band ULCA? Serving cells are collocated and synchronized, so should overlapping slots and TAGs be discussed in the intra-band Pcmax section? It seems this should only apply to inter-band CA.****• Proposal 1: Pcmax for intra-band CA must have more discussion and clarification for observations 1 and 2.** |
| R4-2101285 | Intel | **Rel-16 CR:****Clarify BCS fallback rules based on approved WF R4-2016935.*** **The channel bandwidths that are supported by a UE in a higher order combination are independent of the fallback combinations, even if the fallback combination BCSs do not contain those channel bandwidths, the UE needs to support the CBWs of the higher order combination in the fallbacks.**
* **All supported bandwidths of the higher order combinations need to be properly specified in 38.101 for that combination and its fallbacks, since the higher order combination references MSD and A-MPR of the lower order combinations, which must be specified for the supported bandwidths**
* **If a UE supports fallback BCSs with additional channel BWs compared to the higher order configuration, it needs to signal these supported BCSs separately to the network**
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| R4-2102410 | Qualcomm | **Rel-16 CR:**PEMAX,CA definition is missing for intra-band contiguous and intra-band non-contiguous CA. The use of PPowerClass is ambiguous since a distinction is needed between the power class per cell and the power class for the CA configuration. |
| R4-2102600 | Apple | **Rel-16 CR:**1. Revise the FR1 UL NC CA frequency separation classes definition in Table 5.3A.5-2 from specifying a frequency range to only defining the upper limits.2. Revise the UE power class lower tolerance in Table 6.2A.1.2-1 from -2 dB to -3 dB. |
| R4-2102626 | Huawei | ***Proposal 1: we provide 2 options on separation class definition:******Option 1: keep separation class definition in current TS 38.101-1 5.3A.5.******Option 2: Report separation class UE can support for each RF chain/PA, and separation class is defined as in [1].***[1] R4-2014909, “FR1 intra-band UL NCCA frequency separation and power class”, Apple, RAN4 #97-e |
| R4-2102682 | Huawei | ***Observation 1: According to RAN1/2 spec on PUSCH processing capability, the delay between UL DCI and PUSCH transmission can be different for CCs. It means that DCI timing for PUSCH transmission overlapped in time for CCs can be different. It can be depicted in figure 2:******Observation 2: For NR intra-band UL CA, Pcmax,f,c for PHR reporting cannot be ensured to use the same Pcmax,f,c in physical layer: Ppowerclass-max(MPR, AMPR), where MPR and AMPR are specified for intra-band UL CA.*** ***Proposal 1: For NR intra-band contiguous and non-contiguous UL CA, the Pcmax,f,c for each CC is defined as the Pcmax using the MPR defined for single carrier.*** |

## Open issues summary

### Sub-topic 1-1 intra-band UL CA Pcmax: MPR/AMPR value of single CC

**Issue 1-1-1: for intra-band UL CA, if DCI for transmission of one CC(CC1) come after the PHR trigger of the DCI for the other CC(CC2), how UE report PHR for CCs to the network? Note, in which the UL transmission for CCs are overlapped in time, as seen in below figure.**



* Proposals
	+ Option 1: CC1’s PHR will ignore transmission on CC2 although their transmissions are overlapped in time
	+ Option 2: other
* Recommended WF
	+ **TBA**

**Issue 1-1-2: If Option 1 for issue1-1-1, how to calculate the Pcmax value for CC1 in the PHR report?**

* Proposals
	+ Option 1: Pcmax,f,c for CC1’s PHR will use the MPR/AMPR value in single CC table.
	+ Option 2: Other
* Recommended WF
	+ **TBA**

**Issue 1-1-3: If option 1 for issue 1-1-2, how to define MPR/AMPR value for each CC in intra-band UL CA?**

* Proposals
	+ Option 1: the Pcmax,f,c for each CC is defined as the Pcmax using the MPR/AMPR defined for single carrier.
	+ Option 2: Other
* Recommended WF
	+ **TBA**

### Sub-topic 1-2 intra-band UL CA Pcmax: TAG

**Issue 1-2-1: Can we confirm there is only one TAG for intra-band UL contiguous and non-contiguous CA**

* Proposals
	+ **Option 1:**  **Only one TAG for intra-band UL CA**
	+ **Option 2: Other**
* Recommended WF
	+ **TBA**

### Sub-topic 1-3 intra-band NC CA separation class

**Issue 1-3-1: If separation class is defined as in R4-2102600, with UE indicate ≤600MHz&2PA capability, how gNB validate UE that support ≤200MHz with 1PA capability, and thus the UE can support 2 layer MIMO?**

* Proposals
	+ **TBD**
* Recommended WF
	+ **TBA**

**Issue 1-3-2: If current separation class definition in TS 38.101-1 is kept, with UE indicate ≤600MHz and >200MHz and 2PA capability, how gNB validate the UE also support separation ≤200MHz?**

* Proposals
	+ **Option 1:** As described in R4-2102626, UE could also indicate ≤200MHz and >100MHz separation class to the network, meanwhile 1PA architecture could be indicated simultaneously. i.e. 2 sets of NC CA UE capability are indicated, one is ≤600MHz and >200MHz and 2PA capability, the other is ≤200MHz and >100MHz and 1PA architecture.
	+ **Option 2:** other
* Recommended WF
	+ **TBA**

## Companies views’ collection for 1st round

### Open issues

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| **Sub-topic** | **Comments: (Company: …)** |
| 1-1 | **Issue 1-1-1:**Huawei: we support option 1, as it is already agreed by RAN1.Nokia: Thanks Huawei for a valuable input. But we would like to study this more. There are requirements like total configured maximum output power PCMAX where MPR/A-MPR for CA is used. If we just follow RAN1 agreement that Huawei referred to, what the meaning of these RAN4 requirements etc. Also if the same approach has been taken in LTE as well, better to check what has been tested etc.Qualcomm: Option 1 |
| **Issue 1-1-2:**Huawei: since CC1’s PHR ignore the transmission on CC2, CC1 will use MPR/AMPR value in single CC table.Nokia: The same as those in Issue 1-1-1Qualcomm: Option 1. |
| **Issue 1-1-3:**Huawei: we support option 1, for the case that DCI for transmission of one CC(CC1) come after the PHR trigger of the DCI for the other CC(CC2), MPR/AMPR for each CC in single CC table is applied. We are open to discuss on better solution.Nokia: The same as those in Issue 1-1-1Qualcomm: Option 2. While it may be possible for CC1 to use single carrier MPR, CC2 may not be able to if there is overlapping transmission. It cannot use the MPR from standalone single carrier because there is overlapping transmission. Moreover, since CC1’s Tx power is already fixed, CC2 must take the necessary MPR to ensure that the simultaneous transmission from CC1 and CC2 meets emission requirements, or drop its transmission otherwise. The better solution would be to align the processing timeline. |
| 1-2 | **Issue 1-2-1:**Huawei: in TS 38.133, there is no requirement for intra-band CA MTTD. In RAN1 spec, there is no limitation on intra-band CA that multiple PUCCH group could be configured. From TS 38.133, It seems there is only one TAG for intra-band UL CA. |
| 1-3 | **Issue 1-3-1**The key problem is: for RF architecture with 2 chains supporting intra-band NC CA, we don’t know what is the reference architecture for the reported separation class, it may be 1Tx , or may be 2Tx. For separation capability with definition of <=600MHz, UE is highly possible support it with 2Tx, while when the separation is <=200MHz, maybe 1Tx is applied. However, UE cannot indicate clearly by the separation definition in R4-2102600.Nokia:Can we divide the discussion CA and CA+UL MIMO, since the latter’s introduction into Rel17 is being discussed…As far as CA alone is concerned, in any case, with the provided case, network would just consider the UE can deal with UL CA up to 600MHz. Wouldn’t it be possible for UE to report how many UL MIMO layers are possible per CC via FeatureSetUplinkPerCC?Qualcomm: We prefer option 2 as in R4-2102600 using only the upper limits because the whole purpose is to indicate the maximum NC ULCA separation UE can support if it does NOT declare 2PA. Maybe we need to add this additional sentence to improve the clarification in the spec. So, If UE does not declare 2 PA, then UE indicates the maximum class it can support….It is understood that if you declare 2PA, then UE can support maximum separation class as in inter-band CA.Apple:The Rel-16 intra-band non-contiguous UL CA requirements were defined based on the assumption of dual PA which in principle should not have frequency separation limitation within the band range. Our understanding on the introduction of frequency separation class in FR1 is intended for UE which may use single PA for non-contiguous configuration where it would be subjected to certain frequency separation capability to meet the existing requirements. We suggest to separate the discussions of UL MIMO support and CA separation class requirement definition as they can be taken care by proper signaling solution.  |
| **Issue 1-3-2**We support option 1. We are open to discuss on better solution.AppleOption 2It is still not clear how option 1 works. If UE uses 2 PAs, why would it be limited to below 600 MHz? Does that mean non-contiguous configuration with separation wider than 600 MHz in n77 cannot be supported at all? Also for 1PA why do we need to have lower bound at 100MHz? Would it be misunderstood that separation < 100 MHz cannot be supported at all?The solution can be very simple, UE either signals 2 PA without frequency separation limitation or 1 PA with frequency separation upper limit.  |

### CRs/TPs comments collection

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

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| **CR/TP number** | **Comments collection** |
| R4-2100160 | Title: Introduction of specific Pcmax requirements for inter-band CA category A-B combos |
| Huawei:For PCMAX\_L (p,q,k) = MIN {10 log10 [pCMAX\_L,f,Bi(p) + pCMAX\_L,f,c(3),Bj(k)], PPowerClass}PCMAX\_H (p,q,k) = MIN {10 log10 [pCMAX\_ H,f,Bi (p) + pCMAX\_ H,f,c(3), Bj(k)], PPowerClass}Whether Pemax,CA is needed in the equation?CHTTL: There is no uplink inter-band CA category A-B combos in Rel.16. The uplink inter-band CA category A-B combos are going to be introduced in Rel.17, this CR should be introduced from Rel.17 rather than Rel.16.Nokia: shouldn’t we discuss this after we resolve an issue raised in R4-2102682?InterDigital: Thanks to all of you for the comments. I will address them one by one:@Huawei: Yes, I believe you’re right and we will have to add PEMAX,CA, to the equations, since p-UE-FR1 is a per UE maximum power when UE is configured for CA.@CHTTL: Indeed. After offline discussions we agreed to revise the CR and target Rel-17 as cat B and use the WID as: NR\_CADC\_R17\_2BDL\_xBUL-core@Nokia: This CR has a pointer to the intra-band contiguous subclause 6.2A.4.1.1. So, in our opinion, whatever would be done based on R4-2102682 outcome, it will have no effect on this CR. As a conclusion, I would like to kindly ask for a revision Tdoc number. Qualcomm: For the case of same slot pattern and numerology across all p, q, and k, the index of summation is not clear. For the case where slot k has different slot pattern and/or numerology in a different band, the summation only includes pcmax terms related to slot p and slot k. Why is slot q missing?  |
| R4-2100162 | Title: CA\_n7B\_REFSENS\_CatF\_CR |
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| R4-2102588Cat. A CR | Title: CA\_n7B\_REFSENS\_CatF\_CR |
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| R4-2101285 | Title: CR to 38.101-1 (Rel-16) fall back behaviors |
| CHTTL: just curious this fallback behaviors start from Rel.16 onwards?Nokia: Capturing an agreement based on WF is OK. We think that the agreement is can be addressed by what 36.101 captured. Why don’t we reuse the text from 36.101? Consistency between 36.101 and 38.101 is required. Otherwise, it seems applicability of fallback rule between LTE and NR is different.Qualcomm: We agree with the intent of the CR but we would like to propose alternative wording. Please crosscheck if intent is captured correctly, among other things.The main change is to clarify that there is no concept of fallbacks for BCS. Other changes are editorial.*A terminal that explicitly indicates support for a DL CA combination and bandwidth combination set (‘upper order’) shall continue to support all the bandwidths therein in each of the implicit fallback configurations, regardless of whether the UE terminal explicitly indicates support for a lower order fallback DL CA combination. The terminal is expected to explicitly indicate support for a lower order fallback DL CA combination and bandwidth combination set if it can support bandwidths not contained in the bandwidth combination set of the upper order DL CA combination*Intel: * To CHTTL: The topic was discussed under BC simplification and the actual release is not clear. We are open for further discussion but starting from Rel-16 and onward is a possible option as Rel-15 device is already on the market.
* To Nokia: We understand the agreement from 36.101 is different from the WF (R4-2016935).
* To Qualcomm: The suggested wording looks fine as well but could you share more detail why Qualcomm wants to have an alternative wording?
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| R4-2101286Cat. A CR | Title: CR to 38.101-1 (Rel-17) fall back behaviors |
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| R4-2102410 | Title: Corrections to PCMAX for UL CA |
| Ppowerclass->Ppower class,CA is unnecessary, because it is aligned with the definition for inter-band CA Pcmax.TS 38.331 should be a reference number.Revision on inter-band CA pcmax need to start from Rel-15? |
| R4-2102411CAT. A CR | Title: Corrections to PCMAX for UL CA |
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| R4-2102600 | Title: CR for TS 38.101-1: Corrections to intra-band UL NC CA requirements |
| The key problem is: for RF architecture with 2 chains supporting intra-band NC CA, we don’t know what is the reference architecture for the reported separation class, it may be 1Tx , or may be 2Tx. For separation capability with definition of <=600MHz, UE is highly possible support it with 2Tx, while when the separation is <=200MHz, maybe 1Tx is applied. However, UE cannot indicate clearly by the separation definition in R4-2102600.Nokia: we need to understand what the technical justification to apply delta TC to n78 and n77 is.Apple: Thanks Nokia for the question. The technical justification was provided in last RAN4 meeting in R4-2014909. The reason is that for intra-band non-contiguous UL CA, the requirements were defined based on dual PA implementation. The lower tolerance is allowed for 1 more dB to account for the mismatch between the two Tx paths which has been considered in inter-band/intra-band EN-DC, inter-band UL CA, and UL MIMO. The proposal was already agreed in last RAN4 meeting. |
| R4-2102601CAT.A CR | Title: CR for TS 38.101-1: Corrections to intra-band UL NC CA requirements |
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## Summary for 1st round

### Open issues

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

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| Sub-topic#1 | *Recommendations for 2nd round:* |
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*Recommendations on WF/LS assignment*

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

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

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
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## Discussion on 2nd round (if applicable)

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| T-doc number | Title | Comments |
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## 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*

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| **CR/TP/LS/WF number** | **Title** | **T-doc Status update recommendation** |
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# Topic #2: Switching period between case 1 and case 2

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100596 | Qualcomm | Rel-16 CRUE will lose it cohrence between two antenna ports when it uses one or both TX chains to transmit on an other band. This exception was not added to the list of coherent UL MIMO section during the WI. Added exception for TX switching for coherent UL MIMO requirement validity to the section 6.4D.4 |
| R4-2100792 | China Telecom | Rel-16 CR1) Correct the reference section number of 38.214.2) Correct the capability and IE name for power boosting.3) Minor editorial modification. |
| R4-2100793 | China Telecom | Rel-16 CR1) Indicate that power boosting for 1Tx-2Tx switching between two uplink carriers is only applicable for CA power class 3.2) Correct the reference section number of 38.214.3) Correct the capability and IE name for power boosting.4) Minor editorial modification |
| R4-2100794 | China Telecom | Rel-16 CRCorrect the reference section number of 38.214. |
| R4-2101145 | MediaTek | Rel-16 CR**The timing difference requirement between EUTRAN carrier and NR carrier for Tx switching is missing is current spec. From Tx switch perspective, timing toerlance has no difference between inter-band EN-DC and intra-band EN-DC. Thus we propose 3us timing diference from WID RP-193266.** |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1 Coherent MIMO requirement and Tx switching

**Issue 2-1-1: For case 1 and case 2 Tx switching in Rel-16, whether UE can keep its coherence between 2 antenna ports when switching is happened between last transmitted SRS and scheduled transmission with 2 antenna port? Why?**

* Proposals
	+ CR R4-2100596 shows UE cannot keep its coherence between 2 antenna ports when switching is happened

Moderator note: there is no technical analysis on why coherence cannot be kept

* Recommended WF
	+ TBA

**Issue 2-1-2: If uplinkTxSwitchingPeriodLocation located on the scheduled transmission with 2 antenna ports, does coherence maintained?**

* Proposals
	+ Option 1: Yes
	+ Option 2: No

Moderator note: CR shows UE cannot maintain its coherence only for uplinkTxSwitchingPeriodLocation located between SRS and scheduled transmission

* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

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| **Sub-topic** | **Comments (Company: …)** |
| 2.2.1 Sub-topic 2-1 Coherent MIMO requirement and Tx switching | **Issue 2-1-1: For case 1 and case 2 Tx switching in Rel-16, whether UE can keep its coherence between 2 antenna ports when switching is happened between last transmitted SRS and scheduled transmission with 2 antenna port? Why?**China Telecom: When Tx switching is enabled by RRC, if coherence between 2 antenna ports cannot be kept and coherent UL-MIMO cannot be used, we are afraid of the negative performance impact for the network.Huawei: in our understanding, coherence between antenna port can be maintained after switching between case1 and case2. We would like to see the explanation from company raise the CR.CHTTL: share the similar view as China Telecom.Qualcomm: To respond moderators concerns on technical explanation, the reason is same as for the cases int the specification already:* *UE is not signaled with a change in number of SRS ports in SRS-config, or a change in PUSCH-config*
* *No instance of SRS transmission with the usage antenna switching occurs*

With these in mind, if the UE needs to change its TX to port mapping, the coherence will be lost since the TX chain state is not preserved in relation to the other TX chain state.  |
| **Issue 2-1-2:** |

### CRs/TPs comments collection

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

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| **CR/TP number** | **Comments collection** |
| R4-2100596 | Title: UL Switching and coherent UL MIMO Cat-F CR 38.101-1 |
| Huawei: in our understanding, coherence between antenna port can be maintained after switching between case1 and case2. We would like to see the explanation from company raise the CR.Apple: Agree with the observation and the CR. |
| R4-2100597Cat. A CR | Title: UL Switching and coherent UL MIMO Cat-A CR 38.101-1 |
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| R4-2100792 | Title: CR for TS 38.101-1: Correction on 1Tx-2Tx switching between two uplink carriers (Rel-16) |
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| R4-2100793 | Title: CR for TS 38.101-1: Correction on 1Tx-2Tx switching between two uplink carriers (Rel-17) |
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| R4-2100794 | Title: CR for TS 38.101-3: Correction on 1Tx-2Tx switching between two uplink carriers (Rel-16) |
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| R4-2100795Cat. A CR | Title: CR for TS 38.101-3: Correction on 1Tx-2Tx switching between two uplink carriers (Rel-17) |
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| R4-2101145 | Title: Clarification on timing difference for Tx switching in EN-DC R16 |
| China Telecom: It seems not clear to us whether the max timing difference added here is for BS or UE. If it is for BS, can the time alignment error requirement defined in 38.104 be applicable? If it is for UE, is it the applicable max transmit timing difference or receive timing difference that UE can handle?MTK: To China Telecom, since 38.101-3 is a UE requirement spec, the max timing diff is from UE perspective. From implementation point-of-view, we need a clear requirement on the max timing difference for UE’s internal controling.CHTTL: follow up for clarification the max timing difference from the UE perspective here means the maximum timing difference that UE can handled between 2 carriers? Does it already covered in 38.133 spec?And even the wording is added here, it does not impact the requirement, is it correct understanding?Nokia: It seems for what max timing difference is not clear.Apple: In 38.133, the MTTD for synchronous intra-band EN-DC is defined as 5.21 ms. Is there any relationship to the maximum timing difference of 3 s between the two uplink carriers as proposed in this CR? MTK (2nd comment):**To CHTTL**: Yes, your understnading is correct. It is not covererd by TS38.133. The scenario we for this Tx switching is inter-band EN-DC. But if we follow the requirements of TS38.133 for itner-band EN-DC, the MTTD can be up to 35.21us, which actually does not work for Tx switching. **To Nokia**: Perhaps we can clarify in the revision that this is for “the max timing difference 3us between two uplink carriers at UE.**To Apple**, we borrow this value from WID for time masks of ULSUP-TDM. Timing difference 5.21us is also fine to us, since in the end what we need is a reasonable max value to control the complexity in implementation. We are a bit hesitate to directly refer to 38.133 because 1) in other time mask requirements, the timing difference are provided directly, 2) as we mentioned in the reply to CHTTL, we are now in a inter-band EN-DC case, but we need an MTTD of intra-band EN-DC. Citation could cause more confusion. |
| R4-2101146Cat. A CR | Title: Clarification on timing difference for Tx switching in EN-DC R17 |
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## Summary for 1st round

### Open issues

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

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| **Sub-topic#3** | **Status summary**  |
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*Suggestion on WF/LS assignment*

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

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

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
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## Discussion on 2nd round (if applicable)

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| T-doc number | Title | Comments |
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## 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*

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| T-doc number | Title | **T-doc Status update recommendation**  |
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