**3GPP TSG-RAN WG4 Meeting #112 R4-2412818**

**Maastricht, Netherlands, 19th -23th Aug, 2024**

**Agenda item:** 8.1.3

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

**Title:** Topic summary for [112][116] NR\_ENDC\_RF\_Ph4\_part1

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

Thread [116] includes topic of Power boosting and/or MPR reduction.

There topics are discussed under this thread:

* Topic#1: Power domain enhancements for single carrier
* Topic#2: MPR applicability for FR1 intra-band UL CA
* Topic#3: MPR applicability for FR2

# Topic #1: Power domain enhancements for single carrier

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2411108**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411108.zip) | Further discussion on power domain enhancements for single carrier | CATT | ***Proposal 1: Sufficient evaluation of impacts on BS receiver should be conducted before RAN4 makes a decision to change the spurious domain boundary for the target scenario where a UE channel bandwidth is located in a wider BS channel bandwidth.*** ***Proposal 2: A feasible simple solution is to keep the spurious boundary unchanged for the target scenario if considering the limited time and minimized specs impacts.******Proposal 3: Only consider the approach to enable MPR reduction and/or power boosting for a UE channel bandwidth no less than 10MHz.******Proposal 4: Consider changing SEM level in the modified OOB domain by extending UE BW and keeping spurious emission domain unchanged.******Proposal 5: Keep ACLR unchanged when changing SEM level in the modified OOB domain.******Proposal 6: No relaxation outside BS channel bandwdith.*** |
| [**R4-2411153**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411153.zip) | On Rel-19 power domain enhancement | Apple | ***Observation 1: If the goal is to convert all outer RB allocations into inner RB allocations, then the minimum BS channel needs to be at least twice the size of the UE channel.******Observation 2: If the sole goal is to obtain output power improvements, then it is possible to have a more convenient ratio between UE and BS channel such as two-third. Initial analysis indicates that for 15MHz UE channel and 20MHz BS channel a power output improvement of 0.5 to 1.0dB seems to be possible.*** |
| [**R4-2411326**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411326.zip) | Discussion on MPR reduction for FR1 single carrier | Samsung | ***Proposal 1: The spurious emission boundary should be treated very cautiously and we can only touch the spurious emission boundary specified by 3GPP.******Proposal 2: When the Shifted Channel Edge approaches are applied, the spurious emission boundary specified by 3GPP can be changed.*** ***Otherwise, it is not reasonable to change spurious emission boundary.******Observation 1: When extended UE CBW edge exceeds the BS CBW edge, it is risky to apply the “inner RB allocation” IBE requirements outside the BS CBW.******Proposal 3: When extended UE CBW edge exceeds the BS CBW edge,*** ***it is not feasible to apply the approach to convert full RB allocation in UE CBW to “inner RB allocation” with an extended UE BW and corresponding IBE requirements.******Proposal 4: IBE should be used between edges of UE CBW and extended UE CBW.******Proposal 5: ACLR and SEM should be applicable from the edge of extended UE CBW instead of the BS CBW.******Proposal 6: Integral region and boundary of OOBE should be based on UE CBW.*** |
| [**R4-2411535**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411535.zip) | Further Views on MPR Reduction | Sony | ***Observation 1: The spurious emission requirement in 3GPP is to ensure co-existence when UE operates globally.******Observation 2: The benefit to changing the boundary of general spurious emissions is unclear, especially considering the requirements of spurious emissions for UE co-existence.******Observation 3: Allowing extended UE CBW go beyond the BS CBW may also shift the boundary of ACLR and SEM, which will cause risk for out-of-band protection.******Observation 4: It is possible to obtain some MPR reduction via transferring the edge RB allocation to the inner outer RB allocation, although the gain will be limited.******Observation 5: UE can obtain the cell BW in SIB1 and used it as the extended UE channel BW.*** ***Observation 6: From a signaling perspective, it is most straightforward for the UE to adopt the cell BW bandwidth as reference channel BW to perform the MRP reduction.******Observation 7: From the network aspect, allocating a device with narrow bandwidth towards the inner location within an operator's spectrum block may not be a common scenario in real life since this may create spectrum fragmentation.******Observation 8: The frequency bands are usually small in FDD bands in sub 1 GHz, which makes it not being feasible to move the UE away from the edge of the band.*** ***Observation 9: Depending on the UE RF front implementations and UE bandwidth, the required MPR to meet each out-of-band emission is different with different RB allocations. In addition, it is also different at different frequency bands due to the spurious emission limit for the co-existence.*** ***Proposal 1: Do not consider any change to the level and boundary of the spurious emission.******Proposal 2: The extended UE CBW should not exceed the BS CBW.******Proposal 3: The corresponding in-band and out-of-band emission requirements shall be adjusted according to the extend UE BW.*** ***Proposal 4: The IBE requirements only be applied within the extended UE CBW.******Proposal 5: ACLR and SEM are applicable from the edge of extended UE CBW.******Proposal 6: The integral region and boundary of OOBE is based on extended UE CBW.******Proposal 7: RAN4 shall examine if the proposed MPR reduction scheme can be enabled for all types of UEs, including TDD and FDD, as well as normal UE, Redcap, and eRedcap UEs.*** ***Proposal 8: If any reduction of MPR would be specified in the end, it should be an optional feature for UE with per band capability.*** |
| [**R4-2411601**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411601.zip) | Discussion on power domain enhancement for single carrier | Xiaomi | ***Observation 1: Based on case 3 (extended UE CBW equals to 2\*UE CBW) and case 4 (extended UE CBW equals to 1.5\*UE CBW), the boundary between inner RB allocations and outer RB allocations become less noticeable when extended UE CBW become larger.******Proposal 1: IBE is unnecessary to use between edges of UE CBW and BS CBW or between edges of UE CBW and extended UE CBW.******Proposal 2: SE boundary is unnecessary to change.******Proposal 3: It is possible to define one MPR value for both of inner RB allocations and outer RB allocations when moving the key requirement limits to the outside of extended UE CBW.*** |
| [**R4-2411631**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411631.zip) | Power boosting and MPR reduction | Qualcomm Technologies Int | ***Observation 1: To make all RB allocations in the original UE BW ‘inner’ allocations the minimum excess BW on either side must be at least half the original UE BW.******Proposal 1: If minimum excess BW equal to half of the original UE BW can be placed on both sides of the original UE BW this extended UE BW can be treated as the new UE BW and all performance metrics can be based on this new BW.*** ***Proposal 2: If the minimum extended BW on both sides of original UE BW is less than half the original UE BW then the original UE BW should not be extended, and all performance metrics should be based on the original UE BW.*** ***Observation 2: Dividing a given band into more sub-bands results in lesser inner allocations over the entire band******Observation 3: The addition of excess BW equal to at least ½ of the allocated UE BW to only one side of the allocated UE BW may be a more realistic scenario due to the way the sub-bands are allotted within an operator’s band compared to adding excess BW on both sides which requires not only more BW but also needs to have unused BW on both sides of the allocated BW.******Observation 4: Adding excess BW to either side of the allocated spectrum increases the number of inner allocations******Observation 5: Adding excess BW to either side of the allocated UE spectrum modifies the MPR tables.******Proposal 3: Study the use case where excess BW is only added on one side of the allocated UE BW******Proposal 4: For the case where minimum excess BW equal to half the allocated UE BW is added only on side of the allocated UE BW use the following equations to describe the inner allocations:******Case 1: Excess BW added on lower side of allocated UE BW use:******RBStart,Low = max(1, floor(LCRB/2))******RBStart,High = NRB – RBStart,Low – LCRB******RBStart ≤ RBStart,High,and LCRB ≤ ceil(2NRB/3)******Case 2: Excess BW added on higher side of allocated UE BW use:******RBStart,Low = max(1, floor(LCRB/2))******RBStart,High = NRB – RBStart,Low – LCRB******RBStart\_Low ≤ RBStart*** |
| [**R4-2411674**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411674.zip) | Power domain enhancements for single carrier | Ericsson | ***Observation 1: the general SEM was specified to allow for global circulation of terminals and compliance with regulatory limits. ACLR is stricter than the SEM integrated over the adjacent channel, ACLR used for coexistence studies with requirements specified to ensure robust network performance within and between coexisting networks.****For the prioritized Scenario 1-1****Observation 2: increasing UE output power by allowing relaxed ACLR by means of e.g. (NS) network signaling for the single operator case is not straightforward; there is no guarantee that this is not used by an operator with a victim operator in a neighboring spectrum block, and it is difficult to distinguish between the coexistence issues for the single operator (Scenario 1-1) and adjacent operator (Scenario 1-2) cases.****Alternatively,****Observation 3: rather than relaxing coexistence requirements devised for robust network performance with a view to increasing UE output power, the simulation assumption for power boosting and/or MPR reduction could be reconsidered to reflect state-of-the-art performance at least on a per-band basis with improvements subject to capability.*** *For the case of a ‘narrower UE channel BW within a wider BS bandwidth’, we first observe that****Observation 4: the UE-specific CHBW was specified in Rel-15 to ensure that the UE is compliant with unwanted emission requirements when located within a wider BS (cell) bandwidth not supported by the UE, the UE thus configured compliant with the SEM and ACLR applicable for the UE-specific CHBW.****to propose that****Proposal 1: the feature ‘narrower UE channel BW within wider BS bandwidth’ is specified for a UE configured with a UE-specific CHBW within a wider BS bandwidth, the said UE compliant with selected OOBE requirements applicable for the wider BS bandwidth (the cell bandwidth).*** ***Observation 5: the improvement would only be relevant for a UE not supporting the wider BS bandwidth but can be implemented using existing signaling. All UEs attaching to the cell will have to decode the carrier bandwidth advertised in SIB1 regardless of channel bandwidth capability.******Proposal 2: no changes of signalling are specified for the feature ‘narrower UE channel BW within wider BS bandwidth’ except possibly specification of a capability bit to indicate support of the feature.*** |
| [**R4-2411851**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411851.zip) | Discussion on power domain enhancements for single carrier | ZTE Corporation, Sanechips | ***Observation 1: By comparing the difference of OOB boundary between 3GPP and ITU, it can be observed that OOB boundary defined in 3GPP is stricter than ITU.******Proposal 1: For the first FFS, it can be divided into two cases. One is that there is no adjacent in-band/out-of-band co-existence issue, in which case, it is feasible that extended UE CBW edge exceeds the BS CBW edge. The other is that there exists adjacent in-band/out-of-band co-existence issue, and extended UE CBW edge cannot exceed the BS CBW edge.******Proposal 2: The region between the edge of UE CBW and the edge of extended UE CBW can be regarded as in-band of extended UE CBW, where IBE could be used.******Proposal 3: ACLR and SEM should be applicable from the edge of extended UE CBW instead of edge of BS CBW.******Proposal 4: Integral region and boundary of OOBE should be based on UE CBW.*** |
| [**R4-2412009**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412009.zip) | UE RF Enh 4: Power domain enhancements for single carrier | Nokia | ***Observation 1: Relaxation of ACLR/SEM/spurious emissions limits will lead to higher interference spread over a wide bandwidth (e.g., intra-cell interference within BS channel bandwidth, intra/inter operator BW interference).*** ***Observation 2: The new definition of the extended or aggregated UE CBW may not be necessary, and RAN4 could use UE CBW and the additional guard band terminology similar to the specification.*** ***Observation 3: Defining an additional guard band configuration allows MPR reduction and/or additional power boost capability even with the current ACLR/SEM/spurious emissions limits and UE RF/hardware.*** ***Proposal 1: RAN4 could specify at least one guard band configuration larger than the minimum guard band (i.e., additional guard band) or a maximum transmission bandwidth smaller than the legacy maximum transmission bandwidth as shown in Figure 2, and the associated enhanced MPR/power boost.******Proposal 2: It is not feasible to allow any unrestricted emissions or consider any additional guard band size beyond BS CBW at least from regulatory, interference and co-existence perspectives. RAN4 should restrict the additional band size and UE CBW to strictly lies within BS channel BW.******Observation 4: Defining UE requirements according to the BS channel bandwidth would allow reduced MPR as only IBErequirement would be valid within BS channel bandwidth.******Proposal 3: For MPR reduction the out of boundary is defined according to BS CBW as shown in option 2 of the figure 2. ACLR, SEM and spurious emissions would be define as of today but based on BS channel bandwidth.*** |
| [**R4-2412085**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412085.zip) | Discussion on power domain enhancements for NR single carrier | vivo | ***Proposal 1: The application range of SE should be altered with the shifting of the edge of the UE CBW and the change in the application range of ACLR and SEM.******Proposal 2: The integral region and the boundary of OOBE should be based on UE CBW.******Proposal 3: The edge of the extended UE BW should be inside BS CBW or at least aligned with the BS CBW edge.******Proposal 4: IBE should be used between edges of UE CBW and extended UE CBW. And the IBE of this part should be equal to that of the original UE CBW edge.******Observation 1: Extending the bandwidth by less than 1/2 UE CBW is sufficient to reduce the MPR of full RB allocation to the inner level.******Proposal 5: The required extended bandwidth of the both sides could be set to 2/5 UE CBW as a starting point.******Proposal 6: The frequency intervals for the UE CBW and the BS CBW should be judged by the NW and the indication of MPR reduction could be directly sent to the UE when the corresponding conditions are met.*** ***Proposal 7: Where and how to present the mapping relationship between the original UE CBW, the extended UE CBW and the MPR table should be clarified.*** |
| [**R4-2412351**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412351.zip) | R19 MPR reduction for single carrier | OPPO | ***Observation 1: MPR can be improved via extended UE CBW and converting ACLR/SEM requirements to IBE requirements. And larger extended UE CBW will have more MPR improvement. When the extended UE CBW is large enough the MPR can be reduced to 0dB.******Proposal 1: Consider extended UE CBW approach to improve MPR starting from 1.5\*CBW.******Proposal 2: Study the system performance impacts by this extended UE CBW approach, i.e. impacts due to applying IBE instead of ACLR/SEM in the out of band emission regions.*** |
| [**R4-2412433**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412433.zip) | Views on Power domain enhancements for single carrier | China Telecom | ***Observation1: SE/OOBE/IBE should all study the boundary or region at first rather than relaxation level.*** ***Proposal1:*** ***RB allocation convert scenarios○1****Preclude this aspect for outer RB allocation convert evaluation and use legacy MPR requirements.****RB allocation convert scenarios○2****IBE should be used between edges of UE CBW and extended UE CBW rather than between edges of UE CBW and BS CBW.****RB allocation convert scenarios○3****The start point of ΔfOOB should be extended UE CBW edge.****RB allocation convert scenarios○4****Basing on UE CBW as a start point.****Proposal2: Establish a start point and continue to details for BS indication with the deepen in MPR reduction mechanism.*** |
| [**R4-2412553**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412553.zip) | Discussion on power domain enhancement for NR single carrier | MediaTek (Wuhan) Inc. | ***Proposal 1: Specify the case where extended CBW does not exceed the BS CBW edge.*** ***Proposal 2: For the case where a UE CBW is allocated at the edge of the BS CBW, agree to consider further an “Asymmetrical extended CBW” to allow outer RB allocation MPR reduction applicability for a UE CBW allocated at the edge of the BS CBW.******Proposal 3: Agree that IBE shall apply in the region between UE CBW and extended CBW. Also agree to allow operators to be given control via network signalling to the UE of whether usage of extended UE CBW is permitted within the cell.******Proposal 4: Agree that ΔfOOB shall be the same for ACLR and SEM when extended UE CBW applies.******Proposal 5: Agree that requirements for ACLR and SEM apply from edge of extended CBW.******Proposal 6: Agree to shift the FOOB boundary to the edge of the OOBE for extended CBW.******Observation 1: All modelled RB allocations pass the test. These test points covered the most restrictive cases. We believe that this is sufficient to demonstrate that the requirements would be passed for all RB allocations within NRB of the actual UE CBW.******Observation 2: An extended CBW is shown to be feasible for reducing MPR for Outer RB allocation MPR for PC3, for Symmetrical Extended UE CBW (for QPSK and 16QAM) and also appears to be feasible for Asymmetrical extended UE CBW (for QPSK, with 16QAM FFS).*** |
| [**R4-2412568**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412568.zip) | On power domain enhancements for single carrier | Huawei, HiSilicon | ***Proposal 1: For the scenario when there is no adjacent in-band/out-of-band co-existence issue (single operator), introduce network controlled relaxation on ACLR and SEM mask.**** ***For ACLR, the relaxation means e.g. PC3 requirement 30dB can be relaxed to a smaller value.***
* ***For SEM mask, the relaxation means an upward shift on the whole mask.***
* ***No change on the reference channel bandwidth or the start of ΔfOOB***

***Proposal 2: Check if followings can be adopted for the network controlled relaxation towards no adjacent in-band/out-of-band co-existence issue (single operator) scenario.**** ***Three level of relaxation, e.g. 3dB, 5dB and waived***
* ***Per band and per region (can be based on operator request)***

***Proposal 3: Clarify that the BS channel bandwidth means BS RF bandwidth that covers single carrier, multi-carriers and multi-RATs scenarios.******Proposal 4: If RAN4 picks the following solution for narrower UE channel BW within wider BS bandwidth (with adjacent operators) scenario, UE indication on the minimum shifted frequency of ΔfOOB per concerning band should be allowed.**** ***Symmetrically shift the start of ΔfOOB away from the UE CBW of the frequency equals to the minimum shifted frequency the UE indicated for the concerning band***
	+ ***To acquire the aggregated maximum number of RBs for inner RB determination, include the indicated shifted frequency together with the given UE CBW***

***Proposal 5: If RAN4 picks the following solution for narrower UE channel BW within wider BS bandwidth (with adjacent operators) scenario, the length of BS CBW and the location of UE CBW within BS CBW should be informed to UE.**** ***Use the edge of BS CBW band the start point of ΔfOOB***
	+ ***The BS channel bandwidth means BS RF bandwidth that covers single carrier, multi-carriers and multi-RATs scenarios***
	+ ***To acquire the aggregated maximum number of RBs for inner RB determination, include the indicated shifted frequency together with the given UE CBW***

***Proposal 6: To align the simulation assumption, it is the “general” part of IBE requirements that applies to the gap between the shifted ΔfOOB and the edge of UE CBW with following adaptation:**** ***Use the aggregated NRB which corresponds to the frequency span between two shifted ΔfOOB***
* ***The index  of the first adjacent RB outside of the UE CBW should be 1 or -1***

***Proposal 7: Regardless what mechanism will be evaluated and introduced for Rel-19 single carrier MPR reduction, no RF requirements should be applied to the guard band defined in TS 38.101-1 clause 5.3.3.*** ***Proposal 8: For the shifted start point of ΔfOOB, 1/2 UE CBW can be the default value for UE indication.*** ***Proposal 9: Consider to introduce shorter shifted frequency e.g. 1/3, 1/4 UE CBW in conjunction with the requirement that will be introduced to the shifted frequency.******For instance, the modified general part of IBE requirements which is further relaxed by replacing the EVM corresponding to the scheduling modulation order with the one for BPSK*** |
| [**R4-2412579**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412579.zip) | On reduced MPR when BS CBW is larger than UE CBW | Skyworks Solutions Inc. | ***Proposal: RAN4 to study a new inner, outer and edge allocation definition for MPR based on BS CBW by using in the already defined inner and edge equations:**** ***BS NRB instead of UE NRB.***
* ***Adding the amount of RB by which the UE RBs are shifted within the BS RBs to the UE RBstart.***
* ***The base station shall signal the extended NRB and RBstart shift for the UE to calculate the new inner, outer, and edge regions and reduce MPR.***
* ***For margin or stricter emissions, the BS can signal a reduced NRB and RBshift.***
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| [**R4-2413457**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413457.zip) | Discussion on Power domain enhancements for single carrier | LG Electronics UK | ***Proposal 1: There is a room to relax boundary of OOB. when it is compared with ITU-R regulation.*** ***Proposal 2: Need to consider capability for extended UE CBW procedure.*** ***Proposal 3: In feasilbity aspect, extended UE CBW edge should excced the BS CBW edge upto 1/2 UE CBW.*** ***Proposal 4: IBE should use between edge of UE CBW and extended UE CBW******Proposal 5: ACLR and SEM are applicable the edge of extended UE CBW*** |

## Open issues summary

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

### Sub-topic 1-1: Approaches to enable MPR reduction for scenario 1

*Sub-topic description*

***Scenarios discussed previous RAN4 meetings:***

* ***Scenario 1-1****: Scenario with no adjacent in-band/out-of-band co-existence issue (single operator)*
* ***Scenario 1-2****: Scenario with no adjacent in-band/out-of-band co-existence issue (adjacent operators)*
* ***Scenario 2****: Narrower UE channel BW within wider BS bandwidth*

*Open issues and candidate options before meeting:*

#### **Issue 1-1-1: Approaches for scenario 1**

* Proposals
	+ Proposal 1: For the scenario when there is no adjacent in-band/out-of-band co-existence issue (single operator), introduce network-controlled relaxation on ACLR and SEM mask. (Huawei)
		- For ACLR, the relaxation means e.g. PC3 requirement 30dB can be relaxed to a smaller value.
		- For SEM mask, the relaxation means an upward shift on the whole mask.
		- No change on the reference channel bandwidth or the start of ΔfOOB
		- Check if followings can be adopted for the network-controlled relaxation towards no adjacent in-band/out-of-band co-existence issue (single operator) scenario.
			* Three level of relaxation, e.g. 3dB, 5dB and waived
			* Per band and per region (can be based on operator request)
* Recommended WF
	+ Check whether method in above proposal is a possible approach to be further evaluated with more inputs from companies. Inputs from operators are also encouraged.

CMCC: Scenario 1 is helpful in some case like band n41. We support proposal 1.

OPPO: What does it mean no adjacent co-existence issue? If we relax one CC then there is impact on other CC?

Nokia: If it is relaxation means change of ACLR, we are not OK. We want to keep ACLR but discuss the starting point of frequency point.

Qualcomm: 3dB and 5dB are the values suggested.

Huawei: regarding relaxation of ACLR, there is no adjacent operator. In some region, there is no regulation. The whole solution is based on the request of operator. To Qualcomm, 3 and 5dB is just for example.

Skyworks: We are discussing ACLR and SEM mask and how to apply. What is the additional relaxation? Is it the usual ACLR for larger bandwidth.

CATT: For boundary, we would like to keep the existing. The three levels apply to ACLR, SEM at the same time?

Huawei: To CATT, SEM and ACLR are different requirements. We do not need combine them within the same level.

Skyworks: we would like to understand which bandwidth is assumed.

Huawei: for simplicity, we assume that there no adjacent operating band.

China Telecom: In general, the scenario 1 is beneficial for the operator when there is no adjacent operator. ACLR is defined based on the co-existence. IF there is no co-existence issue, ACLR can be relaxed.

AT&T: how can we handle the case for the band for which the signalling cannot be used for other region?

China Unicom: we have deployment for n1 and n78. Support the proposal.

Nokia: We have proposals.

Skyworks: in the single operator case, you need consider IBE issue.

Verizon: We would like to have common solution for both single operator case and multiple operator case.

### Sub-topic 1-2: Approaches to enable MPR reduction for scenario 2

*Sub-topic description*

*WF on approach to enable MPR reduction and/or power boosting in last meeting;*

* + Study the approach to convert full RB allocation in UE CBW to “inner RB allocation” with an aggregated UE BW (tentative term for illustration), e.g. each side of the UE BW is equal to ½ of the UE BW, inside a larger BS CBW as starting point with consideration of the following aspects
		- The edge of the aggregated UE BW, i.e. the UE CBW plus the shifted frequency symmetrically at each side of the UE CBW, should be inside BS CBW or at least aligned with the BS CBW edge
			* ① FFS feasibility of case where aggregated UE CBW edge exceeds the BS CBW edge, i.e. gap between edges of UE CBW and BS CBW < 1/2 UE CBW
			* ② FFS whether IBE is used between edges of UE CBW and BS CBW or between edges of UE CBW and aggregated UE CBW
			* ③ FFS ACLR and SEM are applicable from the edge of aggregated UE CBW or edge of BS CBW, i.e. the start point of ΔfOOB
			* ④ FFS integral region of OOBE is based on aggregated UE CBW or UE CBW



* + Other mechanisms are not precluded

*Open issues and candidate options before meeting:*

#### **Issue 1-2-1: Clarification of BS CBW**

* Proposals
	+ Proposal 1: Clarify that the BS channel bandwidth means BS RF bandwidth that covers single carrier, multi-carriers and multi-RATs scenarios. (Huawei)
* Moderator observation
	+ For the first meeting discussion, in the WF (R4-2406584) it said “*No relaxation of ACLR/SEM/SE outside of the BS CBW for one* ***operator holding spectrum*** *for scenario 2, i.e. Narrower UE channel BW within wider BS bandwidth*” and companies had some discussion on operator holding spectrum in the AH. The common understanding is that the operator holding spectrum could be larger than a specific CBW. Some clarification would be helpful for the following discussion.
* Recommended WF
	+ Check whether BS CBW discussed in the following issues means BS RF bandwidth or operator holding spectrum.

Nokia: BS channel bandwidth is the RF bandwidth for BS to transmit. BS still has channel bandwidth. RF implementation is other thing.

Ericsson: same understanding as Nokia.

ZTE: In 38.141-1 there is clear definition of BS channel bandwidth. If BS transmits multiple CC, BS RF channel bandwidth is larger than BS channel bandwidth.

CATT: Why do we need clarify BS channel bandwidth here?

Skyworks: Similar to CATT comment. UE does not need to know what BS bandwidth. UE just needs to know the spectrum range to meet ACLR. It could be something different. UE needs to know when it transmits here what ACLR should be applied.

Nokia: Agree with Skyworks. In our proposal, we propose to determine by BS channel bandwidth.

Huawei: UE channel bandwidth does not exceed BS bandwidth. We want consider multiple carrier case.

Nokia: we want to exclude the case UE bandwidth exceeds the BS.

Huawei: Agree with Nokia. UE channel bandwidth may not exceed BS.

#### **Issue 1-2-2: Approaches of converting outer RB allocation to inner RB allocation**

* Proposals
	+ Option 1: The extended UE CBW based method as captured in the WF in last meeting.
	+ Option 2: BS CBW based inner/outer method. (Skyworks)
		- BS NRB instead of UE NRB.
		- Adding the amount of RB by which the UE RBs are shifted within the BS RBs to the UE RBstart.
		- The base station shall signal the extended NRB and RBstart shift for the UE to calculate the new inner, outer, and edge regions and reduce MPR.
		- For margin or stricter emissions, the BS can signal a reduced NRB and RBshift.
	+ Option 3: the feature ‘narrower UE channel BW within wider BS bandwidth’ is specified for a UE configured with a UE-specific CHBW within a wider BS bandwidth, the said UE compliant with selected OOBE requirements applicable for the wider BS bandwidth (the cell bandwidth). (Ericsson)
	+ Option 4: RAN4 could specify at least one guard band configuration larger than the minimum guard band (i.e., additional guard band) or a maximum transmission bandwidth smaller than the legacy maximum transmission bandwidth, and the associated enhanced MPR/power boost. (Nokia)
* Recommended WF
	+ TBA

Skyworks: the concept to extend UE CBW does not work. UE need to know how many RBs can be extended for each side.

Nokia: We have two proposals, which is similar to Ericsson proposal.

OPPO: Quite similar to Skyworks.

CATT: Proposal from Skyworks is quite smart.

*Open issues and candidate options before meeting:*

*The following issues are mainly based on extended UE CBW based approach, but in principle the issues relevant to SE/OOBE/IBE are generic to the inner/outer approaches.*

#### **Issue 1-2-3: whether extended UE CBW edge could exceed the BS CBW edge**

* Proposals
	+ Proposal 1: The extended UE CBW should not exceed the BS CBW. (Samsung, Sony, vivo, MTK, LGE)
	+ Proposal 2: One is that there is no adjacent in-band/out-of-band co-existence issue, in which case, it is feasible that extended UE CBW edge exceeds the BS CBW edge. The other is that there exists adjacent in-band/out-of-band co-existence issue, and extended UE CBW edge cannot exceed the BS CBW edge. (ZTE)
* Recommended WF
	+ Check whether proposal 1 is agreeable

#### **Issue 1-2-4: Whether and where to use IBE in the larger BS CBW**

* Proposals
	+ Proposal 1: IBE should be used between edges of UE CBW and extended UE CBW. (Samsung, Sony, ZTE, CTC, MTK, vivo, Huawei, LGE)
		- And the IBE of this part should be equal to that of the original UE CBW edge. (vivo)
		- it is the “general” part of IBE requirements that applies to the gap between the shifted ΔfOOB and the edge of UE CBW with following adaptation (Huawei)
			* Use the aggregated NRB which corresponds to the frequency span between two shifted ΔfOOB
			* The index of the first adjacent RB outside of the UE CBW should be 1 or -1
	+ Proposal 2: Study the system performance impacts by this extended UE CBW approach, i.e. impacts due to applying IBE instead of ACLR/SEM in the out of band emission regions. (OPPO)
	+ Proposal 3: IBE is unnecessary to use between edges of UE CBW and BS CBW or between edges of UE CBW and extended UE CBW. (Xiaomi)
* Recommended WF
	+ Check whether proposal 1 is agreeable

#### **Issue 1-2-5: Boundary to apply ACLR and SEM**

* Proposals
	+ Proposal 1: ACLR and SEM should be applicable from the edge of extended UE CBW instead of the BS CBW. (Samsung, Sony, ZTE, vivo, LGE)
	+ Proposal 2: ACLR, SEM and spurious emissions would be defined as of today but based on BS channel bandwidth. (Nokia, Ericsson)
* Recommended WF
	+ Check whether proposal 1 is agreeable

#### **Issue 1-2-6: Boundary to apply SE**

* Proposals
	+ Proposal 1: Do not consider any change to the level and boundary of the spurious emission. (Sony, Xiaomi)
	+ Proposal 2: The application range of SE should be altered with the shifting of the edge of the UE CBW. (Samsung, vivo, MTK, Huawei)
	+ Proposal 3: SE is applied at BS channel bandwidth. (Nokia, Ericsson)
* Recommended WF
	+ Check whether proposal 2 is agreeable

#### **Issue 1-2-7: Which CBW is utilized as the basis for the integral region of OOBE**

* Proposals
	+ Proposal 1: The integral region and the boundary of OOBE should be based on UE CBW. (Samsung, vivo, ZTE, China Telecom)
	+ Proposal 2: The integral region and boundary of OOBE is based on extended UE CBW. (Sony)
* Recommended WF
	+ Check whether proposal 1 is agreeable

#### **Issue 1-2-8: Ratio size of extended CBW between UE CBW and larger BS channel BW**

* Proposals
	+ Proposal 1: (Apple)
		- If the goal is to convert all outer RB allocations into inner RB allocations, then the minimum BS channel needs to be at least twice the size of the UE channel.
		- If the sole goal is to obtain output power improvements, then it is possible to have a more convenient ratio between UE and BS channel such as two-third.
	+ Proposal 2: (Qualcomm)
		- If minimum excess BW equal to half of the original UE BW can be placed on both sides of the original UE BW this extended UE BW can be treated as the new UE BW and all performance metrics can be based on this new BW.
		- If the minimum extended BW on both sides of original UE BW is less than half the original UE BW then the original UE BW should not be extended, and all performance metrics should be based on the original UE BW.
	+ Proposal 3: The required extended bandwidth of the both sides could be set to 2/5 UE CBW as a starting point. (vivo)
	+ Proposal 4: Consider extended UE CBW approach to improve MPR starting from 1.5\*CBW (OPPO)
	+ Proposal 5: (Huawei)
		- For the shifted start point of ΔfOOB, 1/2 UE CBW can be the default value for UE indication.
		- Consider to introduce shorter shifted frequency e.g. 1/3, 1/4 UE CBW in conjunction with the requirement that will be introduced to the shifted frequency.
			* For instance, the modified general part of IBE requirements which is further relaxed by replacing the EVM corresponding to the scheduling modulation order with the one for BPSK
* Recommended WF
	+ TBA

#### **Issue 1-2-9: Whether and how to consider the Asymmetrical extended CBW approach**

* Proposals
	+ Proposal 1: For the case where a UE CBW is allocated at the edge of the BS CBW, agree to consider further an “Asymmetrical extended CBW” to allow outer RB allocation MPR reduction applicability for a UE CBW allocated at the edge of the BS CBW. (MTK)
	+ Proposal 2: For the case where minimum excess BW equal to half the allocated UE BW is added only on side of the allocated UE BW use the following equations to describe the inner allocations: (Qualcomm)
		- Case 1: Excess BW added on lower side of allocated UE BW use:

RBStart,Low = max(1, floor(LCRB/2))

RBStart,High = NRB – RBStart,Low – LCRB

RBStart ≤ RBStart,High,and LCRB ≤ ceil(2NRB/3)

* + - Case 2: Excess BW added on higher side of allocated UE BW use:

RBStart,Low = max(1, floor(LCRB/2))

RBStart,High = NRB – RBStart,Low – LCRB

RBStart\_Low ≤ RBStart

* + Proposal 3: For the asymmetrical scenario, the length of BS CBW and the location of UE CBW within BS CBW should be informed to UE. (Huawei)
		- Use the edge of BS CBW band the start point of ΔfOOB
			* The BS channel bandwidth means BS RF bandwidth that covers single carrier, multi-carriers and multi-RATs scenarios
			* To acquire the aggregated maximum number of RBs for inner RB determination, include the indicated shifted frequency together with the given UE CBW
* Recommended WF
	+ TBA.

#### **Issue 1-2-10: Others**

* Proposals
	+ Proposal 1: Only consider the approach to enable MPR reduction and/or power boosting for a UE channel bandwidth no less than 10MHz. (CATT)
	+ Proposal 2: Consider changing SEM level in the modified OOB domain by extending UE BW and keeping spurious emission domain unchanged. (CATT)
	+ Proposal 3: RAN4 shall examine if the proposed MPR reduction scheme can be enabled for all types of UEs, including TDD and FDD, as well as normal UE, Redcap, and eRedcap UEs. (Sony)
	+ Proposal 4: Where and how to present the mapping relationship between the original UE CBW, the extended UE CBW and the MPR table should be clarified. (vivo)
	+ Proposal 5: Regardless what mechanism will be evaluated and introduced for Rel-19 single carrier MPR reduction, no RF requirements should be applied to the guard band defined in TS 38.101-1 clause 5.3.3. (Huawei)
* Recommended WF
	+ TBA.

#### **Issue 1-2-11: Signaling aspects**

* Proposals
	+ Proposal 1: no changes of signalling are specified for the feature ‘narrower UE channel BW within wider BS bandwidth’ except possibly specification of a capability bit to indicate support of the feature. (Ericsson)
	+ Proposal 2: Need to consider capability for extended UE CBW procedure. (LGE)
	+ Proposal 3: If any reduction of MPR would be specified in the end, it should be an optional feature for UE with per band capability. (Sony)
	+ Proposal 4: The frequency intervals for the UE CBW and the BS CBW should be judged by the NW and the indication of MPR reduction could be directly sent to the UE when the corresponding conditions are met. (vivo)
	+ Proposal 5: Establish a start point and continue to details for BS indication with the deepen in MPR reduction mechanism. (CTC)
* Recommended WF
	+ To discuss the signalling aspects after sufficient evaluation of power boosting and/or MPR reduction in terms of relaxed requirements.

# Topic #2: MPR applicability for FR1 intra-band UL CA

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2411049**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411049.zip) | On improved MPR for intra-band ULCA when only one CC has RBs allocated | Skyworks Solutions Inc. | ***Proposal for intra-band contiguous ULCA: Even when transmitted RBs are allocated in only one of the CC, the emissions requirement based on the configured intra-band contiguous ULCA are used (SEM, ACLR, spurious emissions) and all allocations can use the single CC MPR for inner. FFS if a similar approach is applicable to some additional emission requirements.******Proposal for intra-band non-contiguous ULCA: When DualPA is not signalled or TxD or UL MIMO is signalled, transmit interruption may be needed to allow LO switching and the single carrier MPR can be sued when transmitted RBs are allocated in only one of the CC.*** |
| [**R4-2411109**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411109.zip) | Further discussion on MPR applicability for FR1 intra-band UL CA | CATT | ***Proposal 1: MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C for PC3 contiguous UL CA when only 1 CC is transmitted.******Proposal 2: MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated for PC2 contiguous UL CA when only 1 CC is transmitted.******Proposal 3: MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent for PC2 contiguous UL CA when only 1 CC is transmitted.******Proposal 4: Apply single carrier spurious emission/ACLR/SEM requirements for contiguous UL CA with only 1 CC transmitted.*** |
| [**R4-2411314**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411314.zip) | Draft Rel-19 CR on MPR applicability for intra-band contiguous CA with single CC with activated cell | Samsung | *Add the following description into clause 6.2A.2.1:**“For intra-band contiguous carrier aggregation with single CC with activated cell, MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C. MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated. MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent.”* |
| [**R4-2411327**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411327.zip) | Discussion on MPR reduction for FR1 intra-band UL CA | Samsung | ***Observation 1: It is reasonable/justifiable to follow the MPR requirements of single CC operation, which is more stringent compared to intra-band contiguous UL CA MPR.******Observation 2: It has been agreed that the single CC MPR requirements apply for NR FR2 intra-band contiguous UL CA with single CC with activated cell.******Proposal 1: For PC3/PC2 intra-band contiguous carrier aggregation with single CC with activated cell, the single CC MPR requirements can apply.******Proposal 2: Integral region and boundary of spurious emissions/ACLR/SEM should be based on the activated CC CBW*** ***instead of aggregated CBW.******Proposal 3: For PC3/PC2 intra-band contiguous carrier aggregation with single CC with activated cell,*** ***MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C;******MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated;******MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent.******Observation 3: In the WID, it is “Specify MPR applicability” instead of “Specify new MPR requirements/values” and “Specify new MPR requirements/values” brings large workload and ambiguous benefit.******Proposal 4: The work scope for FR1 NC CA should be limited to only study MPR applicability.*** |
| [**R4-2411632**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411632.zip) | MPR applicability for FR1 intra-band UL CA | Qualcomm Technologies Int | ***Proposal 1: For PC3 and PC2 contiguous UL CA use the corresponding single CC MPR when only 1 CC is activated and refer to the following MPR and corresponding configured Tx power requirements.**** + ***MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C, along with configured Tx power requirements for 6.2.4***
	+ ***MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated, along with configured Tx power requirements for 6.2D.4***
	+ ***MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent, along with configured Tx power requirements for 6.2.4***

***Proposal 2: When only 1 CC is activated the aggregated BW for CA should be used for evaluating metrics such as spurious emissions, SEM and ACLR.******Observation 1: For PC3 and PC2 intra-band non-contiguous CA the standard already accounts for using the single CC MPR tables when only one CC is scheduled.******Proposal 3: For PC3 and PC2 intra-band non-contiguous CA as the standard already accounts for the use of the single CC MPR tables when only 1 CC is scheduled no further changes to the standard are required.*** ***Observation2: The exceptions stated in section 6.2A.2.2.0 for the cases when B< 9MHz or 11.52MHz and MPR is set to either 5.5 dB or 6.5 dB for PC3 and PC2 respectively is to meet the -30 dBm/MHz emissions requirement.*** |
| [**R4-2411675**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411675.zip) | MPR applicability for non-contiguous UL CA in fragmented spectrum | Ericsson | ***Observation 1: MPR depending on the cell activation status is in the scope of the work item and (presumably) the intention of the objective on MPR applicability.****For this we propose that* ***Proposal 1: for non-contiguous UL CA configurations with sub-blocks consisting of one cell and supported by dual PA architecture, the non-CA (single CC) MPR applies for one cell active among the configured uplink serving cells, the other cell deactivated.****and****Proposal 2: for non-contiguous UL CA configurations with sub-blocks consisting of one cell not supported by a dual PA architecture, applicability of the non-CA (single CC) MPR for one active cell among the configured uplink serving cells, the other cell deactivated, is subject to UE capability, e.g. indication of [mpr-singleCC-activated-FR1] for the band combination.****while noting that****Observation 2: the per-BC capability [mpr-singleCC-activated-FR1] could also be used for contiguous CA cases.****On the applicability of unwanted emissions requirement applies for configured or active carriers, we observe that****Observation 3: the unwanted emission limits in 38.101-1, the output RF spectrum emissions for CA, apply when the carriers are active; the transmitter is considered OFF for deactivated carriers.*** |
| [**R4-2411852**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411852.zip) | Discussion on MPR applicability for FR1 intra-band UL CA | ZTE Corporation, Sanechips | ***Proposal 1: For PC3 and PC2 contiguous UL CA use the corresponding single CC MPR including power boosting when only 1 CC is activated.******Proposal 2: Using single carrier MPR instead of CA MPR means larger transmission power, and ACLR/SEM/SE requirement needs to meet the corresponding single carrier requirement.******Proposal 3: For PC3 and PC2 intra-band non-contiguous CA as the standard already accounts for the use of the single CC MPR tables when only 1 CC is scheduled no further changes to the standard are required.*** |
| [**R4-2412010**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412010%2B.zip) | R19 UE RF Enh 4 MPR applicability for FR1 intra-band UL CA | Nokia | *For PC3 and PC2 contiguous UL CA use the corresponding single CC MPR when only 1 CC is activated.* * *MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C.*
* *MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated.*
* *MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent.*
 |
| [**R4-2412086**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412086.zip) | Discussion on MPR applicability for FR1 intra-band UL CA | vivo | ***Proposal: When only 1 CC is activated in CA, spurious emissions/ACLR/SEM should be based on the bandwidth of the activated carrier.*** |
| [**R4-2412569**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412569.zip) | On MPR applicability for FR1 intra-band UL CA | Huawei, HiSilicon | ***Proposal 1: RAN4 specifies the following MPR applicability:**** ***For PC3, the single CC MPR requirements (Table 6.2.2-1) apply to FR1 intra-band contiguous UL CA with only one UL CC activated.***
* ***For PC2, the single CC MPR requirements apply to FR1 intra-band contiguous UL CA with only one UL CC activated:***
	+ ***If TxD is indicated for this intra-band contiguous UL CA, single CC with TxD MPR (Table 6.2D.2-1) should apply.***
	+ ***If TxD is not indicated for this intra-band contiguous UL CA, single CC without TxD MPR (Table 6.2.2-2) should apply.***

***Proposal 2: For Rel-19 MPR applicability for FR1 intra-band contiguous UL CA, the spurious emissions/ACLR/SEM are kept for aggregated CBW.******Proposal 3: In Rel-19, the applicable MPR for FR1*** ***intra-band non-contiguous UL CA doesn’t need further enhancement.*** |
| [**R4-2413456**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413456.zip) | Discussion on MPR applicability for FR1 intra-band UL CA | LG Electronics UK | ***Proposal 1: MPR defined in Table 6.2.2-1 could applies for UE power class 3 CA bandwidth classes B and C.******Proposal 2: MPR defined in Table 6.2D.2-1 could applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated******Proposal 3: MPR defined in Table 6.2.2-2 could applies for power class 2 CA bandwidth classes B and C when TxD capability is absent.*** |

## Open issues summary

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

### Sub-topic 2-1: Intra-band contiguous UL CA

*Sub-topic description*

*Open issues and candidate options before meeting:*

#### **Issue 2-1-1: Applicable MPR for intra-band contiguous CA with single activated cell**

* Proposals
	+ Proposal 1: For PC3/PC2 intra-band contiguous carrier aggregation with single CC with activated cell, the single CC MPR requirements can apply. (Samsung)
	+ Proposal 2: For PC3/PC2 intra-band contiguous carrier aggregation with single CC with activated cell, the following MPR requirements are applied (Samsung, CATT,, Nokia, Huawei, LGE)
		- MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C;
		- MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated;
		- MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent.
* Proposal 3: For PC3 and PC2 contiguous UL CA use the corresponding single CC MPR when only 1 CC is activated and refer to the following MPR tables and corresponding configured Tx power requirements (Qualcomm).
	+ - * + MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C, along with configured Tx power requirements for 6.2.4
				+ MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated, along with configured Tx power requirements for 6.2D.4
				+ MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent, along with configured Tx power requirements for 6.2.4
* Recommended WF
	+ Agree with proposal2
		- FFS the conditions to apply the single CC MPR based on discussion of the following issues
		- FFS whether power boosting capability for SC MPR is also applicable

Qualcomm: we support proposal 3. UE could do power boosting.

Vivo: Regarding to power boosting, the previous agreement is that it should be based on configuration. Here the proposal is based on activation. Qualcomm proposal is not aligned.

Skyworks: If we want to apply the single CC MPR, we need the agreement what emission requirements apply.

Qualcomm: We are defining what MPR can be used for CA. We should allow boosting as well.

Ericsson: Support Qualcomm. It is good for performance. We need discuss the applicable requirements based on configuration.

Samsung: to Skyworks, the single CC emission requirements should be applied. To Qualcomm, we can consider it plus power boosting feature. Such enhancement is not precluded by the spec.\

Huawei: No company objects that single CC MPR applies. Question is which other requirements apply like emission. Other question is which boundary should be assumed.

Nokia: to Skyworks, we also support the power boosting should be allowed and single carrier emission requirements applies.

Apple: the idea to use single carrier requirement when one CC is activated. We are fine with the idea. Regarding the power boosting, power boosting is for limited set of RB allocation and limited MCS. We would like to remind power boosting is not finished.

#### **Issue 2-1-2: Single CC CBW or aggregated CBW for applying requirements of ACLR/SEM/SE**

* Proposals
	+ Proposal 1: Integral region and boundary of spurious emissions/ACLR/SEM should be based on the activated CC CBW instead of aggregated CBW. (Samsung)
	+ Proposal 2: When only 1 CC is activated the aggregated BW for CA should be used for evaluating metrics such as spurious emissions, SEM and ACLR. (Qualcomm, Huawei)
* Recommended WF
	+ TBA with consideration of observations in Skyworks paper

#### **Issue 2-1-3: Single CC or CA requirements of ACLR/SEM/SE applied for single activated cell**

* Proposals
	+ Proposal 1: Even when transmitted RBs are allocated in only one of the CC, the emissions requirement based on the configured intra-band contiguous ULCA are used (SEM, ACLR, spurious emissions) and all allocations can use the single CC MPR for inner. FFS if a similar approach is applicable to some additional emission requirements. (Skyworks)
	+ Proposal 2: Apply single carrier spurious emission/ACLR/SEM requirements for contiguous UL CA with only 1 CC transmitted. (CATT, Samsung, ZTE, vivo)
	+ Proposal 3: For Rel-19 MPR applicability for FR1 intra-band contiguous UL CA, the spurious emissions/ACLR/SEM are kept for aggregated CBW. (Huawei)
* Recommended WF
	+ TBA with consideration of observations in Skyworks paper

#### **Issue 2-1-4: Draft Rel-19 CR on MPR applicability for intra-band contiguous CA with single CC with activated cell**

* Proposals
	+ Proposal 1: Add the following description into clause 6.2A.2.1:
		- “For intra-band contiguous carrier aggregation with single CC with activated cell, MPR defined in Table 6.2.2-1 applies for UE power class 3 CA bandwidth classes B and C. MPR defined in Table 6.2D.2-1 applies for power class 2 CA bandwidth classes B and C when TxD capability is indicated. MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD capability is absent.”
* Recommended WF
	+ Endorse the draft CR

### Sub-topic 2-2: Intra-band non-contiguous CA

*Sub-topic description*

*Open issues and candidate options before meeting:*

#### **Issue 2-2-1: General considerations**

* Proposals
	+ Proposal 1: The work scope for FR1 NC CA should be limited to only study MPR applicability. (Samsung)
* Recommended WF
	+ Agree with the proposal as it is aligned with the WID

#### **Issue 2-2-2: Applicable MPR for FR1 intra-band non-contiguous UL CA**

* Proposals
	+ Proposal 1: for PC3 and PC2 intra-band non-contiguous CA as the standard already accounts for the use of the single CC MPR tables when only 1 CC is scheduled no further changes to the standard are required. (Qualcomm, ZTE, Huawei)
	+ Proposal 2: When DualPA is not signalled or TxD or UL MIMO is signalled, transmit interruption may be needed to allow LO switching and the single carrier MPR can be sued when transmitted RBs are allocated in only one of the CC. (Skyworks)
	+ Proposal 3: for non-contiguous UL CA configurations with sub-blocks consisting of one cell and supported by dual PA architecture, the non-CA (single CC) MPR applies for one cell active among the configured uplink serving cells, the other cell deactivated. (Ericsson)
	+ Proposal 4: for non-contiguous UL CA configurations with sub-blocks consisting of one cell not supported by a dual PA architecture, applicability of the non-CA (single CC) MPR for one active cell among the configured uplink serving cells, the other cell deactivated, is subject to UE capability, e.g. indication of [mpr-singleCC-activated-FR1] for the band combination. (Ericsson)
* Recommended WF
	+ Check whether proposal 1 is only valid for UE indicating DualPA capability. FFS the case UE not indicating DualPA capability with consideration of observations in Skyworks paper.

# Topic #3: MPR applicability for FR2

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2411110**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411110.zip) | Further discussion on MPR applicability for FR2 | CATT | ***Proposal 1: Network does not need to enable the MPR improvement originating from the application of MPR requirements for single UL carrier if there is no other particular reason, hence, there is no need to introduce a new UE capability for such MPR improvement.******Proposal 2: Network does not need to enable the MPR improvement originating from changing the BW basis from CABW to UL BWchannel\_CA if there is no other particular reason, hence, there is no need to introduce a new UE capability for such MPR improvement.******Proposal 3: Hold on discussions on whether new MPR requirement is defined for CABW < 400MHz unless the WID can be updated accordingly.*** |
| [**R4-2411693**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411693.zip) | Discussion on MPR reduction for FR2 CA | Samsung | ***Proposal 1: RAN4 to clarify whether FR2 MPR enhancement for the single UL case is also applicable for intra-band DL non-contiguous CA with single UL.******Observation 1: if MPR is to be enhanced with two separate levels for ‘configuration based’ and ‘CC activation based’ respectively, clarification is needed in terms of UE architecture or functionality difference in design******Proposal 2: RAN4 to focus on activation based MPR applicability. If configuration based MPR applicability is also considered, more clarification is needed.******Observation 2: the BW granularity of MPR applicability is at least 400MHz for BW ≥ 400MHz, and 200MHz granularity is already considered in existing spec for DFT-s-BPSK or DFT-s-QPSK where MPRC\_CA = MAX(MPR1, MPR2)******Proposal 3: RAN4 not to specify new column for <400MHz CABW in the MPR table, but to change the MPR calculation for DFT-s-BPSK or DFT-s-QPSK from “MPRC\_CA = MAX(MPR1, MPR2)” to “MPRC\_CA = MPR2”, for UE with UE indication of new capability for MPR improvement.*** |
| [**R4-2411853**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411853.zip) | Discussion on MPR applicability for FR2 | ZTE Corporation, Sanechips | ***Proposal 1: We propose to consider all possible UE implementations, including UE with fast LO switching, or with dedicated LOs for Tx and Rx paths for the new UE capability.******Proposal 2: The new capability shall be defined as optional and per UE, and only applicable to FR2. In addition, it could be release independent.******Proposal 3: Only MPR applicability needs to be discussed in this WID, and defining new MPR requirement is out of scope.*** |
| [**R4-2412356**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412356.zip) | Discussion on FR2 CA MPR improvement | NTT DOCOMO, INC. | ***Observation 1: Based on the description in the WID, it is clear that the prioritized scenarios are (intra-band DL contiguous CA with) intra-band UL contiguous CA and intra-band DL contiguous CA with single UL in Rel-19.******Proposal 1: Clarify that PC1, PC2, PC3, PC4, PC5 and PC6 could be covered.******Proposal 2: If there are no technical issues identified, Rel-19 FR2 MPR reduction applies to both FR2-1 and FR2-2. For FR2-2, it is necessary to take the minimum values of MPR between the intra-band CA case and the single carrier case.******Observation 2: For PC3 in FR2-2, the MPR is constant independent of CABW, which makes it ineffective to apply UL BWchannel\_CA instead of CABW for MPR applicability for intra band UL contiguous CA with DL intra band contiguous CA case.******Proposal 3: Capability should not be dependent on a specific implementation (e.g. MPRimprovementULdependent-R19).*** |
| [**R4-2412570**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412570.zip) | On MPR applicability for FR2 CA | Huawei, HiSilicon | ***Observation 1: Subject to UE capability indication on the support of Rel-19 MPR applicability for FR2 CA, following specification clarifications are required.**** ***For the case of DL intra band CA with UL CA, the reference MPR (originally being Table 6.2A.2.4-1) is changed as:***

***The existing relaxation targeting CABW < 400 MHz and also subject to specific modulation order and waveform should be ignored**** ***For the case of DL intra band CA with single UL CC (activated or configured), the reference MPR (originally being Table 6.2A.2.4-1) is changed as the MPR requirement for single carrier.***

***Observation 2: The necessity of FFS on whether new MPR requirement could be defined for CABW < 400 MHz may need further evaluation.*** |
| [**R4-2413226**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413226.zip) | Activation-based FR2 MPR enhancement | Qualcomm Incorporated | ***Proposal 1: RAN4 to consider as an optional capability:******FR2 UE CA MPR is based on the activated subset of the CCs in the CA configuration that are also enabled for UL, provided the activated CCs with UL comprise a contiguous block. (For reference, legacy CA MPR is based on cumulative aggregated channel BW).*** |

## Open issues summary

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

### Sub-topic 3-1: Scope and cases considered for FR2 MPR enhancements

*According to the inputs from companies, it seems that the objective on MPR applicability for FR2 is still not clear for some cases. The WID objective for MPR applicability enhancement is listed below for reference.*

* *Specify MPR applicability based on the UL CCs with activated cells for NR intra-band UL CA configuration*
	+ *Include both intra-band UL contiguous CA and intra-band non-contiguous UL CA for FR1*
	+ *Include intra-band UL contiguous CA and intra-band DL contiguous CA with single UL for FR2*
	+ *MPR requirement is not applicable until the SCell is activated*

*Open issues and candidate options before meeting:*

#### **Issue 3-1-1: Whether new CA MPR for CABW < 400MHz should be considered in the WI**

* Proposals
	+ Proposal 1: Hold on discussions on whether new MPR requirement is defined for CABW < 400MHz unless the WID can be updated accordingly. (CATT)
	+ Proposal 2: Only MPR applicability needs to be discussed in this WID, and defining new MPR requirement is out of scope. (ZTE)
* Recommended WF
	+ The above proposals are agreeable as they are aligned with the current WID

Agreement:

* + Hold on discussions on whether new MPR requirement is defined for CABW < 400MHz unless the WID can be updated accordingly.
	+ Only MPR applicability needs to be discussed in this WID, and defining new MPR requirement is out of scope.

#### **Issue 3-1-2: whether FR2 MPR enhancement for the single UL case is also applicable for intra-band DL non-contiguous CA with single UL**

* Proposals
	+ Proposal 1: RAN4 to clarify whether FR2 MPR enhancement for the single UL case is also applicable for intra-band DL non-contiguous CA with single UL. (Samsung)
* Moderator observation
	+ According to RAN discussion, up scoping of the WID is strictly controlled. Intra-band DL NC CA with single UL is not included in the WID
* Recommended WF
	+ FR2 MPR enhancement for the single UL case is not applicable for intra-band DL non-contiguous CA with single UL unless the WID is revised

#### **Issue 3-1-3: Power classes considered for FR2 MPR enhancement**

* Proposals
	+ Proposal 1: Clarify that PC1, PC2, PC3, PC4, PC5 and PC6 could be covered. (NTT DOCOMO)
* Recommended WF
	+ All FR2 power classes could be considered for the MPR enhancement

Agreement: All FR2 power classes could be considered for the MPR enhancement

#### **Issue 3-1-4: sub-FR2 frequency ranges**

* Proposals
	+ Proposal 1: If there are no technical issues identified, Rel-19 FR2 MPR reduction applies to both FR2-1 and FR2-2. For FR2-2. (NTT DOCOMO)
* Recommended WF
	+ MPR reduction applies to both FR2-1 and FR2-2.

Agreement: MPR reduction applies to both FR2-1 and FR2-2.

### Sub-topic 3-2: Applicable MPR

*Sub-topic description*

*Open issues and candidate options before meeting:*

#### **Issue 3-2-1: Applicable MPR for FR2 single carrier UL with DL intra band CA**

* Proposals
	+ Proposal 1: For the case of DL intra band CA with single UL CC (activated or configured), the reference MPR (originally being Table 6.2A.2.4-1) is changed as the MPR requirement for single carrier. (Huawei)
* Recommended WF
	+ For the case of single carrier UL with DL intra band CA, the MPR requirements of single carrier case in clause 6.2.2 of TS 38.101-2 should apply.

OPPO: this is FR2. Tx and Rx shares the same LO. For single uplink with DL CA, the LO is in the middle. There is image. Can we reuse the same MPR?

NTT DOCOMO: UE architecture is one implementation. We are discussing the new architecture.

Huawei: Similar understanding as NTT DOCOMO.

OPPO: Does it mean requirements apply to both 1 LO and 2 LO cases?

#### **Issue 3-2-2: Applicable MPR for FR2 UL CA with DL intra band CA**

* Proposals
	+ Proposal 1: For the case of DL intra band CA with UL CA, the reference MPR (originally being Table 6.2A.2.4-1) is changed as. (Huawei)



The existing relaxation targeting CABW < 400 MHz and also subject to specific modulation order and waveform should be ignored

* + Proposal 2: For FR2-2, it is necessary to take the minimum values of MPR between the intra-band CA case and the single carrier case. (NTT DOCOMO)
	+ Proposal 3: RAN4 not to specify new column for <400MHz CABW in the MPR table, but to change the MPR calculation for DFT-s-BPSK or DFT-s-QPSK from “MPRC\_CA = MAX(MPR1, MPR2)” to “MPRC\_CA = MPR2”, for UE with UE indication of new capability for MPR improvement. (Samsung)
	+ Proposal 4: RAN4 to focus on activation based MPR applicability. If configuration based MPR applicability is also considered, more clarification is needed. (Samsung)
* Recommended WF
	+ In general, MPR based on UL BWchannel\_CA applies instead that based on cumulative aggregated channel BW (CABW)
		- If only 1 UL CC is activated, the MPR requirements of single carrier could be reused
		- No need to specify new column for <400MHz CABW in the MPR table. FFS specific spec change to accommodate 200MHz BW granularity
		- FFS whether to take the minimum values of MPR between the intra-band CA case and the single carrier for FR2-2

OPPO: the first sub-bullet is the same as the previous issue.

### Sub-topic 3-3: UE capability

*Sub-topic description*

*Open issues and candidate options before meeting:*

#### **Issue 3-3-1: Whether an optional UE capability is considered**

* Proposals
	+ Proposal 1: no need to introduce a new UE capability for such MPR improvement as Network does not need to enable the MPR improvement originating from the application of MPR requirements. (CATT)
	+ Proposal 2: The new capability shall be defined as optional and per UE, and only applicable to FR2. In addition, it could be release independent. (ZTE)
	+ Proposal 3: RAN4 to consider as an optional capability. (Qualcomm)
	+ Proposal 4: Subject to UE capability indication on the support of Rel-19 MPR applicability for FR2 CA. (Huawei)
* Recommended WF
	+ An optional UE capability is considered, FFS on the granularity of the capability and release independent issue.

#### **Issue 3-3-2: Whether UE capability, if needed, is agnostic to specific LO implementations**

* Proposals
	+ Proposal 1: Consider all possible UE implementations, including UE with fast LO switching, or with dedicated LOs for Tx and Rx paths for the new UE capability. (ZTE)
	+ Proposal 2: Capability should not be dependent on a specific implementation. (NTT DOCOMO)
* Recommended WF
	+ TBA

#### **Issue 3-3-3: Proposal for CC activation-based MPR improvement**

* Proposals
	+ Proposal 1: FR2 UE CA MPR is based on the activated subset of the CCs in the CA configuration that are also enabled for UL, provided the activated CCs with UL comprise a contiguous block. (Qualcomm)
* Recommended WF
	+ TBA