**3GPP TSG-RAN WG4 Meeting # 96e RP-201733**

**Electronic Meeting, 17 – 28 Aug., 2020**

**Agenda item:** 17.2.2

**Source:** Moderator (Huawei, HiSilicon)

**Title:** Email discussion summary for Rel-17 RF FR1 working area

**Document for:** Discussion

# Introduction

In RAN#88e meeting the work areas of RAN4 R17 non-spectrum related WI/SIs was endorsed in [1]. One of working areas is for RF FR1 enhancement. This contribution provides summarized the proposals based on the related contributions in RAN#88e [2~5].

The following proposals are included in this summary:

* Topic#1: Tx switching enhancement, i.e., enabling Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2 based on SUL and NR uplink CA
* Topic#2: 2Tx RF requirement and testing enhancement
* Topic#3: Optimizations on power class fall back
* Topic#4: 26dBm HPUE for TDD intra-band contiguous UL CA
* Topic#5: Efficient utilization of spectrum which is not aligned with existing NR channel bandwidths
* Topic#6: Support overlapping CA for LTE

Companies are welcome to provide the comments. Based on the comments and responses, the topics will be further discussed during RAN4 August meeting and RAN plenary in September.

# Topic #1: Tx switching enhancement

*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** | **Proposed objective(s)** |
| RP-200614 (with modification) | Huawei, HiSilicon | * UE requirements to enable Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2 based on SUL and NR uplink CA
	+ Specify UE time mask requirements for UL Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2
		- UE switches Tx-s with both SUL and NR uplink CA configurations, under the condition that there are only 2 simultaneous Tx at maximum
		- Strive to reuse RAN1 mechanism for Tx switching between case 1 and case 2 in Rel-16
		- Strive to reuse RAN2 signaling for Tx switching between case 1 and case 2 in Rel-16
	+ Enable more SUL/TDD/FDD bands to support 2Tx
		- Specify the necessary Tx requirements
		- Specify the necessary Rx requirements
		- Remove RAN2 restrictions on SUL band UL-MIMO configuration
		- PC2 HPUE can be considered for FDD and SUL bands after related study is complete
	+ Specify the DL interruption RRM requirements, if needed

Note 1: Only addressing the case of co-located and synchronized network deployment for the two UL carriersNote 2: Only addressing the case of single TAG for the two UL carriers for SUL and for UL CANote 3: The UE is configured with two different uplink carrier frequencies. |

## Open issues summary

The motivation for this proposed objective is as follows [2].

In Rel-16 the mechanism and RAN4 requirements are specified for Tx switching between case 1 and case 2. The motivation is to select the better uplink carrier and better transmission mode in a given slot for transmission assuming that there are only two con-current transmitters. In Rel-16 it is assumed that only one transmitter can be supported on one carrier and two transmitters can be supported on the other carrier. But recently two transmitters are enabled for more NR bands. Thus it would be possible for UE to support two transmitter on both carriers. In this case, the Tx switching would be conducted between two carriers which are both capable of 2Tx transmissions. The uplink throughput could be further improved. In the meanwhile, UL-MIMO requirements for interested SUL/TDD/FDD bands are to be further specified to enable UE 2Tx transmissions on both carriers when configured switching with SUL or UL-CA band combinations.

### Sub-topic 1-1

*Sub-topic description:*

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

**Issue 1-1: Specify UE requirements to enable Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2**

* Sub-objective#1: Specify UE time mask requirements for UL Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2
	+ UE switches Tx-s with both SUL and NR uplink CA configurations, under the condition that there are only 2 simultaneous Tx at maximum
	+ Strive to reuse RAN1 mechanism for Tx switching between case 1 and case 2 in Rel-16
	+ Strive to reuse RAN2 signalling for Tx switching between case 1 and case 2 in Rel-16
* Sub-objective#2: Specify the DL interruption RRM requirements, if needed
* NOTEs for above sub-objectives
	+ Note 1: Only addressing the case of co-located and synchronized network deployment for the two UL carriers
	+ Note 2: Only addressing the case of single TAG for the two UL carriers for SUL and for UL CA
	+ Note 3: The UE is configured with two different uplink carrier frequencies.

### Sub-topic 1-2

*Sub-topic description*

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

**Issue 1-2: Enable more SUL/TDD/FDD bands to support 2Tx**

* Sub-objective#1: Add more SUL/TDD/FDD bands to support 2Tx
	+ Specify the necessary Tx requirements
	+ Specify the necessary Rx requirements
* Sub-objective#2: Remove RAN2 restrictions on SUL band UL-MIMO configuration
* For above two sub-objectives, PC2 HPUE can be considered for certain bands after related study is completed.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Sub topic 1-1: Need to be careful to saying that “Strive to reuse RANx mechanism”. We shall make sure that if there are RAN1/RAN2 impacts or not before we move forward to WI if this topic can be part of a WI. We should not introduce new feature before we introduce a fundamental clear requirement like transparent Tx diversity and stable UL MIMO requirements.Sub topic 1-2: This topic was not included into the originally proposed WID in RAN#88e. This topic is fundamentally independent topic from Tx switching. We do not think that mixing two independent topics is a good way. We should not introduce new feature before we introduce a fundamental clear requirement like transparent Tx diversity and stable UL MIMO requirements….Others: |
| Intel | In general, we suggest to have an example band combination for further discussion.Sub topic 1-1: * Not sure whether a new timing requirement is needed on top of the one RAN4 already defined in Rel-16 and the existing values can be reused for the proposed scenario.
* For scenario with switching between SUL and NR uplink CA, do we correctly assume that that there is no simultaneous operation between SUL and NR UL CCs and that SUL CC has 2TX?
* Are there any applicable operation scenarios other than SUL? Are LTE and EN-DC also applicable?

Sub topic 1-2:Sub-objective#1: Add more SUL/TDD/FDD bands to support 2Tx* Overall, we are fine to add 2Tx support for additional bands.  However, would it be better to have some basket approach, since such type of work is expected to continue in the future?
* PC2 HPUE can be considered for certain bands after related study is completed.

Sub-objective#2: Remove RAN2 restrictions on SUL band UL-MIMO configuration* Support removing UL-MIMO configuration constraints for SUL. The current constraint is quite artificial and can be removed.
 |
| QC | Sub-topic 1-1: It seems the proposal is about having switching between two TDD bands, each having 2Tx. The gains from a system perspective are not clear, why wouldn’t the UE just use the UL on one of the CCs if any of them can be used? SUL does not currently allow 2Tx, there should be separate WI to introduce support of 2Tx for SUL. Such new feature should not be “hidden” in a completely different WI.Sub-topic 1-2: this was not included in the original proposal. Feature additions to SUL or other bands should be discussed separately in its own WI, not packaged here with a total different proposal without having any clear connection between them. |
| Apple | Sub topic 1-1It is necessary to clarify that the 1-2 Tx carrier switching issues and any impact on power class should be finalized in Rel-16 before the work on 2-2 switching is started in Rel-17.Regarding SUL for 2-2 switching, we don’t currently find any requirements for UL MIMO with SUL. This should be defined as a prerequisite before defining 2-2 switching with SUL.Sub topic 1-2We prefer seeing 2Tx requirements developed as band-dependent work items, each linked to a specific band. This gives the industry a chance to select only bands for which there is operator demand to enable these rather complex investigations in RAN4 and eventual requirements. We recommend the following rewording of the objective: “Add more bands to support 2Tx should be subject to operators’ request and sufficient feasibility study for the candidates bands to support 2Tx.”For sub-objective #2, we cannot agree to remove RAN2 restrictions on SUL band UL-MIMO configuration, since UL-MIMO requirements are not currently defined for SUL. |
| Ericsson | Sub-topic 1-1: The benefits of adding a case 3 with 2TX on the other carrier are not entirely obvious to us. If the switching case 3 is introduced then it would be a framework, and support for 2TX in different bands should be treated separately. Regarding RAN1/2 striving to avoid changes, is the intention that RAN4 strives to avoid such changes and informs RAN1/2 if changes are needed or that the discussion is led in RAN1/2 ?Sub-topic 1-2: We see this as a separate topic than TX switching; it should be treated separately. Fundamentals of UL MIMO and TX diversity should be in place and then band specific requirements may be handled in a basket WI. Regarding “remove RAN2 restrictions” if this is present it should be a RAN2 objective to review the restrictions, clarify that there is a case for removal and then implement if conformed.  |
| OPPO | Sub-topic 1-1: Enabling this feature is ok, but it is not quite clear to us which new RAN4 requirements or changes are needed, better to make it clearer in the WID.Sub-topic 1-2: Sub-objective#1: Supporting 2T generally is ok but the introduction should be based on the feasibility of implementation and real demands from the industry.Sub-objective#2: See no issue of removing the signaling restrictions in SUL bands once the requirements, feasibility have no problem since these SUL bands typically are low bands which may confront with implementation challenges. |
| MTK | Sub topic 1-1: The use case is not clear to us. If both bands are in 3GHz, then the UL performance should be very similar in both bands. Comparing to keep using the same band for 2Tx UL, what is the additional benefit for this switch which may consume additional switch period?Sub topic 1-2: This topics should be agreed first if we want to introduce 2TX-to-2TX switch for SUL. Benefit of using 2Tx in SUL band needs some justification. Not clear about the Rx requirement part.  |
| China Telecom | Sub-topic 1-1: We support this work in Rel-17.With 2Tx enabled for lower frequency at around 2GHz, it is nature to extend the 1Tx-2Tx switching to 2Tx-2Tx switching.For RAN4 work, some Rel-16 outcome for 1Tx-2Tx switching such as the UL switching time can be used as starting point.For RAN1/2 work, similar to Rel-16, it can be triggered by RAN4 LS. Then RAN1 and RAN2 can investigate and decide whether there is any spec impact and update their specification whenever needed.New proposal for Tx switching enhancement:For Tx switching enhancement, we would propose to add the following new bullet, and welcome feedback from more companies: * **Specify UE requirements to enable Tx switching between 1 carrier in one band and 2 contiguous carriers within the other band, under the condition that there are only 2 simultaneous Tx at maximum**

The motivation is that for 2.1/1.8 GHz + 3.5GHz band combination, we have 200MHz or more contiguous spectrum in 3.5GHz. For the purpose of UL Tx switching, the 2 contiguous CCs in the same band can be considered together.This proposal has been initially discussed in Aug RAN1 meeting for Rel-16. Based on our spectrum status, to enable this feature, we would like to finish the whole spec work in RAN4/1/2 in Rel-17. |
| Xiaomi | Sub-topic 1-1: we are ok to discuss this feature in R17. But some clarification like example bands and introducing new requirements or not shall be neededSub-topic 1-2: This is a separate proposal from the original 2Tx switching enhancement. Whether a band is necessary to be implemented with 2Tx should be discussed case by case.* Regarding the new proposal from China Telecom:
* **Specify UE requirements to enable Tx switching between 1 carrier in one band and 2 contiguous carriers within the other band, under the condition that there are only 2 simultaneous Tx at maximum**

We support this new proposal in general and prefer to have a clarification whether the case that one band with MIMO and other band with intra-band CA is also included. |
| CMCC | Sub topic 1-1In RAN4 May e-meeting, UL-MIMO is introduced for several lower FR1 bands, including n1, n2, n3, n7, n25, n30, n34, n38, n39, n40, n48, n66, n70 and n71. So 2Tx-2Tx switching can further improve the UL throughput compared to 1Tx-2Tx switching. The 2Tx-2Tx switching includes FDD+TDD CA, TDD+TDD CA, SUL+TDD. * For CA, since FDD lower bands can also support UL-MIMO, enable 2Tx-2Tx switching improve the UL throughput. The gain is obvious from our perspective. Also for TDD+TDD CA, if two TDD carriers have different UL/DL configuration and with some slot offsets, the UL-MIMO can be transmitted in the UL slots in each TDD carrier and improve the UL throughput.

* For SUL+TDD, SUL does not support UL-MIMO so far, the main reason is that existing SUL bands is relative low and does not support UL-MIMO. However, since UL-MIMO are introduced for lower bands, it is feasible for SUL bands to support UL-MIMO, e.g. n1 SUL, n39 SUL, n40 SUL and etc. In Rel-16 1Tx-2Tx switching, the switching period requirements are common for SUL and CA. So 2Tx-2Tx switching requirements can also apply to both SUL and CA.

Sub topic 1-2As we commented above, technically, SUL bands can support UL-MIMO since the original TDD/FDD bands already support UL-MIMO.We support to specify UL-MIMO for SUL bands and requirements first in RAN4. According to the experience of introducing UL-MIMO to FDD/TDD bands, CRs are sufficient to introduce UL-MIMO to SUL bands. After RAN4 specified the requirements, RAN2 need to remove the restrictions on SUL band UL-MIMO configuration.Regarding the power class issue, there is another approved WI on HPUE UL CA covered the SAR solution for both CA and SUL. So there is no need to include any power class discussion in this WI. |
| LGE | Sub-topic 1-1: Need to discuss more on the scenario for UL Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2.Sub topic 1-2: Sub-objective#1: Add more SUL/TDD/FDD bands to support 2Tx This topics should be agreed first for the necessity and benefit of using 2Tx in SUL band needs to be clarified. It is not clear about the Rx requirement part. |
| ZTE | Sub-topic 1-1:More clarification is required for Tx switching between 2Tx@carrier #1 and 2Tx@carrier #2 for SUL scenario. Currently SUL does not support UL-MIMO. A separate topic to discuss whether or not to enable UL-MIMO support for SULSub-topic 1-2:Before a decision made on the support of UL-MIMO for SUL, the sub-objective #2 is not acceptable |
| Samsung | Sub-topic 1-1: Share similar view with Intel that it is better to start with an example band combination with 2Tx already supported for each carrier.Sub-topic 1-2: Sub-objective#1: we are open to support 2Tx for some relative high SUL bands but it should be studied in a separate WI/SI.Sub-objective#2: before 2Tx is enabled for SUL bands, it is premature to remove RAN2 restrictions on SUL band UL-MIMO configuration. |
| vivo | Sub-topic 1-1: we are generally fine with this idea as it seems to be an extension for what Rel-16 is defined. As proposed by other companies, certain clarification on the benefits / Spec changes is welcomed.Sub-topic 1-2: FDD HPUE is still pre-mature to be discussed since even a SI is not be agreed for Rel-17. |
| Huawei | To Nokia, Regarding the comment on sub-topic 1-1, this work is Tx switching between different cases where UE RF chains are on different carriers. It is decoupled from any enhancement for Tx diversity and for UL-MIMO from the perspective of defining the requirements. And based on the existing RAN1 specification for Tx switching between case 1 and case 2, the Tx diversity and UL-MIMO operation for Tx switching have already been covered. If company think that “strive to” is vague, we can list which part in RAN1 or RAN2 specifications need the update, which would be small according to our analysis. The purpose here is to minimize the impact on RAN1/RAN2.Regarding the comment on sub-topic 1-2, this objective was updated and the revised version is uploaded into inbox. The purpose is to allow UL-MIMO configuration for SUL and introduce the 2Tx UL-MIMO requirement for more bands. Actually it is relative independent from the 1-1. But 1-1 depends on 1-2 as the pre-requisite. We can change a little bit by adding the clear sub-bullet under 1-1 to enable the support of UL-MIMO for SUL bands and keep 1-2 as introduction of UL-MIMO for more TDD and FDD bands. In that way, the two objectives are decoupled.To Intel,We can have an example band combination for it. But we think the requirements would not be band specific rather band agnostic.For the “new timing requirement”, if we understand correctly, you mean the switching period values of {35, 140, 210}us. We are open to the new values. But according to our internal analysis, the existing values seems sufficient. The longer value, the bigger impact due to interruption. We wonder if there is still benefit if the switching time is too long. One alternative way than introduction of longer value would be that UE reports not to support. Besides, we are also open to smaller value.For the scenario, we prefer not to transmit SUL and NR UL CCS on different bands simultaneously. But we think other companies would still be interested in UL CA based solution Option 2. So we would like to be open to the scenario. From our side, we would like to limit the scenario to maximum 2Tx simultaneous transmissions on one band and no simulation transmission on two bands.Regarding the question “are there any applicable operations other than SUL? Are LTE and EN-DC also applicable”, we are not very interested in EN-DC, since according to our understanding there seems no commercial LTE UE which can support 2Tx. Thus we do not consider 2Tx switching between LTE carrier and NR carrier. But we are open if other companies think that is still valid use case.Regarding comment on sub-topic 1-2, OK. We are open to the basket approach. If other companies are OK, we can provide a basket WI dedicated for it.Thanks for supporting removing RAN2 restriction on SUL for UL-MIMO configuration.To Qualcomm:Regarding the comments on sub-topic 1-1, firstly the gain comes from the fully utilization of available uplink resources. Take an SUL + TDD band for an example. Assuming SUL band has 20MHz channel bandwidth and TDD band has 100MHz channel bandwidths. When the slot on TDD band is DL slot, UE can switch both 2Tx on SUL band and when the slot on TDD band is UL slot, UE can switch both 2Tx on TDD band. Following this approach, UE can optimize the utilization of limited uplink transmit RF chains to optimize the uplink throughout. In our view, that is where the gain come from.The support of 2Tx on SUL band is not hidden agenda. Actually in objective corresponding to sub-topic 1-2, we propose to enable UL-MIMO for SUL,i.e., *Sub-objective#2: Remove RAN2 restrictions on SUL band UL-MIMO configuration*. The reason why SUL cannot support UL-MIMO is that companies did not want to enable 2Tx@SUL to 2Tx@NUL switching in Rel-15. Now more and more FDD/TDD bands are enabled to supported 2Tx. There seems no difficulty for UE to support 2Tx UL-MIMO on the corresponding SUL bands. And now since operators also support enabling 2Tx to 2Tx switching, as the pre-requisite, we should first enable UL-MIMO on SUL band.Regarding comment on sub-topic 1-2, correct, this objective is not included in the original version. But we provided the updated version of WID by adding this one when we provided draft summary months ago. We agree that to allow more bands to support UL-MIMO we should have a basket WI. Firstly we would like to provide the basket WID for adding UL-MIMO for more bands. Secondly in this non-spectrum related WID, we would like to remove the restriction of UL-MIMO configuration on SUL bands in both RAN2 and RAN4 specification, which are band agonistic. To Apple:Regarding comment on sub-topic 1-1, we think that you are talking about the change for configured power for 3dB power boosting. Firstly we do not think that issue is linked to 2Tx-2Tx switching in this proposal, because there is no agreement to apply 3dB power boosting to Tx switching in a general way.And the high power UE issue for SUL band combination and UL CA band combination will be discussed separately in CTC led HPUE work item. To address your concern, can we include the change of configured power due to 3dB power boosting into this work item, though we think the issue can be addressed by UE implementation? We can discuss it further in this WI.Regarding the comment on there is not requirement for UL-MIMO with SUL, we would like to follow the comment from Intel such that in this work item we can select one example band according to operator request.Regarding comment on sub-topic 1-2, as response to other companies, we are fine to have the separate work item to enable more bands for support of 2Tx UL-MIMO. Regarding to sufficient feasibility study, could you clarify what sufficient study should be done? We are fine to add more 2Tx supported bands according to operator requests.Regarding comment on sub-objective #2, it is some kind of chick-and-egg thing. To break the loop, can we first select one example SUL band according to operator request and finalize the UL-MIMO requirement and then remove the restriction of UL-MIMO configuration. Is that OK for you experts?To Ericsson:Regarding the comment on sub-topic 1-1, firstly our intention is not to make thing too complicated. We would like just to enable the Tx switching between 2Tx+0Tx and 0Tx+2Tx. It is not our intention to consider the more complicated case for the Tx switching between three or even more than three cases, i.e., 1Tx+1Tx, 2Tx+0Tx and 0Tx+2Tx. In our view, UE either operates in Tx switching mode between case 1 (1Tx+1Tx) and case 2 (0Tx+2Tx), or UE operates in Tx switching mode between (2Tx+0Tx) and (0Tx+2Tx). That is it.If other companies would like to introduce more complicated case, we are open but those complicated cases would lead to more potential change in RAN1/RAN2.The wording “strive to avoid” is not invented by us. We just borrowed it from the existing WID. The intention is to make modification rather than significant change on the existing RAN1 specification for Tx switching between case 1 and case 2. Either way would be feasible in our view. We prefer to inform RAN1/RAN2 by LS when RAN4 decided the switching case and switching period. The same approach was used in Rel-16 for Tx swtiching. If companies are unhappy, we can clearly list which part of RAN1 will be impacted and which part won’t be. Regarding comment on sub-topic 1-2, please see the response to other companies. In our view whether there is remaining topic for TxD or UL-MIMO should not postpone to introduce the new bands for support of UL-MIMO because those requirements are band-agonistic and RAN4 has introduced a number of new bands for it recently. We are not in favor to let RAN2 deciding “remove RAN2 restriction”. Honestly such action seems just causes the loop and delay the decision-making, because it is RAN4 to decide add such restriction in Rel-15 and some companies insisted on adding additional restriction in RAN2 afterwards, although it seems redundant. Most likely RAN2 has to send LS to RAN4 if we request RAN2 to do it. To OPPO:Regarding comment on sub-topic 1-1, we can make it clear which requirement needs update in the WID, i.e., the time mask requirement.Regarding comment on sub-topic 1-2, the new SUL band supporting 2Tx will be introduced based on operator requests. Thanks for being able to accept to removing the restriction.To MTK:Regarding the comment on sub-topic 1-1, the benefit comes from the fully utilization of available uplink spectrum. As we respond to other companies, take an SUL + TDD band for an example. Assuming SUL band has 20MHz channel bandwidth and TDD band has 100MHz channel bandwidths. When the slot on TDD band is DL slot, UE can switch both 2Tx on SUL band and when the slot on TDD band is UL slot, UE can switch both 2Tx on TDD band. Following this approach, UE can optimize the utilization of limited uplink transmit RF chains to optimize the uplink throughout. In our view, that is where the gain come from.The other use case is for CA with two TDD bands as shown by CMCC. 2Tx-2Tx switching could fully utilize the available uplink spectrum and the UE transmit channels.To China Telecom:Thanks for support.Regarding the new proposal, we prefer SUL based solution for it. In our view, we think that UE may have limited DL baseband processing capability. For example most likely the existing UE can only process 200MHz DL. If the proposal is based on CA, it means that UE should operate in 3CC mode, which will consume some baseband resource such that on 200Mhz channel bandwidth @3.5GHz, UE may not be able to support peak data rate. And from power consumption point of view, UE should maintain 3 CCs which may cause a lot of power.With SUL+UL CA solution, UE just needs do reception on 200MHz channel bandwidth @3.5GHz.To Xiaomi:Regarding comment on sub-topic 1-1, we can take one example band according to comment also from other companies, and make it clear which requirement will be specified.Regarding comment on sub-topic 1-2, please see my replies to other companies on the similar questions.To CMCC:Thanks for support. We fully agree the views from CMCC. The HPUE issue could be discussed in the separate work item.To LGE:Comment on sub-topic 1-1, we wonder if our responses above can clarify the motivation and scenario.Comment on sub-topic 1-2: Support 2Tx UL-MIMO can improve the spectrum efficiency for uplink transmission and for most SUL bands the corresponding FDD or TDD NR bands can support UL-MIMO so far. So it seems not difficult from hardware perspective for UE to support UL-MIMO on the same frequency range for SUL bands. Regarding the comment on Rx requirement, we are not sure if we understood the question clearly. The impact of harmonic cause by 2Tx on Rx requirement, if exists, should be the same as that caused by 1Tx, since the total power is kept the same.We wonder if we put a sub-bullet to enable 2Tx UL-MIMO for SUL firstly under the first bullet which corresponds to sub-topic 1-1, your concern can be addressed.To ZTE:Regarding comment on sub-topic 1-1, please see my responses above to other companies’ comments. Regarding comment on sub-topic 1-2, we would like to make change and first try to reach the agreement on support of UL-MIMO for SUL, and have a separate basket work item for introduction of UL-MIMO for more bands.To Samsung:Regarding comment on sub-topic 1-1, good suggestion, and we can take an example band combination with 2Tx according to request from operator.Regarding comment on sub-topic 1-2, we would like to have a separate basket work item to introduce the more bands for UL-MIMO. But in this work item we would like to remove the restriction of UL-MIMO on SUL band, which is band agnostic issue.Regarding comment on sub-objective#2, we can take an example SUL band and to finalize the UL-MIMO requirement and then remove the RAN2 restriction. It seems a loop. Hope that the above solution can break the loop.To Vivo, Thanks for support.Regarding comment on sub-topic 1-2, we do not intend to introduce FDD HPUE. Here our proposal is just to add more FDD band to support UL-MIMO requirements, which seems decoupled with HPUE. And previously there are a number of NR FDD bands where were introduced to support UL-MIMO as commented by CMCC. |

## Summary

In this section, the summary of comments on Topic#1 and the corresponding recommendations are provided.

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|  | **Status summary**  |
| **Sub-topic#1-1** | **Issue1-1: Specify UE requirements to enable Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2**Specify UE time mask requirements for UL Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2, 15 companies provided the comments. Among companies, two operators clearly show the interest and benefits for this feature, and at least 5 companies show the supportive position to enable 2Tx for SUL and specify the 2Tx-2Tx switching requirements. Targeting at the stabilizing the scope, the comments mainly related to the scope are summarized where the comments with similarity are combined, and correspondingly the recommendations are provided:Regarding Sub-objective#1 (Specify UE time mask requirements for UL Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2):* Support the work in Rel-17 or general OK (China Telecom, CMCC, OPPO, Vivo, Huawei, HiSilicon)
* Comments which need be addressed:
	+ The target scenario (e.g., SUL, CA and/or EN-DC) and the scope for Tx switching (requirements, value of switch period) should be made clear. (Intel, Xiaomi, LGE, ZTE, Vivo)
		- If switching with case 3 (the new case for Tx switching between 2Tx@carrier#1 and 2Tx@carrier2) is introduced, then it would be a framework (Ericsson)
	+ 2Tx-2Tx switching requirement should be introduced only after UL MIMO is enabled for SUL bands. (Nokia, Qualcomm, Apple, Mediatek, ZTE)
		- To enable 2Tx for SUL bands, the example SUL band combinations need be considered. (Intel, Xiaomi, Samsung)
	+ Make clear the relation of Tx switching scope to other requirements, including transparent Tx diversity or PC2 with 2Tx. (Nokia, Apple)
	+ Make clear the impacts on RAN1/RAN2 and how to trigger and/or organize RAN1/RAN2 work. (Nokia, Ericsson)

[Recommendation]: from moderator perspective, to address the comments, it is suggested:* Make scenario, RAN4 requirements and the impacts on RAN1/RAN2 clear.
* Add a sub-bullet to enable UL-MIMO for the example SUL band combinations before discussing 2Tx-2Tx switching
* Focus on power class 3 in this WID and treat the requirements for power class 2 in other WID
* Make clear the impacts on RAN1 and RAN2.

Regarding Sub-objective#2 (Specify the DL interruption RRM requirements, if needed):* No specific comments were provided.

[Recommendation]: Further discuss the objective. |
| **Sub-topic#1-2** | **Issue 1-2: Enable more SUL/TDD/FDD bands to support 2Tx**Targeting at the stabilizing the scope, the comments mainly related to the scope are summarized where the comments with similarity are combined, and correspondingly the recommendations are provided:Regarding Sub-objective#1 (Add more SUL/TDD/FDD bands to support 2Tx):* This topics should be agreed first for the necessity and benefit of using 2Tx in SUL band needs to be clarified. It is not clear about the Rx requirement part. (Mediatek, LGE)
* Adding more bands to support 2Tx should be done in the separate (basket) WI. (Intel, Qualcomm, Ericsson, Apple, Samsung)
	+ Add more bands to support 2Tx should be subject to operators’ request and sufficient feasibility study for the candidates bands to support 2Tx. (Apple, OPPO, Xiaomi)
* PC2 (with 2Tx) should be considered after the related study (SUL HPUE in other WI) is completed. (Intel, Vivo)

[Recommendation]: Not introduce more bands for UL-MIMO in this work item. Have a separate basket work item to introduce UL-MIMO for more bands according to the request from operators.Regarding Sub-objective#2 (Remove RAN2 restrictions on SUL band UL-MIMO configuration):* The restriction on configuration of UL MIMO for SUL bands can be removed. (CMCC, Intel, OPPO, Huawei, HiSilicon)
	+ We support to specify UL-MIMO for SUL bands and requirements first in RAN4. …After RAN4 specified the requirements, RAN2 need to remove the restrictions on SUL band UL-MIMO configuration. (CMCC)
* Comments, which need be addressed
	+ Remove RAN2 restriction depending on the condition that SUL can support UL-MIMO (Apple, ZTE, Samsung)
	+ If removal of restriction, it should be a RAN2 objective (Ericsson)

[Recommendation]: In some sense some companies think RAN2 should do the work to remove the restriction while other companies it cannot be done to remove RAN2 restriction unless UL-MIMO can be supported (in RAN4). There seems a deadlock. So it is suggested to follow CMCC approach, i.e., specify UL-MIMO requirement for the example SUL bands first and then remove the restriction. |
| **Sub-topic#1-3** | **New proposal: Specify UE requirements to enable Tx switching between 1 carrier in one band and 2 contiguous carriers within the other band, under the condition that there are only 2 simultaneous Tx at maximum**Two companies provided the comments:* Support. Have a clarification whether the case that one band with MIMO and other band with intra-band CA is also included. (Xiaomi)
* Supportive. Prefer SUL based solution for it. (Huawei, HiSilicon)

[Recommendation]: Seems OK but need more discussion on the scenarios. |

## Recommendation of objectives (Moderator)

The recommendations are provided inline above, which are highlighted by yellow. Based on the recommendations, the tentative objectives and revision of objectives for this part are provided below.

The original objectives for this part:

* *UE requirements to enable Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2 based on SUL and NR uplink CA*
	+ *Specify UE time mask requirements for UL Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2*
		- *UE switches Tx-s with both SUL and NR uplink CA configurations, under the condition that there are only 2 simultaneous Tx at maximum*
		- *Strive to reuse RAN1 mechanism for Tx switching between case 1 and case 2 in Rel-16*
		- *Strive to reuse RAN2 signaling for Tx switching between case 1 and case 2 in Rel-16*
	+ *Enable more SUL/TDD/FDD bands to support 2Tx*
		- *Specify the necessary Tx requirements*
		- *Specify the necessary Rx requirements*
		- *Remove RAN2 restrictions on SUL band UL-MIMO configuration*
		- *PC2 HPUE can be considered for FDD and SUL bands after related study is complete*
	+ *Specify the DL interruption RRM requirements, if needed*

*Note 1: Only addressing the case of co-located and synchronized network deployment for the two UL carriers*

*Note 2: Only addressing the case of single TAG for the two UL carriers for SUL and for UL CA*

*Note 3: The UE is configured with two different uplink carrier frequencies.*

The recommended objectives are:

* Specify UE requirements to enable Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2 based on SUL and NR uplink CA for UE supporting maximum two concurrent transmission
	+ Remove the RAN2 and RAN4 restriction on UL MIMO configuration for SUL bands, after
		- Specify the UL-MIMO requirements for example SUL configuration with SUL band n80, n84, and n95, i.e., SUL\_n41A-n80A, SUL\_n78A-n84A, and SUL\_n79A-n95A
	+ Specify RAN4 requirement for UL Tx switching between 2Tx@carrier#1 and 2Tx@carrier#2
		- Length of switching period
		- Time mask RF requirements
		- Uplink interruption and downlink interruption (RRM) requirements, if needed
	+ Minimize the impacts on RAN1
		- Update RAN1 uplink switching for carrier aggregation and supplementary uplink to accommodate the new switching cases
	+ Minimize the impacts on RAN2
		- Update the RRC signaling to indicate the switching period location and switching period length
		- Update the UE capabilities

Note 1: Only addressing the case of co-located and synchronized network deployment for the two UL carriers.

Note 2: Only addressing the case of single TAG for the two UL carriers for SUL and for UL CA.

Note 3: The UE is configured with two different uplink carrier frequencies.

* [Specify UE requirements to enable Tx switching between 1 carrier in one band and 2 contiguous carriers within the other band, under the condition that there are only 2 simultaneous Tx at maximum]

# Topic #2: 2Tx RF requirement and testing enhancement

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposed objective(s)** |
| RP-200614 | Huawei, HiSilicon | * Enhance the 2Tx RF requirements
	+ MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA
		- Contiguous CA: MPR enhancement for 2Tx architecture when aggregated channel bandwidth>100MHz
		- Non-contiguous CA: MPR definition for 1Tx architecture if there are other deployment scenarios
	+ Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method

Note: Tx diversity scheme may be concluded in Rel-16, remaining issues can be discussed in TEI16* + Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing
		- 2Tx Antenna isolation assumption for RF requirement measurement: 10dB
		- Study the measurement method enhancement: e.g. How to injecting interference into the antenna connector
 |

## Open issues summary

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

The motivations were provided in [2], which are copied below.

Regarding Rel-16 leftover topics, some enhancements for 2Tx UE requirements based on the previous discussion in RAN4 were identified. Those topics need extensive discussions and cannot be finalized within one or two quarters/meetings, including per-layer EVM requirements for UL-MIMO, impacts of power imbalance on the RF requirements, 2Tx RF requirement enhancement for EN-DC and UL CA.

### Sub-topic 2-1

*Sub-topic description:*

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

**Issue 2-1: MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA**

* Contiguous CA: MPR enhancement for 2Tx architecture when aggregated channel bandwidth>100MHz
* Non-contiguous CA: MPR definition for 1Tx architecture if there are other deployment scenarios

### Sub-topic 2-2

*Sub-topic description*

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

**Issue 2-2: Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method**

Note: Tx diversity scheme may be concluded in Rel-16, remaining issues can be discussed in TEI16

### Sub-topic 2-3

*Sub-topic description:*

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

**Issue 2-3: Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing**

* 2Tx Antenna isolation assumption for RF requirement measurement: 10dB
* Study the measurement method enhancement: e.g. How to injecting interference into the antenna connector

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Sub topic 2-1: This topic should be discussed after seeing the outcome of RAN4#96e.Sub topic 2-2: Rel17 FeMIMO WI may cover this topic.Sub topic 2-3: In principle, the same for 2-1 applies.….Others: |
| Intel | Sub topic 2-1: In Rel-16 FR1 enhancement, MPR for UL CA is being discussed. We have clarification question what is difference of MPR enhancement compared to Rel-16 UL CA MPR?Sub topic 2-2: Overall we are  fine with the investigation of impact of RF impairments.Sub topic 2-3: We support the idea |
| Qualcomm | Overall for the topics some clarifications in terms of the actual scope is needed. Current proposal of “study and enhance if needed” is too vague and broad. If there is a clear target to be enhanced, it should be mentioned directly.Sub topic 2-1: this should be discussed after Rel.16 work is concluded and possible enhancements are clear.Sub topic 2-2: How would the requirements be “enhanced”. For such work we would support having a definition of per layer EVM for UL-MIMO.Sub topic 2-3: A similar discussion already happened a while ago in LTE and it was seen as too complicated to do anything. We still think such testing is not feasible given the number of antennas that many UEs have. |
| Apple | Sub topic 2-1We do not see a strong market need for non-contiguous UL CA in FR1, and we recommend removing the related objective from consideration for the Rel-17 work item.Sub topic 2-2The discussion of this potential objective for Rel-17 work should be informed by the outcome related to TxD from the RAN4 #96e meeting. Once this is known, the scope of objectives for Rel-17 work (i.e. aspects which RAN4 could not finish within the Rel-16 timeframe) can be understood.Sub topic 2-3As the work with EN-DC and UL MIMO HPUE for band 41/n41 has shown, the antenna assumptions, RIMD, and A-MPR definitions were all derived and measured for this band specifically. Thus, RAN4 should approach this topic as a band-specific investigation and should avoid defining generic requirements for 2TX. We recommend collecting input from operators to understand which bands and configurations are of interst. Furthermore, we prefer to prioritize UL CA effort, since the industry is expected to continue to accelerate stand-alone deployments. |
| Ericsson | Issue 2-1: What mechanisms are envisaged to reduce MPR? This should be stated more clearly. Regarding non-contiguous CA, what is meant by “if other deployment scenarios”. Are scenarios envisaged or is the work speculative? Which band combinations are envisaged or are the enhancements generic? What is seen as the baseline to improve against?Issue 2-2: We should have the ambition to create appropriate requirements for UL-MIMO in Rel-16. We would like to understand what the enhancements would be on the Rel-16 baseline.Issue 2-3: We should consider whether RIMD degrades the feasibility of some combinations to the extent that the MPR would be so great that the combinations would not be feasible; if this is the case there is no need to solve measurement etc. If there are combinations that are feasible with reasonable MPR then we should consider further.Regarding measurement methods, it is important not to repeat work in the past (injecting interference did not conclude before); please clarify what additional work would build upon past conclusions. |
| OPPO | **Issue 2-2: Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method**Not quite clear of the objective. Is this issue only about the power imbalance for UL MIMO? Is the intention to define additional requirements based on non-equal power split requirements? This might make the spec changes a lot and not clear what’s the benefit of defining these new requirements. In TxD there are also discussions whether power imbalance will be assumed for the UEs under test. The outcome should be considered here.**Issue 2-3: Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing**The measurement enhancement in our understanding should be discussed in RAN5 rather than RAN4. RAN4 should focus on the impact of RIMD on MPR and define requirements only. |
| CMCC | **Issue 2-1: MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA**CMCC prefer the MPR enhancement for PC3 TDD intra-band UL CA. From the perspective of China Mobile, n41 band is more than 100MHz in china, and MPR enhancement for uplinking carrier aggregation is needed.**Issue 2-2: Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method**As we know, some consensus has been reached on 2Tx for UL-MIMO in Rel-16. If there is no conclusion on some remaining issues such as TxD, it is suggested to put it into this WI for further enhancement.**Issue 2-3: Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing**RAN4 is still performed RIMD analysis of 5G based on the assumptions of LTE period. We support to investigate the impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing. |
| LGE | **Issue 2-1: MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA**We don’t think this is necessary. For the intra-band Contiguous CA, RAN4 already defined Class C up to 200MHz. These MPR can be reused for 2Tx/2PA RF architectures. For the NC-CA, it is already defined to support 1Tx architecture. **Issue 2-2: Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method**We think it is necessary. RAN4 should investigate how much power imbalance would be allowed to support the coherent UL-MIMO operation. Based on this, RAN4 further discuss whether or not to introduce enhanced RF requirements.**Issue 2-3: Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing**RAN4 considered the RIMD impact according to the band specific simulation assumption. So, UE vendor can provide some critical RIMD impacts according to specific band combinations. It is difficult to specify general MPR by RIMD problems. It should be discussed case by case DC/CA band combinations. |
| ZTE | **Issue 2-1: MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA**RAN4 have already study the MPR for intra-band PC3 contiguous/noncontiguous CA in the past RAN4 meetings, also the work is still ongoing in Aug meeting. What’s the difference comparing with Rel-16 study?**Issue 2-3: Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing**For the value, we share same view with Quaclcomm, we also think it is not appropriate to give a number in the WID. Similar discussions on the antenna isolation were happened in LTE and the discussions were complicated.For the measurement method, it should be discussed in RAN5. |
| Samsung | **Issue 2-1: MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA**Does this mean there will be different MPR requirements for 1Tx and 2Tx respectively? If so, outcome of ongoing Rel-16 TxD discussion may be a reference. **Issue 2-2: Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method**Power imbalance need to be investigated. Previous assumption is average power splitting, but power imbalance will affect the transmitter performance, consequently test method should be also standardized for this perspective. |
| vivo | Issue 2-3: Certain work, if considered, may also consider with TxD which may share some study. |
| Huawei | **Issue 2-1: MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA**In Rel-16, contiguous UL CA MPR is specified based on 1PA assumption which also can be used for 2PA architecture. However, for 2PA architecture, the RIMD is much lower compared with forward IMD product, so MPR for 2PA architecture can be largely improved.In Rel-16, non-contiguous UL CA MPR is specified based on 2PA assumption which cannot apply to 1PA architecture.**Issue 2-2: Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method**For UL MIMO, we know there is some discussion on EVM requirement in Rel-16. But TE implementation development is needed for 2 layer codebook, considering transient time for TE enhancement is required we think discuss UL MIMO EVM requirement in Rel-17 is more suitable. Additionally, currently EVM requirement and test are focus on non-coherent codebook. If we consider of coherent codebook for FR1 UL MIMO, EVM requirement enhancement is needed in Rel-17.**Issue 2-3: Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing**When we evaluate on MPR requirement for 2 PA architecture, we assume 10dB isolation between antennas, and emulate reverse IMD generating procedure by inject interfering into PA output port. For 2PA architecture, such RIMD cannot be presented by conducted test method which is commonly used for FR1 GCF verification. UE with 2PA architecture may be pass the test with 0dB MPR but cannot reach RF requirement in real network. So we think it is necessary to study on enhancing 2Tx RF measurement for UL CA and EN-DC testing. |

## Summary

In this section, the summary of comments on Topic#2 and the corresponding recommendations are provided.

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#2-1** | **Issue 2-1: MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA**Targeting at the stabilizing the scope, the comments mainly related to the scope are summarized where the comments with similarity are combined, and correspondingly the recommendations are provided:* MPR enhancement for PC3 TDD intra-band UL CA is needed (CMCC, Huawei, HiSilicon)
* Comments, which need be addressed
	+ Clarification on the MPR enhancement scope compared to Rel-16 is needed, including scenario, baseline for comparison (Nokia, Intel, Qualcomm, Ericsson, ZTE, Samsung)
		- Outcome of ongoing Rel-16 TxD discussion may be a reference. (Samsung)
		- Responses from proponent: MPR for 2PA can be largely improved for contiguous CA; for non-contiguous CA MPR based 2PA cannot applied to 1PA architecture.
	+ Suggest to remove it or not needed (Apple, LGE)

 [Recommendation]: Need clarifications on the enhancement compared to Rel-16. |
| **Sub-topic#2-2** | **Issue 2-2: Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method**Targeting at the stabilizing the scope, the comments mainly related to the scope are summarized where the comments with similarity are combined, and correspondingly the recommendations are provided:* Generally support it (Intel, LGE, Samsung, Huawei, HiSilicon)
	+ Previous assumption is average power splitting; test method needs also be standardized. (Samsung)
* Comments, which need be addressed
	+ Clarifications on objectives are needed. How would the requirements be “enhanced”. For such work we would support having a definition of per layer EVM for UL-MIMO. (Qualcomm, Ericsson, OPPO)
		- Responses from proponent: TE implementation development is needed for 2 layer codebook; EVM requirement enhancement is needed for coherent codebook for FR1 UL MIMO.
	+ Related to TxD discussion in Rel-16. (Apple)
		- If there is no conclusion on some remaining issues such as TxD, it is suggested to put it into this WI for further enhancement. (CMCC)

[Recommendation]: Need clarifications on the enhancement compared to Rel-16 and the relation to Tx.  |
| **Sub-topic#2-3** | **Issue 2-3: Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing**Targeting at the stabilizing the scope, the comments mainly related to the scope are summarized where the comments with similarity are combined, and correspondingly the recommendations are provided:* Generally support it (Intel, CMCC, Huawei, HiSilicon)
	+ Support to investigate the impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing. (CMCC)
* Comments, which need be addressed
	+ Not feasible, given the number of antennas that many UEs have (Qualcomm, LGE, ZTE)
		- Difficult to specify general MPR by RIMD problems. It should be discussed case by case DC/CA band combinations. (LGE)
	+ We recommend collecting input from operators to understand which bands and configurations are of interest. Furthermore, we prefer to prioritize UL CA effort, since the industry is expected to continue to accelerate stand-alone deployments. (Apple)
	+ Study the possible degradations of RIMD on combinations and specify the requirement for the case with reasonable MPR. (Ericsson)
	+ Should be discussed in RAN5. (OPPO, ZTE)
	+ Being considered with TxD (Vivo)

[Recommendation]: The proponent should convince the companies about the feasibility. |

## Recommendation of objectives (Moderator)

The recommendations are provided inline above, which are highlighted by yellow. Based on the recommendations, the tentative objectives and revision of objectives for this part are provided below.

The original objectives for this part:

* *Enhance the 2Tx RF requirements*
	+ *MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA*
		- *Contiguous CA: MPR enhancement for 2Tx architecture when aggregated channel bandwidth>100MHz*
		- *Non-contiguous CA: MPR definition for 1Tx architecture if there are other deployment scenarios*
	+ *Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method*

*Note: Tx diversity scheme may be concluded in Rel-16, remaining issues can be discussed in TEI16*

* + *Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing*
		- *2Tx Antenna isolation assumption for RF requirement measurement: 10dB*
		- *Study the measurement method enhancement: e.g. How to injecting interference into the antenna connector*

The follow updated objectives are suggested for further discussion:

* MPR enhancement for power class 3 TDD intra-band contiguous and non-contiguous UL CA
	+ Contiguous CA: MPR enhancement for dual PA architecture when aggregated channel bandwidth >100MHz
	+ Non-contiguous CA: study whether Rel-16 MPR definition can be reused for single PA architecture
		- If not, define MPR requirements for single PA architecture
* Enhance the 2Tx RF requirements
	+ Investigate the impact of power imbalance between Tx antennas for UL-MIMO, and enhance the RF requirements, e.g., EVM and MOP, and the test method

Note: Tx diversity scheme may be concluded in Rel-16, remaining issues can be discussed in TEI16

* + Investigate impact of RIMD on MPR, and enhance 2Tx RF measurement for UL CA and EN-DC testing
		- 2Tx Antenna isolation assumption for RF requirement measurement: 10dB
		- Study the measurement method enhancement: e.g. How to injecting interference into the antenna connector

# Topic #3: Optimizations on power class fall back

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposed objective(s)** |
| RP-200945 | Vivo, China Unicom | The objective of the study item is to study the optimized power class fall back mechanisms for HPUE when network scheduling UL traffic duty exceeds UE capability, i.e. enhanced schemes instead of falling back to lower PC class in R15/R16 specifications. Detailed work tasks include: * Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.
* Study the schemes by reducing the power on one or multiple cell groups in case of MR-DC, e.g. reduced LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc.
* Other schemes are not precluded.
* Optimization for different operation modes can be considered, including SA, TDD+TDD MR-DC and FDD+TDD MR-DC etc.
* Power class 1.5 can be considered
* UE test effort needs to be considered
* Release independency can be considered depending on outcome of the study.
 |

## Open issues summary

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

The motivations were provided in [3], which are copied below.

For UE which support a higher power class than default, certain conditions need to be satisfied to have a controlled emission. The UL/DL configuration had been used in LTE phase and duty cycle based approach was introduced in NR. In case the condition cannot be satisified, e.g. uplink transmission ratio is higher than a threshold, there would be fallback of the maximum output power of this UE. The default method is to fallback to default power class, which was used for LTE and introduced in NR since Rel-15. However, there is concern that fallback to default power class is too conservative and there were multiple proposals to introduce different fallback schemes, such as linear, step function etc, in Rel-16 time frame, but no conclusion was reached.

In addition, in FDD-TDD EN-DC SI and WI phase, multiple behaviours and schemes were discussed but not included yet, such as by reducing LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc. Further enhancement on the performance might be possible.

There are also other HPUE related topics that may also have fall back problems that worthy of study.

### Sub-topic 3-1

*Sub-topic description:*

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

**Issue 3-1: Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.**

* Other schemes are not precluded
* Optimization for different operation modes can be considered, including SA, TDD+TDD MR-DC and FDD+TDD MR-DC etc.
* Power class 1.5 can be considered
* UE test effort needs to be considered
* Release independency can be considered depending on outcome of the study.

### Sub-topic 3-2

*Sub-topic description*

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

**Issue 3-2: Study the schemes by reducing the power on one or multiple cell groups in case of MR-DC, e.g. reduced LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc.**

* Other schemes are not precluded
* Optimization for different operation modes can be considered, including SA, TDD+TDD MR-DC and FDD+TDD MR-DC etc.
* Power class 1.5 can be considered
* UE test effort needs to be considered
* Release independency can be considered depending on outcome of the study.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Sub topic 3-1: It is premature to start with FDD+TDD PC2/TDD+TDD PC2. Alternative is start with simpler one that is a basic method used in TDD single band PC2 if the WI is approved. Since this includes FDD+TDD PC2, firstly we need to wait for the outcome of FDD+TDD PC2 WI.Sub topic 3-2: The same comment for 3-1 applies.….Others: |
| Intel | Sub topic 3-1: We support to have studies in Rel-17Sub topic 3-2:* Rel-16 SI/WI was about EN-DC but this WID is intended for MR-DC. Since the previous discussion was not converged, we suggest RAN4 focus on EN-DC only in Rel-17.
* Question for clarification. What is the motivation to change LTE power in MR-DC?
 |
| Qualcomm | Sub-topic 3-1: Current TDD networks do not use UL duty cycle higher than 50% so the value of such enhancements is not very clear. This could apply only in the case of TDD+FDD CA but we expect a very difficult discussion considering the Rel.16 related work. Also, the overall gain will be rather small, ~1.5dB in UL?Sub-topic 3-2: This seems to be RAN1 scope of power control, power allocation and priorities. We do not believe RAN4 should define “enhancements” that go against already defined power allocation rules. |
| Apple | Current work item on PC2 EN-DC FDD+TDD HPUE already discusses power class fallback schemes, and we should check its outcome before considering any further enhancements. Compliance with SAR regulations is always the UE responsibility, and according to our understanding, the proper mechanism for this is P-MPR. Network-based mechanisms for SAR compliance are questionable in their efficacy, and we don’t see this proposal as well justified. |
| Ericsson | Issue 3-1: The gains of the enhancements for TDD may be marginal considering typical duty cycles with common TDD pattern (less than 50%). The scope has some dependency on Rel-16 agreements. Issue 3-2: For MR-DC, assumes specification of NR-DC PC2 case1 & 2. We support the objective, which will give predictable behavior for the network. Study is not needed; this objective could be a WI. |
| OPPO | **Issue 3-1: Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.**This has been discussed for a long time (more than a year) and no solution has been agreed, it is not because of lack of time. In our view, the power class fall back is more clean in the network, the leaner or step functions which is beautiful in paper but infeasible in the network since it needs the UE and NW has the same real time calculation of the duty cycle, however, now the calculation is defined with the famous ambiguous wording “certain evaluation window” which makes it is impossible for the NW and UE has the same understanding of the “evaluation window”.RAN4 has spent too much time in this kind of work, and we should focus on the more important and useful features rather than these minor “optimisation”. Actually it already takes too much valuable meeting time.In short, we are not in favor of this study. |
| China Telecom | Ok to consider power class fall back optimization for SA single carrier and EN-DC, since the baseline PC2 work has been completed.Suggest to not include any study for SA UL CA and SUL PC2, since the WI for UL CA and SUL PC2 is currently ongoing in Rel-17. |
| Xiaomi | Sub-topic 3-1: We understand your intention. This topic has been discussed for a long time. Some potential solutions may seem to work in theory, but they are complex to be implemented. We don’t against to have a study on this issue but doubt whether those problems in implementation can be addressed in R17. |
| LGE | **Issue 3-1: Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.**In Rel-16, RAN4 decided P-MPR solution is baseline, if blind scheme and duty-cycle is not supported in specification. So we prefer to follow the agreements for SAR compliance issues of high power UE. It is not necessary.**Issue 3-2: Study the schemes by reducing the power on one or multiple cell groups in case of MR-DC, e.g. reduced LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc.**We don’t think this is necessary. If target is to change some principle for power allocation rule for EN-DC, then it could be studied in RAN1/RAN4 and request RAN1 to revise the power allocation rule for MR-DC. If target is only to specify additional rule in RAN4 for MR-DC, then it is not applicable without changing RAN1 power allocation rule. |
| ZTE | In our understanding, the motivation seems to further studies the scheme such as ‘blind scheme’ in Rel-17. RAN4 have spent lots of time to discuss this issue during SI and WI phase. and do the other schemes means the schemes RAN4 discussed in the SI? If it is the case, we don’t think there is a need to discuss them again in R17 since the schemes on the table on the table have been discussed in the past RAN4 meeting.Moreover, due to there is FDD+TDD PC2/TDD+TDD PC2 basket WID in Rel-17, if this WID is needed, does it mean the FDD+TDD PC2/TDD+TDD PC2 combinations works can not be started?Also, there is FDD+TDD/TDD+TDD PC2 NR CA WID, and the SAR issues were also discussed. So far it can be foreseen that the NR CA SAR issue was using PC2 ENDC as starting point. We are not sure if this WID will postpone the PC2 NR CA work. |
| Vodafone | Generically, it is important that UEs are complying with the principle of SAR requirements in all field scenarios. Therefore we need clearly defined and predictable UE behaviour with whatever we specify when the network configures a device to Tx beyond 23dBm. Network changes to allow this should be minimal too.  |
| Samsung | In Rel-16 FDD+TDD ENDC, “blind scheme” have been discussed extensively, and we don’t prefer blind scheme as it has unexpected impact to current specification than the P-MPR solution and UL duty cycle solution. On the other hand, it can be also observed that UL Tx power maybe waste for UL duty cycle based solution, that’s the basis of TEI16 discussion on the power class fallback optimization. As optional solution, it is maybe useful for UE to maximize its UL coverage with further study on more optimization solutions. We do not think we can start a WI to specify the blind scheme in Rel17. We also see some supporting comments for blind scheme, to address such comments, we think best way maybe to include blind scheme together with other solutions in a SI. |
| China Unicom | The optimization of power class fall back has been a long discussion in previous RAN4 meetings. For SA and MR-DC scenarios, we support to study the potential gains if the optimization of power class fall back works well. For power allocation rule, it is related with RAN1, and the impact on RAN1 power allocation needs to be considered when the gains of the optimization of power class fall back is proved. |
| Vivo: | Sub-topic 3-1:This possible “overkill” problem, in case a duty cycle threshold is exceeded, identified and remains for sometime without be solved. It was actually identified from late stage of Rel-15 and remains for all dutycyle based SAR control scheme. There were some attempts to do further optimization/enhancement, mostly via TEI, but not agreement reached. Though seems not that complex, achieving good balance of complexity/risk/gain and agreeable for everyone proved to be not easy. The scenarios using duty cycle are continuously increasing and impact may be expanded. We can understand there is concerns on the need of this and the gain may be marginal for ceratin scenarios, e.g., considering the usual <50% UL dutycyle for TDD field deployment etc. However, with dutycycle method further extended with the introduction of TDD-TDD/FDD-TDD ENDC, the scenarios encountered are continuously increased, while some of them is already different. Let alone, the currently progressing inter-band CA and already proposed intra-band CA, the duty cycle method is still likely to be typical SAR control scheme in addition to P-MPR. We think some form of formal study may be better compared to be raised as TEI over and over again. As for the schemes, the existing approaches of “MPR-like”, “linear”, “stepwise” could be further discussed and one of them could be used as baseline.As for the relationship with on going and other possible Rel-17 WI/SIs such as Inter-band CA PC2, Intra-band CA PC2 etc, we believe that the work can be separated. Ongoing WIs may not have to wait or follow the decision in this study, while keep an eye on it in later stage full on the ongoing WIs’ own decision. Subtopic 3-2:During the study of FDD-TDD EN-DC in Rel-16, the “blind scheme” is controversial and not included. This could be treated as another way of optimization. Many companies still have fundamental concerns even in the last meeting of WI closure. We are still open to discuss this in Rel-17, however, considering the current situation that some major concerns remains, it seems that a WI objective for this is currently not likely to be agreed even in Rel-17, and an objective in SI may be more agreeable for the group as a compromise.As for the relationship with other on-going CA related WIs, the comments is the same to previous one. |
| Huawei | **Issue 3-1: Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.**Power class fallback makes a HPUE turn into PC3 UE even when the real UL dutycycle is 1% higher than UE capability of maxUplinkDutyCyle which is obviously not reasonable. We are open to the detail solution, but this optimization is necessary.For the concern of TDD UL-DL configuration, firstly the UL duty cycle evaluation period may not always one radio frame, for the case that UE evaluate on the UL duty cycle within window with UL symbols(may be configured by SFI), duty cycle can be larger than UL-DL configuration. Secondly, for EN-DC case, maxULdutycycle is reported from 30%, it is definitely useful for such case. **Issue 3-2: Study the schemes by reducing the power on one or multiple cell groups in case of MR-DC, e.g. reduced LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc.**We are open to further discuss on blind scheme in Rel-17. Considering it is related to NB configuration(**PLTE**) thus the upper limitation of total power is impacted, we prefer to have a study phase for this topic under the WI range. |

## Summary

In this section, the summary of comments on Topic#3 and the corresponding recommendations are provided.

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#3-1** | **Issue 3-1: Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.**Targeting at stabilizing the scope for this part, the comments from companies are summarized as below and accordingly the recommendations are provided.* Support the study (Intel, China Telecom, Vivo, China Unicom)
	+ Suggest not to include UL CA and SUL PC2 (China Telecom)
	+ Support the study of potential gains (China Unicom)
* Comments, which need be addressed
	+ Premature to start with FDD+TDD/TDD+TDD PC2. Suggest to start with simpler one. (Nokia)
	+ Focus on EN-DC only in Rel-17 and need clarification on the motivation to change LTE power in MR-DC. (Intel)
	+ Difficult to proceed and small gain (Qualcomm, Ericsson, OPPO, Xiaomi, ZTE)
		- Gain of enhancements for TDD is marginal (Ericsson)
	+ Need justification. (Apple)
	+ Follow P-MPR. No need of enhancement. (LGE)
	+ Response from proponents: problem exists for a long time without being solved. The big gain can be found for TDD-TDD/FDD-TDD ENDC case with UL duty cycle >50%.

[Recommendation]: It seems a way forward to investigate the gain based on FDD-TDD EN-DC PC2 case, which was completed recently, and if there was significant gain for a certain scenario the requirements can be specified accordingly. |
| **Sub-topic#3-2** | **Issue 3-2: Study the schemes by reducing the power on one or multiple cell groups in case of MR-DC, e.g. reduced LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc*.***Targeting at stabilizing the scope for this part, the comments from companies are summarized as below and accordingly the recommendations are provided.* Support it (Vivo, Ericsson)
* Comments, which need be addressed
	+ Premature to start with FDD+TDD/TDD+TDD PC2. Suggest to start with simpler one. (Nokia)
	+ Seems RAN1 scope of power control. (Qualcomm, LGE)
		- No need (LGE)
	+ Not start a WI to specify blind scheme in Rel-17 (Samsung)
	+ Response from proponents: seems SI may be agreeable.

[Recommendation]: Need clarify the impact on RAN1. Not sure if a further study is an easy agreement, but it seems suggested by proponents and other companies to move forward. |

## Recommendation of objectives (Moderator)

The recommendations are provided inline above, which are highlighted by yellow. Based on the recommendations, the tentative objectives and revision of objectives for this part are provided below.

The original objectives for this part:

*The objective of the study item is to study the optimized power class fall back mechanisms for HPUE when network scheduling UL traffic duty exceeds UE capability, i.e. enhanced schemes instead of falling back to lower PC class in R15/R16 specifications. Detailed work tasks include:*

* *Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.*
* *Study the schemes by reducing the power on one or multiple cell groups in case of MR-DC, e.g. reduced LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc.*
* *Other schemes are not precluded.*
* *Optimization for different operation modes can be considered, including SA, TDD+TDD MR-DC and FDD+TDD MR-DC etc.*
* *Power class 1.5 can be considered*
* *UE test effort needs to be considered*
* *Release independency can be considered depending on outcome of the study.*

The proponent suggested to approve a separate SI. Thus it is suggested to have further discussion based on the objectives above.

The recommended objectives are as follows:

The objective of the study item is to study the optimized power class fall back mechanisms for HPUE when network scheduling UL traffic duty exceeds UE capability, i.e. enhanced schemes instead of falling back to lower PC class in R15/R16 specifications. Detailed work tasks include:

* Study the schemes with finer relationship between UL duty and back off power instead of ΔPPowerClass =3dB sharp, e.g. linear, step function etc.
	+ Investigate the gain under based on FDD-TDD EN-DC PC2 case
* Study the schemes by reducing the power on one or multiple cell groups in case of MR-DC, e.g. reduced LTE power (PLTE) and use of the common UL-DL patterns on the TDD CG for FDD+TDD EN-DC etc.
	+ Investigate the impact on RAN1
* Other schemes are not precluded.
* Optimization for different operation modes can be considered, including SA, TDD+TDD MR-DC and FDD+TDD MR-DC etc.
* Power class 1.5 can be considered
* UE test effort needs to be considered
* Release independency can be considered depending on outcome of the study.

# Topic #4: HPUE for TDD intra-band contiguous CA

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposed objective(s)** |
| RP-200614 | Huawei, HiSilicon | * HPUE for TDD intra-band contiguous UL CA
	+ Study the impact of different UE architectures on the requirements
		- Power class Relation between single CC and intra-band contiguous CA on HPUE band can be studied in this phase(TBD)
	+ Specify the mechanism to meet SAR requirements
		- Mechanism for HPUE on single carrier can be a start point considering the same UL-DL configuration assumption
		- Power class fallback enhancement is specified for TDD intra-band contiguous UL CA
	+ Specify MPR requirements
	+ Specify the RF requirements for an example band (n41)
		- A-MPR requirement
 |

## Open issues summary

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

The motivations were provided in [1], which are copied below.

The second topic is to support 26dBm high power UE for intra-band contiguous UL CA. The motivation is quite straightforward. But more study would be needed. Because the much wider channel bandwidth for NR is supported compared to LTE. It would be non-trivial to investigate the UE architecture, e.g., 23dBm+23dBm PA and 23dBm+26dBm PA, to support high power as well as the large aggregated channel bandwidth. And the supported channel bandwidth for PA also needs be studied. If the supported channel bandwidth of a single PA is less than the available channel bandwidth, then some tradeoff among the supported channel bandwidth, supported antenna ports per CC and achievable uplink power per CC should be considered. Based on the outcome of discussion on UE architecture, the RF requirements can be specified.

### Sub-topic 4-1

*Sub-topic description:*

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

**Issue 4-1: Specify the mechanism to meet SAR requirements**

* Mechanism for HPUE on single carrier can be a start point considering the same UL-DL configuration assumption
* Power class fallback enhancement is specified for TDD intra-band contiguous UL CA

### Sub-topic 4-2

*Sub-topic description*

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

**Issue 4-2: Study and specify 26dBm HPUE RF requirements for TDD intra-band contiguous CA**

* Study the impact of different UE architectures on the requirements
	+ Power class Relation between single CC and intra-band contiguous CA on HPUE band can be studied in this phase(TBD)
* Specify MPR requirements
* Specify the RF requirements for an example band (n41)
	+ A-MPR requirement

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Sub topic 4-1: Power class fallback enhancement should be out of scope of this work. We even do not have such enhancement for single CC case. We should start with something fundamental one if necessary.Sub topic 4-2: Specifying UL CA with PC2 itself is beneficial. We, however, do not think that we need to introduce something new mechanism from the beginning unless we identify the necessity of it during the work. Just finish UL CA with PC2 using current mechanism such that 1Tx architecture as the base line.….Others: |
| Intel | In the last plenary several HPUE WIs were approved. Moving forward, we recommend to have a certain umbrella WI to have HPUE aspects rather than splitting discussion into multiple different WIs (e.g. all HPUE aspects are handled in FR1 RF WI).Sub topic 4-1: Support the idea that a single carrier can be a starting point.Sub topic 4-2: Agree that PC relation between single CC and intra-band contiguous CA on HPUE can be studied. |
| Qualcomm | Sub-topic 4-1: Why the current mechanism is not good enough? This work should not be for “enhancements” when there already is a different proposalSub-topic 4-2: This seems to be business as usual  |
| Apple | Sub topic 4-1TS38.101-1 already defines P-MPR in the configured output power requirements, and we don’t view a proposal to define additional techniques well justified. We suggest removing this objective from the Rel-17 WID.Sub topic 4-2As the work with EN-DC and UL MIMO HPUE for band 41/n41 has shown, the antenna assumptions, RIMD, and A-MPR definitions were all derived and measured for this band specifically. Thus, RAN4 should approach this topic as a band-specific investigation and should avoid defining generic requirements for 2TX. We recommend collecting input from operators to understand which bands and configurations are of interst. A separate new work item can be initiated for each band with such operator interest. |
| Ericsson | Sub-topic 4-1: We support solutions that could improve predictability for the network. Sub-topic 4-2: A-MPR will be band specific, not clear why to take an “example” band. If something is missing, it is “business as usual” when a CA combination is added. Power class relation will be covered by the Rel-16 signaling arrangement introduced by RAN2.  |
| OPPO | **Issue 4-1: Specify the mechanism to meet SAR requirements**Even RAN4 has spent many time on the SAR solutions, however, unfortunately in the real NW and SAR certifications, none of them except PMPR is applicable to meet SAR regulations. Therefore, we shall make the SAR discussion within a very limited scope to not extend the discussion if there is interests in this area. The power fall back optimisation should be removed, see the comments in Issue 3-1.**Issue 4-2: Study and specify 26dBm HPUE RF requirements for TDD intra-band contiguous CA**HPUE for intra-band contiguous CA should be operator demand based, and be more focused rather than introducing this challenging new HPUE type widely. |
| China Telecom | We support to introduce HPUE for TDD intra-band contiguous CA. For TDD intra-band contiguous CA, there will be 200MHz spectrum at maximum. To maintain the same per PRB uplink power density, the total transmit power with a large PRB number would be high. So, we see the benefit of HPUE for TDD intra-band contiguous CA. |
| Xiaomi | **Issue 4-1:** support the idea that reusing the SAR solutions as a starting point.Issue 4-2: It is good to have the following bullet to give some clear clarification on power class before defining the specific requirements.* + Power class Relation between single CC and intra-band contiguous CA on HPUE band can be studied in this phase(TBD)
 |
| CMCC | Support the HPUE for TDD intra-band contiguous CA. We suggest that the MPR for in-band UL CA needs to be optimized. Otherwise, excessive MPR is the bottleneck affecting the high-power UE application of uplink carrier aggregation. |
| LGE | **Issue 4-1: Specify the mechanism to meet SAR requirements**We don’t think this is necessary. We prefer that the existing principle and mechanism will be considered for wideband TDD band. If needed, exact use case will be provided.**Issue 4-2: Study and specify 26dBm HPUE RF requirements for TDD intra-band contiguous CA**We support this. RAN4 need to specify the PC2 HPUE RF requirements for TDD intra-band contiguous CA based on RF architecture. Prefer defining separate MPR/A-MPR requirements according to 1Tx/2Tx RF architecture. |
| ZTE | We respect operator’s request and could support the HPUE for TDD intra-band contiguous CA. |
| Samsung | We support the HPUE for TDD intra-band contiguous CA based on operator’s request. MPR could be optimized for different UE architecture. About power class fallback enhancement, not sure if it is related with topic #3 (Optimizations on power class fall back) |
| China Unicom | We support for HPUE for TDD intra-band contiguous CA. |
| Vivo | Issue 4-1SAR scheme is now being discussed in different WIs. If another specific WI/SI could be set, this issue can be either discussed there or keep in this WI, and this is can be decided by the rapporteur. However, it is likely that only more “traditional” way can be agreed here if no progress in the specific WI/SI for power class optimization, considering the current situation. |
| Huawei | **Issue 4-1: Specify the mechanism to meet SAR requirements**For intra-band UL CA, mechanism to meet SAR requirement is necessary and need to be based on single carrier. For power class fallback optimization, we are open to discuss on the suitable WI to work on.**Issue 4-2: Study and specify 26dBm HPUE RF requirements for TDD intra-band contiguous CA**In Rel-16, we define RF requirement for PC3 intra-band UL CA. High power enhancement in Rel-17 is natural and necessary. |

## Summary

In this section, the summary of comments on Topic#3 and the corresponding recommendations are provided.

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#4-1** | **Issue 4-1: Specify the mechanism to meet SAR requirements**Targeting at stabilizing the scope for this part, the comments from companies are summarized as below and accordingly the recommendations are provided.* Support it (Intel, Ericsson, China Telecom, Xiaomi, CMCC, ZTE, Samsung, China Unicom, Huawei, HiSilicon)
	+ Support reusing existing SAR solution. (Xiaomi)
	+ Optimize MPR. (CMCC)
* Comments, which need be addressed
	+ Power class fallback enhancement is out of scope (Nokia, OPPO)
	+ Not sure if the power class fall back is related to Topic #3. (Samsung)
	+ Why the current mechanism is not good enough? This work should not be for “enhancements” when there already is a different proposal (Qualcomm)
	+ P-MPR has already been defined. No additional technique is proposed. Suggest to remove it. (Intel)
	+ Response from proponent: for intra-band UL CA, SAR solution need be based on solution for single carrier; open to discuss power class fallback optimization.

[Recommendation]: It seems most companies are OK with this topic. Can companies agree to take n41 intra-band UL CA as an example for necessary investigation, i.e., architecture and MPR, and specify the requirements? The more intra-band UL CA HPUE will be introduced in the other separate basket work item according to the operator inputs.The SAR solution should be based on the solution for single carrier and whether or not to include power class fallback needs more discussion. |
| **Sub-topic#4-2** | **Issue 4-2: Study and specify 26dBm HPUE RF requirements for TDD intra-band contiguous CA**Targeting at stabilizing the scope for this part, the comments from companies are summarized as below and accordingly the recommendations are provided.* Generally support it (Intel, Qualcomm, LGE, Huawei, HiSilicon)
	+ RAN4 need to specify the PC2 HPUE RF requirements for TDD intra-band contiguous CA based on RF architecture. Prefer defining separate MPR/A-MPR requirements according to 1Tx/2Tx RF architecture.
* Comments, which need be addressed
	+ Use the current mechanism such that 1Tx architecture as baseline. (Nokia)
	+ A-MPR is band specific. Basket WI is needed to introduce the requirements for intra-band UL CA on a specific band. (Apple, Ericsson)
	+ Focus on operator interested band. (OPPO)
	+ Power class Relation between single CC and intra-band contiguous CA on HPUE band can be studied in this phase(TBD). (Xiaomi)

[Recommendation]: Can we accept to use 1Tx architecture as baseline? |

## Recommendation of objectives (Moderator)

The recommendations are provided inline above, which are highlighted by yellow. Based on the recommendations, the tentative objectives and revision of objectives for this part are provided below.

The original objectives for this part:

* *HPUE for TDD intra-band contiguous UL CA*
	+ *Study the impact of different UE architectures on the requirements*
		- *Power class Relation between single CC and intra-band contiguous CA on HPUE band can be studied in this phase(TBD)*
	+ *Specify the mechanism to meet SAR requirements*
		- *Mechanism for HPUE on single carrier can be a start point considering the same UL-DL configuration assumption*
		- *Power class fallback enhancement is specified for TDD intra-band contiguous UL CA*
	+ *Specify MPR requirements*
	+ *Specify the RF requirements for an example band (n41)*
		- *A-MPR requirement*

The recommended objectives for further discussions are

* HPUE for TDD intra-band contiguous UL CA
	+ Take n41 intra-band contiguous UL CA for an example band
	+ Investigate and specify the 26dBm power class for n41 intra-band contiguous UL CA
		- Study the impact of different UE architectures on the requirements
			* [Use 1Tx architecture as baseline]
			* [The other architecture is not precluded]
			* [Power class Relation between single CC and intra-band contiguous CA on HPUE band can be studied in this phase(TBD)]
		- [Specify the mechanism to meet SAR requirements
			* Mechanism for HPUE on single carrier can be a start point considering the same UL-DL configuration assumption
			* Power class fallback enhancement is specified for TDD intra-band contiguous UL CA]
		- A-MPR requirement
	+ Specify MPR requirements [and optimize the requirement, if necessary]

# Topic #5: Efficient utilization of spectrum which is not aligned with existing NR channel bandwidths

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposed objective(s)** |
| RP-200610 | Huawei, HiSilicon | * For requests of available spectrum with bandwidths which is not multiple of 5MHz
	+ Study the approach for efficient utilization of spectrum allocations that are not aligned with existing NR channel bandwidth and the relevant requirements including spectrum utilization, channel arrangement, and emission requirement, with the assumption that UEs not supporting such available spectrum with new bandwidth can still access the network.
	+ The following cases will be examples in this WI:
		- Efficient use of an available 7 MHz NR allocation bandwidth for in n26
		- Efficient use of an available 13 MHz NR allocation bandwidth for n28
 |
| RP-201352 | T-Mobile USA | The objectives of this study item are:1. Identify operator licensed channel bandwidths that do not align with existing NR channel bandwidths.
2. Evaluate the potential use of larger channel bandwidths than operator licensed bandwidth, including the impacts on regulatory emission requirements and UE blocking impacts.
3. Study the use of overlapping UE channel bandwidths to cover operator’s license spectrum, and if new gNB channel bandwidths are needed.

NOTE: From a UE perspective Channel Bandwidths in multiple of 5MHz are assumed as the baseline for this work1. Identify operator licensed bandwidths that are not compatible with the use of techniques like intra-band CA or overlapping UE channel bandwidths.
2. Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA.
3. Other solutions are not precluded.
4. Generic and future proof solution(s) should be intended, with priority should be given to approaches that avoid the introduction of new channel BWs on the UE side
5. Impact on RAN1 and RAN2 should be considered and minimized
 |

## Open issues summary

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

The topic was discussed extensively in RAN#88e. The main intention of this work is to fully utilize the available spectrum for operators, e.g., 7MHz, 13MHz and etc. The main debate is whether the use of overlapping UE channel bandwidths from UE perspective should be included in the SI.

In [6] the concepts of proposed solutions were provided. We represent them below. Maybe at the end of the day more than one solution would be chosen as general solutions.

* Approach#1: Use of overlapping UE channel bandwidth from UE perspective (Both BS and UE support the aggregated overlapping UE channel bandwidth, say, intra-band contiguous overlapping CA in [4, 5]);
* Approach#2: Use of overlapping UE channel bandwidth from network perspective (BS supports the aggregated overlapping UE channel bandwidth, say, intra-band contiguous overlapping CA in [4, 5], while UEs only supports the existing channel bandwidth)
* Approach#3: Use of larger channel bandwidths than operator licensed bandwidth
* Approach#4: Intra-band CA

   

Approach#1 Approach#2 Approach#3 Approach#4

Figure: 5.2-1 Candidate solutions to support irregular channel bandwidths

### Sub-topic 5-1

*Sub-topic description:*

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

**Issue 5-1: Should the use of overlapping UE channel bandwidth from UE perspective be included in the SID?**

Companies are encouraged to provide the detailed reasons.

### Sub-topic 5-2

*Sub-topic description*

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

**Issue 5-2: Comments for the other part of scope in RP-201352**

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | Sub topic 5-1: It is important 3GPP studies all possible solutions, and evaluates their pros and cons. One of main motivation of the SID is having systematic solution to support non-standard bandwidth some of operators hold. From this point of view, we are open to evaluate all proposals. However, we expect overlapping UE channel BW from UE perspective needs more works and implies larger complexity than network perspective and paralleling two discussions might not be efficient and constructive given limited time. Also, NW throughput is mainly limited by the total BS CBW and the benefits of approach 1 is increased max UE throughput only. From that reason, we prefer to start looking into overlapping UE CBW from network perspective first (i.e. Approach 2). Sub topic 5-2: Our preference is to evaluate different possible solutions and their pros and cons. Perhaps different non-standard CBWs might have different solutions to maximize its spectrum utilization. So, RAN4 can analyze which CBWs may benefit from each of the proposed solutions. ….Others: |
| Qualcomm | Sub-topic 5-1: this work does not need to be included. This will require a lot more work, not only in RAN4 without any gain over other schemes that were proposed. |
| Apple | Sub topic 5-1We are fine to consider all possible solutions as a starting point of the SID in RP-201352Sub topic 5-2We prefer to take the T-Mobile proposed SID in RP-201352 as the baseline for further progress on this topic. Regarding the SID itself, we have one minor comment related to the proposed scope: the proposed Objective 5 aims to “Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA.” In our understanding, having or not having this objective would not materially change the nature of the related discussions, since 3GPP is contribution-drive, and companies can bring arguments related to complexity at any time. However, having the objective in the SID might detract from the clarity of the work scope. Thus, we have a slight preference to remove this objective from the SID. |
| Nokia | Sub topic 5-1: Since the intention of the Study Item is to analyze and compare different solutions, overlapping UE channel bandwidths both from UE and network perspectives should be considered. It is proposed that new (dedicated) channel filters (e.g. non-integer-multiples of 5MHz) are not considered. Sub topic 5-2: We propose the following modifications/clarifications in the SI objective:* “Identify operator licensed channel bandwidths that do not align with existing NR channel bandwidths.” Clarify that the intention of this SI is to find a solution for licensed spectrum blocks above 5MHz only (all proposed licensed blocks to be studied are larger than 5MHz).
* “Evaluate the potential use of larger channel bandwidths than operator licensed bandwidth, including the impacts on regulatory emission requirements and UE blocking impacts.” We suggest extending this sentence to: “…impacts on regulatory emission requirements/UE output power implications and UE ACS/blocking impacts, depending on the guard band and the SCS”.
* “NOTE: From a UE perspective Channel Bandwidths in multiple of 5MHz are assumed as the baseline for this work”. We propose to clarify for all considered solutions that new (dedicated) channel filters (e.g. non-integer-multiples of 5MHz, see also approach #4 above) are neither considered for the UE nor the gNB.
* “Identify operator licensed bandwidths that are not compatible with the use of techniques like intra-band CA or overlapping UE channel bandwidths”. Every proposed method shall be summarized w.r.t. whether all considered spectrum scenarios are supported or whether there are specific limitations. Some limitations for a specific method shall not disqualify such method if there is a trade-off between flexibility and implementation challenges.
* “Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA”. Testing aspects shall be included in that study.
* “Generic and future proof solution(s) should be intended, with priority should be given to approaches that avoid the introduction of new channel BWs on the UE side”. We propose to include the following text: “Spectrally efficient methods providing a fine channel bandwidth granularity as well as low to moderate guard band width and signalling overhead should be preferred”.
* “Impact on RAN1 and RAN2 should be considered and minimized”. While we agree impact to RAN1/2 should be minimized (e.g. to LS communication only) in the study item phase, it shall be considered in case RAN4 will find promising solution which would require minor/moderate RAN1/2 impact.
* Clarify in objectives if solutions to be studied apply for both DL and UL. Furthermore, it is proposed to add a statement that any potential Work Item will not start before all considered methods are evaluated and compared.

Furthermore, we propose to add the following aspects:* The study item focus is for FR1.
* For any considered solution, UEs not supporting such solution (in particular legacy UEs) should be able to use the next lower supported channel bandwidth in the UL and DL without implications.

Others:* For spectrum block of 33MHz in n28 it should be noted there is dual duplexer assumption (2x30MHz) for this band.
 |
| Ericsson | Sub-topic 5-1: Overlapping bandwidths from the UE perspective could be a large amount of work and complex; we think it is better to focus on other solutions.Sub-topic 5-2: Note that the proposed objectives from RP-201352 were updated slightly in R4-2010058, which was submitted to the August RAN4 meeting:*The objectives of this study item are:*1. *Identify operator licensed channel bandwidths that do not align with existing NR channel bandwidths.*
2. *Evaluate the potential use of larger channel bandwidths than operator licensed bandwidth, including the impacts on regulatory emission requirements and UE blocking impacts.*
3. *Study the use of overlapping UE channel bandwidths to cover operator’s license spectrum, and if new gNB channel bandwidths are needed.*

*NOTE: From a UE perspective Channel Bandwidths in multiple of 5MHz are assumed as the baseline for this work*1. *Identify operator licensed bandwidths that are not compatible with the use of techniques like intra-band CA or overlapping UE channel bandwidths.*
2. *Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA.*
3. *Other solutions are not precluded.*
4. *Generic solution(s) should be intended as much as possible, with priority should be given to approaches that avoid the introduction of new channel BWs on the UE side. Proprietary solutions if proven relevant should not be precluded.*
5. *Impact on RAN1 and RAN2 should be considered and minimized*
 |
| OPPO | **Issue 5-1: Should the use of overlapping UE channel bandwidth from UE perspective be included in the SID?**For the study item it is ok to include all the possible solutions for comparison but for the WI then the complexity should be taken into account. |
| MTK | Sub-topic 5-1: No. Prefer to do the study in a separate SID.Sub-topic 5-2:* Limit this work in FR1 only
* Study the use of overlapping UE channel bandwidths can be from purely from BS perspective or also from UE perspective.
* UE RF requirements should still assume multiple of 5MHz as the baseline
* Impact to RAN1 and RAN2 is not clear, e.g., whether to BWPs or CORSETs in 2 CCs can be overlapped or not. RAN1 and RAN2 should be involved in the study.
* Impact to RRM is not clear, e.g., for 7MHz BW formed by 2 overlapping 5MHz CCs do we assume single SSB or 2 SSBs.
 |
| China Telecom | We are interested in the irregular channel bandwidths. Meanwhile, we think the impact to legacy UE needs to be considered, at least we should guarantee the legacy UE can also access to the network with new irregular channel bandwidth. |
| Xiaomi | Overlapping bandwidths is totally new compared to traditional CA case which may lead to heavy work on the spec. But that can be also as a part of study. |
| CMCC | Sub-topic 5-1: Yes. The motivation of the study item is to study the solutions to support irregular bandwidth to help operator utilize spectrum more efficiently. A generic solution to support irregular bandwidth is very important for future proof. From this perspective, we support to study all the possible solutions in this study item.Sub-topic 5-2: Regarding the last bullet in the SID, 8) Impact on RAN1 and RAN2 should be considered and minimizedWe think the impact on RAN1 and RAN2 also need to be identified in this study item if any. So we propose to modify this bullet as:8)Study and identify the RAN1 and RAN2 impact on the solutions. |
| LGE | **Issue 5-1: Should the use of overlapping UE channel bandwidth from UE perspective be included in the SID?**We are Ok to add all the possible solutions for comparison.**Issue 5-2: Comments for the other part of scope in RP-201352*** Limit this work in FR1 only
* Consider overlapping UE channel bandwidth from network perspective.
* UE RF requirements should still assume multiple of 5MHz as the baseline.
* Identify operator licensed bandwidths that are not compatible with the use of techniques like intra-band CA or overlapping UE channel bandwidths.
* Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA.
 |
| ZTE | Sub-topic 5-1: Overlapping bandwidths from the UE perspective, we could see lots of RAN1/RAN2 work involved, base on the existing TU allocation and schedule in other group, we need to find better solution to minimize the impacts in other groups.Clarifications should be needed on whether or not a generic method to introduce any irregular channel bandwidth is targeted in this WI, or just some specific irregular channel bandwidth, i.e., 7MHz and 13MHz.Sub-topic 5-2:Before discussing the RF requirement like SU and emission requirements, RAN1/RAN2 impacts should be clarified at first, in addition, what’s the use case of such band request should be clarified also to further discuss the related requirements. In addition, the existing framework intra-band CA or overlapping UE channel bandwidth should be considered as baseline.  |
| Huawei | Issue 5-1: Firstly this is a study item. According to our understanding, it is fair to allow the study on all the possible solutions. We are not convinced why the overlapping CA from UE perspective should be precluded.And if company is unhappy and have a concern on the potential impacts on RAN1 and RAN2, then we can clearly state in the object that no RAN1 and RAN2 impact is allowed except for some capability signaling. From our point view, the impact on RAN1 and RAN2 is undesirable since operator may use it in a release independent manner. |

## Summary

In this section, the summary of comments on Topic#3 and the corresponding recommendations are provided.

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#5-1** | **Issue 5-1: Should the use of overlapping UE channel bandwidth from UE perspective be included in the SID?**Targeting at stabilizing the scope for this part, the comments from companies are summarized as below and accordingly the recommendations are provided.* Include overlapping CBW from network perspective only or do not consider overlapping CBW from UE perspective (Intel, Ericsson, Mediatek, ZTE, Qualcomm)
* Include overlapping CBW from both network and UE perspective (Huawei, HiSilicon, Apple, Nokia, OPPO, CMCC, LGE)
	+ It is proposed that new (dedicated) channel filters (e.g. non-integer-multiples of 5MHz) are not considered. (Nokia)
	+ Need consider the impact on legacy UE (China Telecom)

[Recommendation]: more companies seems OK to include overlapping CBW from UE perspective. Can we include it with clarification that no RAN1 impact is foreseen? |
| **Sub-topic#5-2** | **Issue 5-2: Comments for the other part of scope in RP-201352**Targeting at stabilizing the scope for this part, the comments from companies are summarized as below and accordingly the recommendations are provided.* Regarding the SID itself, we have one minor comment related to the proposed scope: the proposed Objective 5 aims to “Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA.” Thus, we have a slight preference to remove this objective from the SID. (Apple)
* Concrete comments from Nokia, Ericsson, Mediatek, LGE, CMCC.

[Recommendation]: Take Nokia, Ericsson, Mediatek, LGE, CMCC’s concrete comments into account. |

## Recommendation of objectives (Moderator)

The recommendations are provided inline above, which are highlighted by yellow. Based on the recommendations, the tentative objectives and revision of objectives for this part are provided below.

The original objectives for this part:

*The objectives of this study item are:*

1. *Identify operator licensed channel bandwidths that do not align with existing NR channel bandwidths.*
2. *Evaluate the potential use of larger channel bandwidths than operator licensed bandwidth, including the impacts on regulatory emission requirements and UE blocking impacts.*
3. *Study the use of overlapping UE channel bandwidths to cover operator’s license spectrum, and if new gNB channel bandwidths are needed.*

*NOTE: From a UE perspective Channel Bandwidths in multiple of 5MHz are assumed as the baseline for this work*

1. *Identify operator licensed bandwidths that are not compatible with the use of techniques like intra-band CA or overlapping UE channel bandwidths.*
2. *Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA.*
3. *Other solutions are not precluded.*
4. *Generic and future proof solution(s) should be intended, with priority should be given to approaches that avoid the introduction of new channel BWs on the UE side*
5. *Impact on RAN1 and RAN2 should be considered and minimized*

By capturing Nokia, Ericsson, Mediatek, LGE, CMCC’s concrete comments, the recommended objectives for further discussions are as follows. Besides, more discussion is needed whether to include overlapping CBW from UE perspective.

The objectives of this study item are:

* Identify operator licensed channel bandwidths that do not align with existing NR channel bandwidths.
	+ The intention of this SI is to find a solution for licensed spectrum blocks above 5MHz only
	+ [UE RF requirements should still assume multiple of 5MHz as baseline].
* Evaluate the potential use of larger channel bandwidths than operator licensed bandwidth, including the impacts on regulatory emission requirements/UE output power implications and UE ACS/blocking impacts, depending on the guard band and the SCS
* Study the use of overlapping UE channel bandwidths to cover operator’s license spectrum, and if new gNB channel bandwidths are needed
	+ [Study the use of overlapping UE channel bandwidth can be from BS perspective and/or from UE perspective]

NOTE: From a UE perspective Channel Bandwidths in multiple of 5MHz are assumed as the baseline for this work.

NOTE: For all considered solutions that new (dedicated) channel filters (e.g. non-integer-multiples of 5MHz, see also approach #4 above) are neither considered for the UE nor the gNB.

* Identify operator licensed bandwidths that are not compatible with the use of techniques like intra-band CA or overlapping UE channel bandwidths.
	+ The trade-off between flexibility and implementation is expected.
* [Study the complexity and efficiency of adding new channel bandwidths vs. using existing techniques like intra-band CA.]
* Other solutions are not precluded.
* Generic and future proof solution(s) should be intended, with priority should be given to approaches that avoid the introduction of new channel BWs on the UE side
	+ Spectrally efficient methods providing a fine channel bandwidth granularity as well as low to moderate guard band width and signalling overhead should be preferred
* Study and identify the RAN1 and RAN2 impact on the solutions
* The study focuses on FR1 and applies for both UL and DL. For any considered solution, UEs not supporting such solution (in particular legacy UEs) should be able to use the next lower supported channel bandwidth in the UL and DL without implications.

# Topic #6: Support overlapping CA for LTE

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposed objective(s)** |
| RP-200612 | Huawei, HiSilicon | The objectives of the core part of WI are as follows:* Downlink overlapping intra-band contiguous CA is considered
* Study and address the potential issues for RF/RRM when there is CRS/PDCCH overlapping
* Specify the necessary UE RF requirements, e.g., channel arrangement and emission requirements
* Specify the necessary signaling to support it

The objective of performance part of WI is as follows* Specify the necessary UE demodulation performance requirements
 |

## Open issues summary

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

The motivations were provided in [7], which are copied below.

Six channel bandwidths are specified for LTE. But the available spectrum for operator quite diverse, which may not be aligned with the specified LTE channel bandwidths or aggregated channel bandwidths.

For LTE non-CA deployment, there is gap between two adjacent CCs serving as the guard band, which is the sum of guard bands of two adjacent CCs. For LTE CA deployment, the nominal spacing is usually applied between two adjacent CCs. For example, for the above two scenarios, more than 1.4MHz spectrum exists between two 20MHz CCs, which cannot be utilized.

If the two adjacent CCs are allowed to be overlapped with each other, there would be two benefits:

* The spectrum which is not aligned with LTE bandwidths can be fully utilized with a certain overlapping area between two CCs
* The guard band(s) between two adjacent CCs can be saved.

### Sub-topic 6-1

*Sub-topic description:*

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

**Issue 6-1: Study and address the potential issues for RF/RRM when there is CRS/PDCCH overlapping in order to support intra-band DL overlapping CA for LTE**

### Sub-topic 6-2

*Sub-topic description*

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

**Issue 6-2: Specify the necessary RAN4 requirements and signalling**

* Specify the necessary UE RF requirements, e.g., channel arrangement and emission requirements
* Specify the necessary signaling to support it
* Specify the necessary UE demodulation performance requirements

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Sub topic 6-1: This WI shall not be a part of NR WI discussion. Considering 3GPP work resource, it would be better not to touch mature technology like LTE but rather better to focus on enhancing something new like NR. If we can use 100MHz channel bandwidth of NR, this issue can be solved to some extent.Sub topic 6-2: The same for 6-1 applies.….Others: |
| Intel | Sub topic 6-1: In our understanding for LTE the scope is not limited to potential RF/RRM issues and overlapping CA may have impact on RAN1 design. For instance, it is not clear how to handle PDCCH in overlapping carriers in LTE. LTE spec has been matured for a while and we don’t see much benefit to open a new issue in LTE which would cause a new RAN1 design.  Since a similar concept has been proposed to NR to address non-standard channel BW, we prefer to focus on NR discussion not in LTE.Sub topic 6-2: Same as the issue 6-1 |
| Qualcomm | Sub-topic 6-1: This was already proposed multiple times in LTE and there was never enough support/interest to approve it. We are already discussing the use of “irregular” channel bandwidths in NR, that should be enough. Operators can directly deploy NR instead of a complicated feature that might not even be implemented in LTE.Sub-topic 6-2: same comment as for 6-1 |
| Apple | Sub topic 6-1The justification for this enhancement is not very clear, since the proposal would impact LTE deployments and LTE devices in Rel-17, which seems to be counterintuitive, given the accelerated adoption of NR already under way in the industry.Sub topic 6-2We should address the feasibility of introducing any enhancement to LTE in the Rel-17 timeframe (see our comment to Sub topic 6-1) before considering work scope related to this proposal. |
| Ericsson | We share the view that this is LTE focused, has been discussed many times and is likely to involve changes in other WG. We do not support to include this LTE WI in Rel-17. |
| MTK | We do not see the benefit to work on an LTE WI with such big spec impact at this moment.  |
| LGE | **Issue 6-1: Study and address the potential issues for RF/RRM when there is CRS/PDCCH overlapping in order to support intra-band DL overlapping CA for LTE**We don’t think it is necessary. We just focus on NR study and enhanced NR RF requirements to avoid the overlapped cases with LTE. It may need to change the LTE in RAN1/2/4. It should be excluded in Rel-17 enhancement RF WI. **Issue 6-2: Specify the necessary RAN4 requirements and signaling**We don’t think it is necessary. Do not need to study in RAN4. |
| ZTE | We also think it’s not necessary to have such fundemental changes on channel arrangement or CA arrangement in such late phase, In addition, we didn’t see the operator request on LTE RAT for such kind of scenarios. |
| Huawei | Our intention is not to change RAN1/RAN2. The intention is to improve the spectrum efficiency by reducing the guard band between LTE CCs. In our view, it would be still valuable for DSS cases. |

## Summary

In this section, the summary of comments on Topic#3 and the corresponding recommendations are provided.

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#6-1** | **Issue 6-1: Study and address the potential issues for RF/RRM when there is CRS/PDCCH overlapping in order to support intra-band DL overlapping CA for LTE**Most companies had concern on further enhancement for LTE. More discussion is needed. |
| **Sub-topic#6-2** | **Issue 6-2: Specify the necessary RAN4 requirements and signalling**Most companies had concern on it. More discussion is needed. |

## Recommendation of objectives (Moderator)

More discussion is needed.

# References

[1] RAN4 Chairman (Futurewei), RP-201331, “Work areas of RAN4 R17 non-spectrum related WI/SIs”, RAN#88e.

[2] Huawei, HiSilicon, RP-200614, “New WID proposal: RF requirements enhancement for NR frequency range 1 (FR1) in Rel-17”, RAN#88e.

[3] Vivo, RP-200945, “New SID: Optimizations on power class fall back”, RAN#88e.

[4] Huawei, HiSilicon, RP-200610, “New WID proposal: introduction of brand new channel bandwidths for NR”, RAN#88e.

[5] T-Mobile USA, RP-201352, “New SID on Efficient utilization of licensed spectrum that is not aligned with existing NR channel bandwidths”, RAN#88e.

[6] Huawei, HiSilicon, RP-200609, “Motivation for new WI on introduction of brand new channel bandwidths for NR”, RAN#88e.

[7] Huawei, HiSilicon, RP-200612, “New WID proposal: supporting overlapping CA for LTE”, RAN#88e.