**3GPP TSG-RAN WG4 Meeting #111 R4-2408935**

**Fukuoka, Japan, May 20 - 24, 2024**

**Agenda item:** 10.1.2

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

**Title:** Topic summary for [111][124] 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 [124] includes topic of Power boosting and/or MPR reduction.

# Topic #1: Power boosting and/or MPR reduction

*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** |
| **[R4-2407070](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407070.zip)** | On MPR reduction for NR | Apple | ***Observation 1:*** *Early evaluation on 20MHz CBW with CP-OFDM indicates that SEM would be the major limiting factor if ACLR requirement is removed entirely. With SEM requirements still in place the power back-off improves but is far more than zero dB.****Observation 2****: Spectral shaping is an interesting tool to achieve increased output power. However, the downside is that it is only relevant for low order modulations such as PI/2 BPSK and QPSK and only for DFT-s-OFDM. The understanding of scope of the Rel-19 WID is that general relaxations are prioritised which provide improvements to DFT-s-OFDM as well as CP-OFDM. Therefore, spectral shaping should not be considered for the MPR reduction at this stage.* |
| **[R4-2407227](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407227.zip)** | On MPR reduction for NR UL CA | Apple | ***Observation****: RAN4 uses the assumption of configured CCs for UL CA when specifying MPR and A-MPR. When changing this assumption to a different scheme such as activation-based then then RAN4 should discuss a basic RF architecture assumption to achieve a common understanding for further analysis.****Proposal:*** *RAN4 should find a common understanding on how activation-based UL CA affects the architecture assumptions.*  |
| **[R4-2407404](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407404.zip)** | On emission requirement relaxations for power domain enhancements | Skyworks Solutions Inc. | ***Proposal on single operator and UE CBW < BS CBW cases:**** ***In both cases, adjacent bands should be considered to see if emission requirement relaxation applies.***
* ***UE CBW < BS CBW cases, relaxation should be based on distance between the UE CBW edge to BS CBW edge and different if the channel is at the band edge.***

***Proposal on relaxed requirement evaluation:**** ***Relaxation of SEM is prioritized as it favors narrow allocations power domain enhancement and is applicable to all power classes.***
* ***Requirement relaxation is not studied for 256QAM and may be marginal for 64QAM***
* ***Edge allocation MPR can be ignored if the BS CBW is >1MHz larger than the UE CBW. This also applies when the band is single operator.***
* ***It is studied whether two types of inner allocations should be considered (narrow allocations that may be only IBE/EVM limited and large allocations that may be SEM/ACLR limited). An alternative is to define two inner allocation types depending on IMD3 falling within the BS CBW or outside the BS CBW.***
* ***Within the BS CBW outside the allocated UE CBW RBs, IBE should still apply.***
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| **[R4-2407409](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407409.zip)** | Further Views on MPR reduction | Sony | *Observation 1: allowing out-of-band emission relaxation outside the operators' spectrum block will no longer ensure the protection between the operators based on the 3GPP specification, regardless of whether any adjacent operator exists.* *Observation 2: The required MPR to meet the out-of-band emission limits can be reduced when the UE is allocated at the inner RB allocation of BS CBW/operator spectrum block.**Observation 3: From signaling perspective, it is most straightforward to the UE to adopt the BS channel bandwidth as reference channel BW to perform the MRP reduction.**Observation 4: 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 5: 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 6: 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: it is not feasible to allow the out-of-band emission limits outside the operator spectrum block to be relaxed even if the adjacent spectrum is not used.*** ***Proposal 2: RAN4 shall focus on the scenario 2 when a UE uses a narrower channel bandwidth within a wider BS CBW/operator spectrum block for the MPR reduction in Rel-19.******Proposal 3: RAN4 may consider redefining the RB allocation with respect to the BS CBW/operator spectrum block to enable inner RB MPR when the UE is placed in the inner allocation of a wider BS CBW/operator spectrum block.*** ***Proposal 4: RAN4 shall decide which channel BW (BS CBW, cell CBW and operator spectrum block bandwidth) shall be used as the reference channel bandwidth when redefining the inner, outer and edge RB allocation.******Proposal 5: 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 6: If any reduction of MPR would be specified in the end, it should be an optional feature for UE with per band capability.*** |
| **[R4-2407551](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407551.zip)** | Consideration on MPR applicability for FR1 intra-band UL CA | CATT | *Observation 1: According to current RAN2 signalling design, for an FR1 intra-band CA band combination, there is no such case that DL has multiple activated CCs, while only one UL CC is activated.****Proposal 1: RAN4 to clarify MPR applicability for FR1 intra-band UL CA as:******For FR1 intra-band contiguous and non-contiguous UL CA,**** ***If only one UL CC is scheduled or transmitted,***
	+ ***For PC3, the single CC MPR requirements (Table 6.2.2-1) should apply.***
	+ ***For PC2, if TxD is indicated for this intra-band contiguous ULCA, single CC with TxD MPR (Table 6.2D.2-1) should apply; if TxD is not indicated for this intra-band contiguous ULCA, single CC without TxD MPR (Table 6.2.2-2) should apply.***

***If multiple UL CCs are scheduled or transmitted at the same time, MPR requirements specified in clause 6.2A.2.1 or 6.2A.2.2 should apply for contiguous or non-contiguous UL CA respectively.*** |
| **[R4-2407585](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407585.zip)** | Power boosting and MPR reduction | Qualcomm Technologies Int | ***Proposal 1: Further discuss scenario 1-1 ” Scenario with no adjacent in-band/out-of-band co-existence issue (single operator)” to ensure that it is a scenario that represents a realistic deployment.*** *Observation1: For scenario2 “Narrower UE channel BW within wider BS bandwidth” in order to enable companies to better align on the results analyse several simple yet realistic cases first and then study the harder cases later.****Proposal 2: Initially study the cases where 1) The excess bandwidth on either side of the UE BW is equal to ½ of the UE BW and 2) The excess bandwidth of either side of the UE BW is equal to the UE BW. For these cases the aggregated UE bandwidth should be considered as the UE BW plus the excess BW on either side of the UE BW for SEM, ALCR and spur specifications.****Observation2: Certain features developed in earlier releases of the standard can be revised in later releases as new features are added.* ***Proposal 3: Companies to bring specific technical concerns with addressing Rel-18 power boosting similar to other legacy capabilities like Rel-16 TxD, Rel-16 dualPA-Architecture and Rel-15 2Tx coherence requirements for UL MIMO, in context of the Rel-19 WI to enhance UL power with relaxed emissions requirements.******Proposal 4: Establish what mechanism should be used for “BS indication” to indicate to a UE or groups of UEs that power domain enhancement is possible.******Proposal 5: BS to indicate signalling to the UE or groups of UEs regarding support of power domain enhancements during UE configuration.*** |
| **[R4-2407586](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407586.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 tables when only 1 CC is activated.*** *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 2: 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.***  |
| **[R4-2407590](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407590.zip)** | Discussion on MPR reduction for FR1 single carrier | Samsung | ***Proposal 1: No relaxation of ACLR/SEM/SE outside of one operator holding spectrum for scenario 2 will be considered since there are potential adjacent co-existence issues.******Proposal 2:*** ***Discuss the following sub-scenarios of scenario 2:*** ***Scenario 2-1 can be when non-RedCap UE CBW is located at the edge of BS BW;*** ***Scenario 2-2 can be when RedCap UE CBW is located at the edge of BS BW with the Shifted Channel Edge approaches;*** ***Scenario 2-3 can be when non-RedCap UE CBW is located around the center of BS BW;*** ***Scenario 2-4 can be when RedCap UE CBW is located around the center of BS BW with the Shifted Channel Edge approaches.******Proposal 3: The Shifted Channel Edge approaches should not be considered for non-RedCap UE.******Proposal 4: For RedCap UE, the Shifted Channel Edge approaches can be considered and IBE requirements can be applied to the new extended CBW.******Proposal 5: SE requirements should not be relaxed in lack of justification.****Observation 1: In the discussion of Rel-18, some power boosting/MPR reduction technologies were limited to inner RB allocations, such as FDSS without SE.**Observation2: The MPR values are relatively small for inner RB allocations.**Observation 3: When ACLR and SEM are relaxed, outer RB allocations can gain the most.**Observation 4: ACLR is the major limiting factor for QPSK outer RB allocations with large RB numbers.**Observation 5: ACLR and SEM are the major limiting factor for QPSK outer RB allocations with medium RB numbers.**Observation 6: SEM is the major limiting factor for QPSK outer RB allocations with small RB numbers.**Observation 7: It is not necessary to identify the major bottleneck for each allocation and define the relaxed condition and requirements accordingly.****Proposal 6: For simplify, ACLR/SEM can be relaxed for MPR reduction together.****Observation 8: When ACLR/SEM are relaxed 1 dB, MPR can reduce 0.234-0.361 dB for QPSK outer RB allocations.**Observation 9: When ACLR/SEM are relaxed 2 dB, MPR can reduce 0.464-0.697 dB for QPSK outer RB allocations.* |
| **[R4-2407591](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407591.zip)** | Discussion on MPR reduction for FR1 intra-band UL CA | Samsung | *Observation 1: The RF requirements/UE behaviors can be changed at least from Rel-19, when the component carrier(s) is deactivated from activated status or activated from deactivated status.**Observation 2: 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 3: It is worth noting that NR\_Power\_class thread has had relevant discussion for this case to allow exceedance of the per-BC power class capability thus UE behaviors/requirements changed accordingly, but it was deprioritized in last meeting and we feel pessimistic it would yield meaningful outcome to impact the discussion of this topic.****Proposal 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.****Observation 4: In the existing non-contiguous CA specification, the MPR requirement will fallback to single carrier MPR requirement if only one CC is scheduled.**Observation 5: 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 2: There is no need to specify MPR applicability based on the UL CCs with activated cells for NR intra-band non-contiguous UL CA configuration.******Proposal 3: There is no justification to specify new MPR requirements/values based on the UL CCs with activated cells for NR intra-band non-contiguous UL CA configuration.*** |
| **[R4-2407629](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407629.zip)** | Draft Rel-19 CR on MPR applicability for intra-band contiguous CA with single CC with activated cell | Samsung | ***Add the following decription 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.”*** |
| **[R4-2407722](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407722.zip)** | Power domain enhancements for single carrier? | Ericsson | *Observation 1: for the UE, the stricter Category B spurious emission limit of -30 dBm/MHz was selected for UTRA and E-UTRA (presumably also NR) to allow for global circulation of terminals.**Observation 2: the general SEM was also specified to allow for global circulation of terminals. ACLR is stricter than the integrated SEM, ACLR used for coexistence studies with requirements specified to ensure robust network performance within and between coexisting networks.**Observation 3: increasing UE output power by allowing relaxed ACLR by e.g. (NS) network signaling is awkward for there is no guarantee that the NS indication would not used between an aggressor and victim operator at the operator block edge of the aggressor; it is not straightforward to distinguish between the coexistence issues for the single operator and adjacent operator cases.**For Scenario 2 we propose that****Proposal 1: the feature ‘narrower UE channel BW within wider BS bandwidth’ is specified for RedCap UEs in bands with a maximum channel bandwidth greater than 20 MHz and is based on the requirements for the largest channel bandwidth (MHz) with a transmission bandwidth configuration less than or equal to the carrier bandwidth advertised in SIB1.*** *The UE would not be aware of the operator block size without further changes of common signalling.* ***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.*** |
| **[R4-2407723](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407723.zip)** | MPR applicability for non-contiguous UL CA in fragmented spectrum | Ericsson | *Observation 1: the MPR for non-contiguous carriers and transmission on a single CC with a single-PA architecture is significantly larger than the MPR for non-CA transmissions.* *Observation 2: the unwanted emission limits, the output RF spectrum emissions for CA, apply when the carriers are active, the transmitter is considered OFF for deactivated carriers.**For the “MPR applicability for FR1 intra-band UL non-contiguous CA”, we propose to* ***Proposal 1: introduce a capability “single-CC-transmission-with-single-CC-MPR” for single-PA architecture (could also be indicated for dual-PA architecture) per band combination to indicate support of single-CC MPR with two configured non-contiguous carriers and one scheduled/activated.*** *with* ***Proposal 2: the capability applicable for a frequency separation ≤ 50 MHz for FDD and ≤ 100 MHz for TDD for a single-PA architecture to facilitate implementation with a single Tx chain.****Taking it further**Observation 3: UL-MIMO could optionally be supported in addition to enable 1-layer or 2-layer “switching” between active carriers by scheduling (non-simultaneous transmission on carriers)****.*** |
| **[R4-2407814](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407814.zip)** | Discussion on power domain enhancement for single carrier | Xiaomi | ***Proposal 1: we can first evaluate MPR reduction based on below case to guarantee there is no co-existence issue for both scenario 1-1 and scenario 2**** ***The frequency range occupied by single operator or BS bandwidth is at least equal to or larger than 3 times of assigned UE channel BW.***

***Proposal 2: The SEM and ACLR requirements can be relaxed by moving it to the outside of adjacent channel of the assigned UE channel BW or the outside of BS channel BW.******Proposal 3: Using previous MPR simulation assumptions to evaluate the MPR reduction and requirements relaxation as the starting point:**** ***PA model calibration***
	+ ***DFT-s-OFDM QPSK 20MHz***
	+ ***100RB0***
	+ ***4dB post PA loss***
	+ ***1dB MRP***
* ***Carrier Leakage: 28dB***
* ***IQ Image: 28dBc***
* ***CIM3: 60dBc***
* ***EVM: 17.5% for QPSK, 12.5% for 64QAM***
* ***ACLR: 30dB for PC3, 31dB for PC2***
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| **[R4-2407815](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407815.zip)** | Discussion on power domain enhancement for FR1 intra-band UL CA | Xiaomi | ***Proposal 1: RAN4 should first discuss whether need modify the MPR value for intra-band non-contiguous UL CA with only one UL CC activated.******Proposal 2: If not, the applicable MPR for intra-band non-contiguous UL CA with only one UL CC activated doesn’t need further enhancement.******Proposal 3: If needed, RAN4 need further discuss how to modify the MPR, i.e., allow LO shifting or reduce the allocation size B.*** |
| **[R4-2407816](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407816.zip)** | Discussion on power domain enhancement for FR2 intra-band UL CA | Xiaomi | ***Proposal 1: RAN4’s discussion for FR2 should just focus on intra-band UL contiguous CA and intra-band DL contiguous CA for the cases in last meeting WF.**** ***single carrier UL with DL intra band contiguous CA***
* ***intra-band UL contiguous CA with DL intra band contiguous CA (configuration based)***
* ***intra-band UL contiguous CA with DL intra band contiguous CA (CC activation based)***

***Proposal 2: Single carrier UL with DL intra band contiguous CA and intra-band UL contiguous CA with only one UL CC activated can apply the single CC MPR requirements (in clause 6.2.2).******Proposal 3: Intra-band UL contiguous CA with DL intra band contiguous CA can apply the MPR for intra-band contiguous CA in Table 6.2A.2.2.1 for PC1, Table 6.2A.2.3-2 for PC2, Table 6.2A.2.4-1 for PC2, PC3, PC4, PC5 and PC6 based on the UL aggregated channel bandwidth.*** |
| **[R4-2407893](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407893.zip)** | Discussion on MPR reduction for FR2 CA | Samsung | *Observation 1: Enhanced UEs with new FR2 MPR reduction UE capability is assumed with distinct LO between RX and TX.****Proposal 1: 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 applies for UE supporting the new capability.******Proposal 2: 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 2: 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* |
| **[R4-2407910](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407910.zip)** | Discussion on power domain enhancement for NR single carrier  | MediaTek (Shenzhen) Inc. | *Observation 1: It is feasible and useful for RedCap UE to apply Tx emissions requirements relaxation inside a spectrum block >20MHz if MPR reduction can be achieved.**Observation 2: For a non-RedCap UE operating in a spectrum block <100MHz, there is some flexibility today to enable relaxed emissions and tighter MPR via existing functions and requirements framework. For a non-RedCap UE operating in a spectrum block >100MHz, emissions requirements relaxation appears to be feasible, if sufficient to enable MPR reduction.**Observation 3: Relaxing ACLR without relaxing SEM/Spurious emissions will likely have smaller MPR reduction benefit, more RAN4 effort, more complex MPR rules, and more complex real-time derivation of MPR for the UE.**Observation 4: 1dB – 1.5dB MPR reduction for Outer RB allocations is achievable with sufficient Tx emission requirements relaxations, depending on waveform (DFT-S-OFDM or CP-OFDM) and modulation scheme (QPSK or 16QAM). On the other hand, aiming to reduce MPR lower than that of the inner RB allocation will lead to more RAN4 work to identify the requirement bottlenecks and would fully or partially repeat the Rel-18 effort.**Observation 5: Relaxing UE ACLR/SEM/SE requirements by shifting the starting frequency (channel edge) for Tx emissions requirements away from the first or last allocated RB by a sufficient amount can enable an Outer RB allocation to become equivalent to an Inner RB allocation from MPR perspective.****Proposal 1:*** ***Agree that applying a shift in ACLR/SEM requirements is feasible for RedCap UE in Scenario 2, as long as the OOB requirements outside of the BS CBW are no worse than that of an existing eMBB UE configured to operate in the full BS CBW.*** ***Proposal 2: Agree that relaxation of UE spurious emission requirement is feasible whilst still adhering to ITU REC SM.329, and necessary if ACLR and/or SEM are relaxed.******Proposal 3: Prioritize study on reduction of Outer RB allocation MPR to similar level as Inner RB allocation MPR for PC3 UE, without increasing reference UE complexity (particularly hardware), by appropriate Tx emission requirement relaxation. Consider MPR reduction for Inner RB allocations a low priority for all power classes.******Proposal 4: Endorse a Tx emission requirements relaxation approach of shifting the Tx emissions requirements “channel edge” (ΔfOOB = 0 MHz) away from real channel edge to create sufficient guardband from the UE channel bandwidth edge, to enable ACLR, SEM, and Spurious Emission relaxation. “Extension of” IBE or equivalent to apply from first/last allocated RB to new Tx emission requirements “channel edge”.******Proposal 5:*** ***Further focus evaluation on the Wider CBW Tx emission requirements framework is feasible to enable Outer RB allocation MPR reduction, for RedCap and non-RedCap UE. Also further study the Spurious Emission requirement issue as described for this approach.******Proposal 6: Further focus evaluation on the Shifted Channel Edge with “Same CBW” Tx emission requirements framework as one option to enable Outer RB allocation MPR reduction for RedCap and non-RedCap UE.******Proposal 7: Conclude that the “One-Sided” Shifted Channel Edge enhancement to Proposal 5 and Proposal 6 approach is feasible to enable Outer RB allocation MPR reduction for RedCap and non-RedCap UE, when UE channel bandwidth is at one edge of the operator’s spectrum block. The maximum partial RB allocation for Outer RB allocation can be further analyzed.******Proposal 8: For the non-RedCap UE, study further the following aspects for the shifted channel edge approach:**** ***Which Tx emissions requirements framework would apply for Wider Channel Bandwidth >100MHz?***
* ***Whether the CBW/2 shift from the channel edge proposed for RedCap also scales in exactly the same way for larger UE channel bandwidths such as 80-100MHz.***
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| **[R4-2408035](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408035.zip)** | FR2 CA MPR enhancement by changing BW basis for MPR table | Qualcomm Incorporated | ***Proposal 1: The Rel-19 FR2 MPR enhancement is based on targeting the UE architecture that uses LOs separately centred on the UL and DL CA aggregated BWs respectively*** *Observation 1: FR2 UEs with separate R/T LOs can get by with a back-off that depends on UL BWchannel\_CA rather than CABW**Observation 2: A new FR2 UE capability can indicate to the network that it can support, CA MPR reduction by changing the BW basis of the CA MPR table from cumulative aggregated channel BW (CABW) to UL BWchannel\_CA.**Observation 3: Allowing the UE capability to depend on UL CA configuration rather than activation status will encourage more UEs to support a low MPR scheme, owing to less challenging timelines.****Proposal 2: To encourage UEs to support the enhancements in FR2, define a first level of enhancement based on CA configuration, and then a second level of enhancements based on CC activation.*** ***Proposal 3: For FR2, define 2 UE capability that changes the BW basis of the CA MPR table from cumulative aggregated channel BW (CABW) to UL BWchannel\_CA . The first capability indicates that the UE can support the MPR appliablity change based on configuration of CCs, and the second indicates that the UE can support the change based on activation status of the CCs with UL.******Proposal 4: For FR2, enhance the case of intra-CA with single CC UL (configured or activated) by making the single CC MPR table applicable for a supporting UE.*** |
| **[R4-2408132](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408132.zip)** | Discussion on power domain enhancements for NR single carrier | vivo | *Observation 1：MPR could be reduced to a certain extent when ACLR is omitted during OOB emission evaluation, and the reduction is concentrated in the outer RB region.* ***Proposal 1：****In scenario1-1, ACLR could be omitted from out-of-band emission evaluation,**and the outer region should be regarded as a high priority for MPR reduction study.**Observation 2: After reduction the MPR of part of the outer region could fall back to below 1dB and meet the requirement of the inner region,**i.e.,**omitting ACLR would cause part of the outer area to merge with the inner area, and the inner region could be expanded.****Proposal 2:*** *In scenario 2, the starting point for applying ACLR could be changed from the edge of UE CBW to BS CBW, and for the region between UE CBW and BS CBW the IBE\_BW requirement could be applied instead.**Observation 3: If the starting point of the ACLR application range is relaxed to the edge of the BS CBW, the MPR in some outer regions will fall back below 0dB, thereby meeting the requirements of the inner region.* ***Proposal 3:*** *A new inner region should be defined for scenario1-1 and scenario 2 with ACLR relaxed and SEM/SE unchanged：** *For scenario 1-1, ACLR is omitted in MPR evaluation.*
* *For scenario 2, ACLR is applied from edge of BS CBW rather than UE CBW.*
* *FFS on whether the new inner should be same or not for both scenarios.*

***Proposal 4:*** *The SEM could be relaxed to apply from the BS edge instead of UE edge. And whether the power level of SEM could be relaxed is FFS.**Observation 4: If both SEM and ACLR are relaxed to start applying from the edge of BS CBW, the MPR would basically fall back below 0dB.* ***Proposal 5:*** *The MPR reduction value and the range of inner region depend on the type and quantity of relaxed out-of-band emission requirements, whether to relax or not should be judged and indicated by the BS.* *Observation 5: For scenario 2, if both SEM and ACLR are relaxed to start applying from the edge of BS CBW, the RB allocation region division should be based on the actual RB allocations in BS rather than UE.* ***Proposal 6:*** *If the starting point of the application range of ACLR and SEM is relaxed to the edge of the BS CBW, the inner and outer area ranges need to be redefined based on the relationship between RB allocation, UE CBW and the BS CBW.* ***Proposal 7:*** *ACLR outside the BS CBW should not be relaxed even if the BS CBW is smaller than the bandwidth of the operator's holding spectrum band.* |
| **[R4-2408133](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408133.zip)** | Discussion on MPR applicability for FR1 intra-band UL CA | vivo | *Observation 1: If LO position is not changed when 2CC falls back to 1CC in intra-band NC CA, the IMD product will fall into more stringent spurious emission limit band so that a larger MPR is needed in a narrower configuration.* *Observation 2: The MPR of single carrier could be reused if the UE has the capability of retuning LO, but it should not be considered as a required feature.****Proposal 1：****It’s up to UE implementation that**the application of single-carrier MPR in 1CC scheduling for intra-band NC CA narrow B configuration.* |
| **[R4-2408134](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408134.zip)** | Discussion on MPR applicability for FR2 | vivo | ***Proposal1：****For sub-bullet 1, single carrier UL with DL intra-band CA could reuse the MPR requirements of single carrier with UE supporting LO-independent feature.****Proposal2：****For sub-bullet 2: intra-band UL CA with DL intra band CA (configuration based),**when UE supports corresponding LO-independent feature, the current MPR requirements of intra-band CA could be reused with changing CABW to UL aggregated BW. And a note could be added to the MPR table:****Proposal3：****For sub-bullet3: intra-band UL CA with DL intra band CA (CC activation based), when UE supports LO-independent feature, the MPR requirement should depend on the total aggregated BW of all the UL activated CCs. When only 1 UL CC is activated, the MPR requirements of single carrier could be reused.* |
| **[R4-2408222](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408222.zip)** | Discussion on enhanced MPR scenario | CMCC | ***Proposal 1: following list the sub-scenarios of scenario 2 as starting point.**** ***Sub-scenario 2-1: instead of ACLR 1, ACLR 2 or even higher order ACLR may apply due to less UE bandwidth.***
	+ ***Note: this is due to the flexible UE bandwidth location within gNB bandwidth***
* ***Sub-scenario 2-2: Equivalent ACLR due to unequal aggressor and victim bandwidth for adjacent carrier co-existence scenario***
	+ ***Note: this is due to less UE aggressor bandwidth compared with gNB victim bandwidth***

***Proposal 2: for scenario 1-1, the ACLR and SEM may not be needed when taken spatial isolation factor into consideration.******Proposal 3: for scenario 1-1, RAN4 further discuss whether the ACLR relaxation is allowed for the case when there is guard band but the guard band is less than CBW assumption for ACL******Proposal 4: RAN4 needs to discuss whether there is any relaxation for higher order ACLR for the scenario when UE bandwidth is less than gNB bandwidth.*** ***Proposal 5: no relaxation of 1st ACLR, SEM and SE when narrower UE channel BW within wider BS bandwidth.******Proposal 6: it’s suggested to study the extent of ACLR/SEM relaxation at first with limited number of relaxation values to reduce further MPR reduction analysis workload.*** |
| **[R4-2408755](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408755.zip)** | Discussion on FR2 MPR improvement for single carrier and intra band CA | NTT DOCOMO INC.. | ***Proposal 1: Apply the MPR depending on the UL BW for all modulation schemes to obtain further MPR reductions in addition to the existing exceptions. In particular, the area of use is expected to be expanded for DFT-s-16QAM.******Proposal 2: For FR2 intra-band UL CA, specify MPR requirement for CABW < 400 MHz (e.g.,*** *≤* ***200 MHz) to expand the cases where MPR reductions can be obtained.****Observation 1: For FR2 intra-band UL CA, CC activation based MPR reduction can offer the advantage that no configuration changes are required in the movement to and from the cell edge****.*** |
| **[R4-2408763](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408763.zip)** | R19 power enhance for single carrier | OPPO | *Observation 1: For the case of only one operator holding spectrum in a band, how the requirements can be relaxed need to be clear considering the regulation restrictions and also operator demands before power enhancement evaluations.**Observation 2: For the case of only one operator in a band, relaxing requirements only inside the operator holding spectrum seems more cautious from regulation restriction and potential interference handling perspective.****Proposal 1: For the case of only one operator in a band, relaxing emission requirements only inside the operator holding spectrum. For the outside of operator spectrum, ACLR/SEM/SE still applies when the frequency ranges are overlapped.****Observation 3: Adjacent operator scenario is more complex than the single operator case, and it is more cautious to only relax the emission requirements inside operator holding spectrum.****Proposal 2: For the case of adjacent operators in a band, relaxing emission requirements only inside the operator holding spectrum. For the outside of operator spectrum, ACLR/SEM/SE still applies when the frequency ranges are overlapped.****Observation 4: In most of the regulations, UE is required to meet all the Tx emission requirements outside of its transmission bandwidth without relaxation. How much benefit this emission relaxation can be derived is unclear.****Proposal 3: The power enhancement by emission relaxations shall be an optional feature if introduced. And UE must have ways to make sure the relaxation of emissions will not violate the regulations.*** |
| **[R4-2408764](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408764.zip)** | R19 MPR applicability for FR1 intra-band UL CA | OPPO | *Observation 1: The interruption duration of SCC activation/deactivation is slot based (at ms level) and UE adjust its RF configurations usually is less than 210us. Time seems enough for UE to adjust itself during the SCC activation/deactivation interruptions.* |
| **[R4-2408794](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408794.zip)** | Discussion on power domain enhancements for single carrier | ZTE Corporation, Sanechips | *Observation 1: The stricter Category B requirements in ITU-SM.329 were selected for the UE in 3GPP to allow for global circulation of terminals. 3GPP and ITU-R share the same applying range of spurious emission requirements.****Proposal 1: For spurious emission requirements, they can’t be relaxed.******Proposal 2: We propose that MPR reduction for outer RB allocation is prioritized.****Observation 2: Our simulation results demonstrate that when ACLR is relaxed by 2 dB, MPR reduction can reach up to 0.6 dB for DFT-s-OFDM and 0.8 dB for CP-OFDM with QPSK/16QAM.****Proposal 3: Further relaxation of SEM will not result in additional MPR reduction when relaxing ACLR, and there is no need to relax ACLR with SEM.****Observation 3: Scenario 2 can be divided into two cases for discussion. Case 1 is the distance between UE CBW and the nearest BS CBW is larger than the half of UE CBW, and case 2 is the distance between UE CBW and the nearest BS CBW is smaller than the 1/2 UE CBW.****Proposal 4: For case 1, the starting point of ACLR, SEM domain on both sides can be shifted by half of UE CBW. Instead of applying ACLR and SEM requirement in the shifted range, IBE requirement can be used.******Proposal 5: In case2, relaxing the ACLR outside the BS channel bandwidth isn’t possible. It's conceivable that no MPR reduction can be achieved in this case.*** |
| **[R4-2408795](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408795.zip)** | Discussion on MPR applicability for FR1 intra-band UL CA | ZTE Corporation, Sanechips | ***Proposal 1: For PC3, the single CC MPR requirements (Table 6.2.2-1) can be applied to FR1 intra-band contiguous UL CA with only one UL CC activated.******Proposal 2: For PC2, the single CC MPR requirements can be applied to FR1 intra-band contiguous UL CA with only one UL CC activated. If TxD is indicated for this intra-band contiguous ULCA, single CC with TxD MPR (Table 6.2D.2-1) should apply; if TxD is not indicated for this intra-band contiguous ULCA, single CC without TxD MPR (Table 6.2.2-2) should apply.****Observation 1: In current specification, it has been defined that MPR for single CC should apply to FR1 intra-band non-contiguous UL CA with only one UL CC activated.**Observation 2: There are some cases are excluded, e.g. B < 9 MHz where 5.5 dB MPR is used. These exclusions are defined for specific bands.****Proposal 3: Whether MPR for single CC can be applied to these excluded cases requires input from operators.*** |
| **[R4-2408796](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408796.zip)** | Discussion on MPR applicability for FR2 | ZTE Corporation, Sanechips | ***Proposal 1: It is feasible for UEs with fast LO switching or with dedicated LOs for Tx and Rx paths to change applicable MPR from CABW dependent to UL carrier/CABW dependent.******Proposal 2: For single UL CC with intra-band DL CA, it can use MPR for single CC based on power class, channel bandwidth and frequency range of single UL CC with UE capability.******Proposal 3: For case 2, if a UE supports LO switching or has separate LOs for Tx and Rx, it also can decouple intra-band UL CA and intra-band DL CA. In this case, applied MPR could change from CABW to intra-band UL CA with UE capability.******Proposal 4: If only one UL CC activation, we think single CC MPR can be utilized with UE capability, which is similar to case 1. If more than one UL CCs activation, it looks like case 2, applied MPR could change from CABW to intra-band UL CA with UE capability.*** ***Proposal 5: It is necessary to introduce to a new UE capability of changing applicable MPR from CABW dependent to UL carrier/CABW dependent. This new UE capability could be optional and release independent.*** |
| **[R4-2409169](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409169.zip)** | On power domain enhancements for single carrier | Huawei, HiSilicon | *Observation 1: For what have been extensively studied for transparent schemes in Rel-18, power boosting on top of advertised power class can be delivered only for inner RB region subject to BPSK/QPSK modulation order and DFT-s-OFDM waveform, but cannot be achieved for other cases.**Observation 2: For QPSK, the ACLR/SEM requirements are the bottleneck for better MPR performance in outer/edge RB region, while the bottleneck for inner RB region is IBE requirement instead.**Observation 3: With existing implementation aiming for interference mitigation including BS filter design, guard band, spatial isolation and coordination based on measurements, there could be no concern on adjacent in-band/out-of-band co-existence. Examples are:** *NR band n28 in China is co-construction and sharing by CMCC and CBN*
* *NR band n78 in China is co-construction and sharing by China Unicom and China Telecom*
* *NR band n34 and n41 in China are exclusively allocated to CMCC*

*Observation 4: For the case that UE channel bandwidth equals to BS channel bandwidth, preliminary measurement results show that PC2 QPSK with DFT-s-OFDM waveform, about 1 dB MPR reduction gain can be expected for outer region when both ACLR and SEM requirements are waived.* ***Proposal 1: Only consider outer/edge region for ACLR/SEM relaxation based MPR reduction in Rel-19.*** ***Proposal 2: Do not consider relaxation on spurious emission requirement in Rel-19.******Proposal 3: Clarify the BS channel bandwidth means BS RF bandwidth that covers single carrier, multi-carriers and multi-RATs scenarios.******Proposal 4: Conclude that it is feasible to relax ACLR and/or SEM requirements for******no adjacent in-band/out-of-band co-existence issue scenario when UE channel bandwidth equals to BS channel bandwidth.**** ***Further study on how exactly ACLR and/or SEM requirements can be relaxed.***

***Proposal 5: Conclude that it is feasible to relax ACLR and/or SEM requirements for******no adjacent in-band/out-of-band co-existence issue scenario when UE channel bandwidth is smaller than BS channel bandwidth.**** ***Further study on how exactly ACLR and/or SEM requirements can be relaxed comparing to IBE requirement within the gap between UE channel bandwidth and the edge of BS channel bandwidth.***

***Proposal 6: For the case with adjacent operators and narrower UE channel bandwidth within BS channel bandwidth, following mechanism can be considered for MPR reduction:**** ***Define new starting point of ΔfOOB which is Y MHz away from X MHz UE channel bandwidth at each side***
	+ ***Y is determined so that X MHz can be equivalently viewed as “inner RB allocation” relative to (X+2Y) MHz***
* ***FFS whether IBE requirements can be applied within the Y MHz at each side in order to achieve reduced MPR***
* ***Preclude the case when the extended Y MHz exceeds BS channel edge, for which legacy MPR requirements apply***

***Proposal 7: Only transparent schemes can be considered but not pursue RAN1 and RAN4 specification impacts.******Proposal 8: For the case with adjacent operators and narrower UE channel bandwidth within BS channel bandwidth, if UE indicates support of Rel-19 MPR reduction, the reduced MPR for outer/edge RB regions cannot be smaller than the MPR requirement for inner RB region respective to each configuration of modulation order and OFDM waveform. Additionally, if UE indicates support of Rel-18 power boosting:**** ***Alternative 1: Power boosting can be allowed for outer/edge RB regions only with QPSK DFT-s-OFDM waveform, i.e. PC3+1dB for all bands or PC2+0.5dB for TDD bands.***
* ***Alternative 2: Power boosting cannot be allowed for outer/edge RB regions.***

***Proposal 9: With what have been specified in Rel-18 power boosting WI, do not consider further enhancement for inner RB regions in Rel-19.*** |
| **[R4-2409170](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409170.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: In Rel-19, the applicable MPR for FR1******intra-band non-contiguous UL CA doesn’t need further enhancement.*** |
| **[R4-2409171](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409171.zip)** | On MPR applicability for FR2 CA | Huawei, HiSilicon | *Observation 1: Specify split PLL for Tx/Rx RF architecture as an optional feature is not in line with how RAN4 defined the MPR requirements, given that both common and split Tx/Rx PLL structures have been studied before and the eventually specified core requirements is implementation agnostic about this aspect.**Observation 2: The split PLL may not be the strong implementation assumption/limitation behind following MPR applicability rule for PC1 UE configured with intra-band UL NC CA operation.****Proposal: Consider following way during the nominal working procedure:**** ***Explicitly capture in specification (e.g., as a note for the UE capability) that the support of applicable intra-band contiguous UL CA MPR change subject to split PLL for Tx/Rx, or***
* ***Preclude PC3 UE from those UE types can indicate support of applicable intra-band contiguous UL CA MPR change from DL CABW dependent to UL carrier/CABW.***
 |
| **[R4-2409194](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409194.zip)** | Power domain enhancements for single carrier | Nokia | *Observation 1: We propose a solution that could be applied for any scenario* *Observation 2: 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).****Proposal 1: Prioritize the study of MPR enhancement with current 5G NR ACLR/SEM/spurious emissions limits for all identified scenarios, and FFS OOBE limit relaxation for each scenario based on the co-existence/interference impact.******Proposal 2: Prioritize the study of MPR enhancement solutions applicable for all identified scenarios.******Proposal 3: MPR enhancement for RedCap and non-Redcap devices should avoid higher interference over a wide bandwidth and carefully handle intra/inter-cell and intra/inter-operator interference.****Observation 2: Defining wider/relaxed guard band configuration allows MPR reduction and/or additional power boost capability with the current ACLR/SEM/spurious emissions limits.* ***Proposal 4: RAN4 should specify at least one guard band configuration larger than the minimum guard band and its associated enhanced MPR/power boost for (non-)RedCap devices.****Observation 3: Defining UE requirements according to the BS channel bandwidth would allow reduced MPR as the IBE will be further relaxed.****Proposal 5: For MPR reduction the UE requirements (ACLR/SEM/spurious emission, IBE) should be defined according to BS CBW as shown in option 2 of the figure 3.*** |
| **[R4-2409628](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409628.zip)** | Discussion on power domain enhancements for single carrier | LG Electronics UK | ***Proposal 1: Consider the following sub-scenarios of scenario 2:******Scenario 2: Narrower UE channel BW within wider BS bandwidth**** ***Scenario 2-1: single operator***
* ***Scenario 2-2: adjacent operators***

***Proposal 2: If relaxation of SE does not significantly improve MPR reduction, do not consider the relaxation of SE.******Proposal 3: For scenario 2, it is necessary to consider IBE relaxation along with the relaxed ACLR/SEM/SE for the region of out of UE CBW within BS 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: Scenarios for power domain enhancements for single carrier

*Sub-topic description*

***Scenarios discussed in last RAN4 meeting:***

* ***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*

***Way forward in RAN4#110-bis:***

* *Prioritize scenario 1-1 and scenario 2 for initial study of power domain enhancements for single carrier in terms of relaxed requirements*
	+ *FFS on* *sub-scenarios of scenario 2.*

*Scenario 1-2 will be studied after scenario 1-1 and scenario 2*

*Open issues and candidate options before meeting:*

#### **Issue 1-1-1: Alignment/clarification of scenarios for power domain enhancements for single carrier**

* Proposals
	+ Proposal 1: RAN4 shall focus on the scenario 2 when a UE uses a narrower channel bandwidth within a wider BS CBW/operator spectrum block for the MPR reduction in Rel-19. (Sony)
	+ Proposal 2: Further discuss scenario 1-1” Scenario with no adjacent in-band/out-of-band co-existence issue (single operator)” to ensure that it is a scenario that represents a realistic deployment. (Qualcomm)
	+ Proposal 3: Discuss the following sub-scenarios of scenario 2: (Samsung)
		- Scenario 2-1 can be when non-RedCap UE CBW is located at the edge of BS BW;
		- Scenario 2-2 can be when RedCap UE CBW is located at the edge of BS BW with the Shifted Channel Edge approaches;
		- Scenario 2-3 can be when non-RedCap UE CBW is located around the center of BS BW;
		- Scenario 2-4 can be when RedCap UE CBW is located around the center of BS BW with the Shifted Channel Edge approaches.
	+ Proposal 4: the feature ‘narrower UE channel BW within wider BS bandwidth’ is specified for RedCap UEs in bands with a maximum channel bandwidth greater than 20 MHz and is based on the requirements for the largest channel bandwidth (MHz) with a transmission bandwidth configuration less than or equal to the carrier bandwidth advertised in SIB1. (Ericsson)
	+ Proposal 5: we can first evaluate MPR reduction based on below case to guarantee there is no co-existence issue for both scenario 1-1 and scenario 2 (Xiaomi)
		- The frequency range occupied by single operator or BS bandwidth is at least equal to or larger than 3 times of assigned UE channel BW.
	+ Proposal 6: following list the sub-scenarios of scenario 2. (CMCC)
		- Sub-scenario 2-1: instead of ACLR 1, ACLR 2 or even higher order ACLR may apply due to less UE bandwidth.
			* Note: this is due to the flexible UE bandwidth location within gNB bandwidth
		- Sub-scenario 2-2: Equivalent ACLR due to unequal aggressor and victim bandwidth for adjacent carrier co-existence scenario
			* Note: this is due to less UE aggressor bandwidth compared with gNB victim bandwidth
	+ Proposal 7: Consider the following sub-scenarios of scenario 2: (LGE)
		- Scenario 2: Narrower UE channel BW within wider BS bandwidth
			* Scenario 2-1: single operator
			* Scenario 2-2: adjacent operators
	+ Proposal 8: In both cases, adjacent bands should be considered to see if emission requirement relaxation applies. (Skyworks)
	+ Proposal 9: ACLR/SEM relaxation can be considered for the following sub-cases in scenario 1-1 (Huawei):
		- Scenario A-1: UE channel bandwidth equals to BS channel bandwidth
		- Scenario A-2: UE channel bandwidth smaller than BS channel bandwidth
	+ Proposal 10: Conclude that it is feasible to relax ACLR and/or SEM requirements for no adjacent in-band/out-of-band co-existence issue scenario when UE channel bandwidth equals to BS channel bandwidth.
		- With existing implementation aiming for interference mitigation including BS filter design, guard band, spatial isolation and coordination based on measurements, there could be no concern on adjacent in-band/out-of-band co-existence. Examples are**:**
			* NR band n28 in China is co-construction and sharing by CMCC and CBN
			* NR band n78 in China is co-construction and sharing by China Unicom and China Telecom
			* NR band n34 and n41 in China are exclusively allocated to CMCC
* Recommended WF
	+ Check operators view on the rationality of scenario 1-1 by taking realistic deployment examples into account
	+ Discuss whether further prioritization for scenario 1-1 and scenario 2
	+ Discuss whether sub-scenarios are to be further considered for identified scenarios in last meeting with consideration on issues for requirements relaxation

CMCC: we prefer to keep the previous agreements. In our scenario, the single band single operator is typical.

Skyworks: Operators have SCS alignment always.

CMCC: in China, operators always have aligned assumptions.

Qualcomm: Do you want to keep 1-1 and 1-2?

CMCC: we would like to keep both. It could happen that the adjacent band belongs to other operators.

Skyworks: In some scenario, the grid is not aligned. In this scenario 1-2, can we assume the channel is aligned?

Verizon: 1-2 is very common scenario in US and it is important for sharing the spectrum. We need consider such scenario.

Huawei: tend to agree with CMCC. Scenario 1-2 is not precluded.

OPPO: what is the difference between 1-1 and 1-2. UE transmission needs to protect other.

Ericsson: What does no co-existence scenario mean? How to address the two adjacent operator scenario? We should make sure it can work for all the scenarios. In some scenarios and some bands belong to other operators. What prevents other operator to use the techniques. We are very careful to relax the requirements. We have intend to also specify it for LTE.

AT&T: We support comment made by Ericsson and Verizon. It needs to work with the scenario. Otherwise it cannot be deployed.

Skyworks: at least for scenario 1-2, I want to know what the impact is. We are talking about the co-located scenario.

Moderator: Scenario 1-2 includes two cases: 1) two operators coordinate; 2) even if we have two operators, there is some spatial separation, then there could be some room to increase the power.

Huawei: for scenario 1-1, it is special case for Chinese operators. We do not need consider ACLR and SEM for this scenario. For this scenario, there will not be co-existence issue. That is the simple case. We do not need further discuss the prioritization again.

OPPO: This is optional feature. If UE is in n78, we can relax the emission. UE still fulfils the regulation.

Verizon: we need consider co-located and non-collocated cases. We need consider the sharing case. We band 66 and n66… which belongs to different operators. In some spectrum we share with other operators. We have no co-existence issue for such sharing scenario.

Sony: One concern is that we have too many different scenarios. We are going down to look at all the details. We would like to have general solutions for all the scenario. Scenario 2 is more general solutions.

Huawei: Scenario 2 is general one. But scenario 1-1 is important considering the widely deployment.

#### **Issue 1-1-2: Further considerations for identified scenarios**

* General proposals
	+ Proposal 1: SE requirements should not be relaxed in lack of justification. (Samsung, Huawei, ZTE)
	+ Proposal 2: Agree that relaxation of UE spurious emission requirement is feasible whilst still adhering to ITU REC SM.329, and necessary if ACLR and/or SEM are relaxed. (MTK)
	+ Proposal 3: it is not feasible to allow the out-of-band emission limits outside the operator spectrum block to be relaxed even if the adjacent spectrum is not used. (Sony)
	+ Proposal 4: Clarify the BS channel bandwidth means BS RF bandwidth that covers single carrier, multi-carriers and multi-RATs scenarios. (Huawei)
	+ Proposal 5: RAN4 shall decide which channel BW (BS CBW, cell CBW and operator spectrum block bandwidth) shall be used as the reference channel bandwidth when redefining the inner, outer and edge RB allocation. (Sony)
* Proposals for scenario 1-1
	+ Proposal 1: for scenario 1-1, the ACLR and SEM may not be needed when taken spatial isolation factor into consideration. (CMCC)
		- RAN4 further discuss whether the ACLR relaxation is allowed for the case when there is guard band but the guard band is less than CBW assumption for ACL
	+ Proposal 2: For the case of only one operator in a band, relaxing emission requirements only inside the operator holding spectrum. For the outside of operator spectrum, ACLR/SEM/SE still applies when the frequency ranges are overlapped. (OPPO)
	+ Proposal 3: In scenario1-1, ACLR could be omitted from out-of-band emission evaluation, and the outer region should be regarded as a high priority for MPR reduction study. (vivo)
	+ Proposal 4: Conclude that it is feasible to relax ACLR and/or SEM requirements for no adjacent in-band/out-of-band co-existence issue scenario when UE channel bandwidth equals to BS channel bandwidth. (Huawei)
		- Further study on how exactly ACLR and/or SEM requirements can be relaxed.
	+ Proposal 5: Further relaxation of SEM will not result in additional MPR reduction when relaxing ACLR, and there is no need to relax ACLR with SEM. (ZTE)
	+ Proposal 6: For simplify, ACLR/SEM can be relaxed for MPR reduction together. (Samsung)
* Proposals for scenario 2
	+ Proposal 1: RAN4 needs to discuss whether there is any relaxation for higher order ACLR for the scenario when UE bandwidth is less than gNB bandwidth. (CMCC)
	+ Proposal 2: For the case of adjacent operators in a band, relaxing emission requirements only inside the operator holding spectrum. For the outside of operator spectrum, ACLR/SEM/SE still applies when the frequency ranges are overlapped. (OPPO)
	+ Proposal 3: No relaxation of ACLR/SEM/SE outside of one operator holding spectrum for scenario 2 will be considered since there are potential adjacent co-existence issues. (Samsung)
	+ Proposal 4: Agree that applying a shift in ACLR/SEM requirements is feasible for RedCap UE in Scenario 2, as long as the OOB requirements outside of the BS CBW are no worse than that of an existing eMBB UE configured to operate in the full BS CBW. (MTK)
	+ Proposal 5: Conclude that it is feasible to relax ACLR and/or SEM requirements for no adjacent in-band/out-of-band co-existence issue scenario when UE channel bandwidth is smaller than BS channel bandwidth. (Huawei)
		- Further study on how exactly ACLR and/or SEM requirements can be relaxed comparing to IBE requirement within the gap between UE channel bandwidth and the edge of BS channel bandwidth

Proposal 6: ACLR outside the BS CBW should not be relaxed even if the BS CBW is smaller than the bandwidth of the operator's holding spectrum band.

* Recommended WF
	+ Discuss and determine whether spurious emissions should be relaxed in the evaluation
	+ Clarify BS channel bandwidth in terms of operator holding spectrum
		- BS channel bandwidth means BS RF bandwidth that covers single carrier, multi-carriers and multi-RATs scenarios
	+ FFS ACLR relaxation with or without relaxation with SEM

Moderator: most companies think that no spurious emission can be relaxed. For BS channel bandwidth less than the spectrum held by operator, it is widely observed scenario. Both ACLR and SEM relaxation can be considered.

OPPO: for spurious emission, the relaxation means 1) removing it 2) relax the requirement. We should not relax or remove spurious emission. We can focus on single carrier case. The last one is reasonable.

Skyworks: It seems that the emission relaxation will be evaluated only in term of co-existence. For FDD, we need evaluate De-REFSENS, should we evaluate it also?

Qualcomm: I saw some paper said spurious emission can be relaxed.

CATT: Just use the BS RF bandwidth rather than BS bandwidth.

Mediatek: if we shift the region of spurious emission, it is the relaxation.

ZTE: We need clarify what the relaxation is: 1) relax the value 2) shift the starting point.

Apple: Spurious emission is not the limiting factor. If we are going to relax ACLR, then the next limit factor is SEM. We would like to propose to relax ACLR and then SEM if needed.

Xiaomi: share the similar view as ZTE. If we just relax ACLR and SEM value, maybe we do not relax spurious emission. If we shift ACLR and SEM, then we need shift spurious emission.

Nokia: We need discuss what the relaxation means. We can first look at ACLR and then SEM, which is related the regulation, and the region to apply the relaxation. We should not go to discuss the de-REFSENS at the beginning. For BS channel bandwidth vs BS RF bandwidth, we need discuss more about two terms.

Huawei: in any cases, the value of spurious emission cannot be relaxed. In scenario 1-1, we can relax the ACLR and SEM. For scenario 2, we do not need change the value of SE rather than region. Regarding BS bandwidth vs BS RF bandwidth, we agree with CATT. We can consider the single carrier case. Relaxing ACLR with or without SEM, there would be no benefit relaxing SEM.

OPPO: The relaxation can be applied to all bands.

LGE: regarding the spurious emission, it depends on the regulation. It is hard to control the spurious mask. It is not the limiting factor.

Nokia: There is some room according to ITU.

Ericsson: we still be careful to changing any ACLR requirement. For operator, you have non-collocated cells. If looking at MPR requirement, we have the same discussion previously. We may improve the MPR to ensure ACLR. That could be other alternative way to take.

Apple: to Ericsson, the work to improve PA is out of scope of WI.

Sony: we agree with Ericsson. It is danger to change the ACLR level. We can consider the applicable region for ACLR.

Huawei: for scenario 1-1, there is no co-existence issue. The ACLR can be relaxed. Spurious emission could not be relaxed.

LGE: Regarding the updated simulation, we have the similar view as Apple to see the impact of relaxed ACLR requirement.

Nokia: Agree with Huawei that the number of spurious emission number cannot be changed. We can consider the spurious emission region.

Agreement:

* No relaxation of level of spurious emission requirements
	+ FFS on whether to change the spurious emission boundary

### Sub-topic 1-2: Evaluation consideration on power domain enhancements for single carrier with relaxed requirements

*Sub-topic description*

*Open issues and candidate options before meeting:*

#### **Issue 1-2-1: General considerations for power domain enhancements**

* Prioritization for the evaluation
	+ Proposal 1: We propose that MPR reduction for outer RB allocation is prioritized. (ZTE)
	+ Proposal 2: Prioritize study on reduction of Outer RB allocation MPR to similar level as Inner RB allocation MPR for PC3 UE, without increasing reference UE complexity (particularly hardware), by appropriate Tx emission requirement relaxation. Consider MPR reduction for Inner RB allocations a low priority for all power classes. (MTK)
	+ Proposal 3: Only consider outer/edge region for ACLR/SEM relaxation based MPR reduction in Rel-19. (Huawei)
	+ Proposal 4: Prioritize the study of MPR enhancement solutions applicable for all identified scenarios. (Nokia)
	+ Proposal 5: The outer region should be regarded as a high priority for MPR reduction study. (vivo)
* Recommended WF
	+ Discuss whether MPR reduction for outer RB allocation is prioritized in Rel-19

OPPO: we do not need restrict which part will be prioritized.

Qualcomm: Agree with comment from OPPO. What region to be relaxed depends on study.

Xiaomi: Agree with OPPO and Qualcomm. We should first discuss how to relax ACLR and SEM and consider the region or just relaxing some regions.

Apple: We see the benefit for outer region by relaxing ACLR. We can see the evaluation first.

Mediatek: Similar view as Apple.

CATT: for inner region, there is already some improvement. If we do not think about the power boosting, the MPR is already 0. There is no room to improve. We can focus on outer region.

Samsung: Share the similar view as Apple, Mediatek and CATT. The outer region can get most benefit. In past release, we have enhancement for inner region. The MPR of inner region is less than outer region usually.

Skyworks: Share Apple, etc. view. We could reconsider what the inner and outer regions mean. Some edge location may not exist considering the potential change of reference bandwidth.

Nokia: we need first focus on evaluation. We should consider all the scenario before precluding some.

Moderator: based on input, in this meeting, we see more input to focus on outer region. I agree with CATT comments.

Nokia: The moderator comment does not capture Skyworks’ comment. There is no point to say inner or outer. We need discuss what the target is.

Qualcomm: Agree with Nokia. There are two issues: 1) what regions to be targeted, i.e., outer region. Boosting can be used for outer region. We should consider all the regions.

LGE: We have the similar view as Apple and Qualcomm. It depends on the study. We do not prioritize the region now.

#### **Issue 1-2-2: Mechanisms for enabling MPR reduction and/or power boosting**

* Proposals
	+ Proposal 1: Endorse a Tx emission requirements relaxation approach of shifting the Tx emissions requirements “channel edge” (ΔfOOB = 0 MHz) away from real channel edge to create sufficient guardband from the UE channel bandwidth edge, to enable ACLR, SEM, and Spurious Emission relaxation. “Extension of” IBE or equivalent to apply from first/last allocated RB to new Tx emission requirements “channel edge”. (MTK)
		- Further focus evaluation on the Wider CBW Tx emission requirements framework is feasible **to enable Outer RB allocation MPR reduction**, for RedCap and non-RedCap UE. Also further study the Spurious Emission requirement issue as described for this approach.
		- Further focus evaluation on the Shifted Channel Edge with “Same CBW” Tx emission requirements framework as one option to enable Outer RB allocation MPR reduction for RedCap and non-RedCap UE.
		- Conclude that the “One-Sided” Shifted Channel Edge enhancement approach is feasible to enable Outer RB allocation MPR reduction for RedCap and non-RedCap UE, when UE channel bandwidth is at one edge of the operator’s spectrum block. The maximum partial RB allocation for Outer RB allocation can be further analyzed.
	+ Proposal 2: For the non-RedCap UE, study further the following aspects for the shifted channel edge approach: (MTK)
		- Which Tx emissions requirements framework would apply for Wider Channel Bandwidth >100MHz?
		- Whether the CBW/2 shift from the channel edge proposed for RedCap also scales in exactly the same way for larger UE channel bandwidths such as 80-100MHz.
	+ Proposal 3: The Shifted Channel Edge approaches should not be considered for non-RedCap UE. (Samsung)
	+ Proposal 4: For RedCap UE, the Shifted Channel Edge approaches can be considered and IBE requirements can be applied to the new extended CBW. (Samsung)
	+ Proposal 5: RAN4 may consider **redefining the RB allocation with respect to the BS CBW/operator spectrum block to enable inner RB MPR** when the UE is placed in the inner allocation of a wider BS CBW/operator spectrum block. (Sony)
	+ Proposal 6: Initially study the cases where 1) The excess bandwidth on either side of the **UE BW is equal to ½ of the UE BW** and 2) The excess bandwidth of either side of the UE BW is equal to the UE BW. For these cases the aggregated UE bandwidth should be considered as the UE BW plus the excess BW on either side of the UE BW for SEM, ALCR and spur specifications. (Qualcomm)
	+ Proposal 7: For the case with adjacent operators and narrower UE channel bandwidth within BS channel bandwidth, following mechanism can be considered for MPR reduction: (Huawei)
		- Define new starting point of ΔfOOB which is Y MHz away from X MHz UE channel bandwidth at each side
		- Y is determined so that X MHz can be **equivalently viewed as “inner RB allocation”** relative to (X+2Y) MHz
		- FFS whether IBE requirements can be applied within the Y MHz at each side in order to achieve reduced MPR
		- Preclude the case when the extended Y MHz exceeds BS channel edge, for which legacy MPR requirements apply
	+ Proposal 8: UE CBW < BS CBW cases, relaxation should be **based on distance between the UE CBW edge to BS CBW edge** and different if the channel is at the band edge. (Skyworks)
	+ Proposal 9: on relaxed requirement evaluation: (Skyworks)
		- Relaxation of SEM is prioritized as it favors narrow allocations power domain enhancement and is applicable to all power classes.
		- Requirement relaxation is not studied for 256QAM and may be marginal for 64QAM
		- Edge allocation MPR can be ignored if the BS CBW is >1MHz larger than the UE CBW. This also applies when the band is single operator.
		- It is studied whether two types of inner allocations should be considered (narrow allocations that may be only IBE/EVM limited and large allocations that may be SEM/ACLR limited). An alternative is to define two inner allocation types depending on IMD3 falling within the BS CBW or outside the BS CBW.
		- **Within the BS CBW outside the allocated UE CBW RBs, IBE should still apply**.
	+ Proposal 10: The SEM and ACLR requirements can be relaxed by moving it to the **outside of adjacent channel of the assigned UE channel BW or the outside of BS channel BW**. (Xiaomi)
	+ Proposal 11: we can first evaluate MPR reduction based on below case to guarantee there is no co-existence issue for both scenario 1-1 and scenario 2 (Xiaomi)
		- The frequency range occupied by single operator or BS bandwidth is at least equal to or larger than 3 times of assigned UE channel BW.
	+ Proposal 12: For case 1, the **starting point of ACLR, SEM domain on both sides can be shifted by half of UE CBW**. Instead of applying ACLR and SEM requirement in the shifted range, IBE requirement can be used. (ZTE)
	+ Proposal 13: In case2, relaxing the ACLR outside the BS channel bandwidth isn’t possible. It's conceivable that no MPR reduction can be achieved in this case. (ZTE)
	+ Proposal 14: Prioritize the study of MPR enhancement with current 5G NR ACLR/SEM/spurious emissions limits for all identified scenarios, and FFS OOBE limit relaxation for each scenario based on the co-existence/interference impact. (Nokia)
	+ Proposal 15: For MPR reduction the UE requirements (ACLR/SEM/spurious emission, IBE) should be defined according to BS CBW as shown in option 2 of the figure 3. (Nokia)
	+ Proposal 16: MPR enhancement for RedCap and non-Redcap devices should avoid higher interference over a wide bandwidth and carefully handle intra/inter-cell and intra/inter-operator interference. (Nokia)
	+ Proposal 17: RAN4 should specify at least one guard band configuration larger than the minimum guard band and its associated enhanced MPR/power boost for (non-)RedCap devices. (Nokia)
	+ Proposal 18: In scenario 2, **the starting point for applying ACLR could be changed from the edge of UE CBW to BS CBW**, and for the region between UE CBW and BS CBW the IBE\_BW requirement could be applied instead. (vivo)
	+ Proposal 19: A new inner region should be defined for scenario1-1 and scenario 2 with ACLR relaxed and SEM/SE unchanged (vivo)
		- For scenario 1-1, ACLR is omitted in MPR evaluation.
		- For scenario 2, ACLR is applied from edge of BS CBW rather than UE CBW.
		- FFS on whether the new inner should be same or not for both scenarios.
	+ Proposal 20: **The SEM could be relaxed to apply from the BS edge instead of UE edge**. And whether the power level of SEM could be relaxed is FFS. (vivo)

Ericsson: the aggregated BW covers multiple cells. If yes, the new signalling is needed.

Samsung: the aggregated UE bandwidth means the extended UE bandwidth. We can focus on single CC.

Vivo: ACLR relaxation is OK. We have consider whether SEM range can be shifted. The SEM definition considers not only the regulation but actual emission mask. SEM should not be shifted with UE channel edge.

Moderator: We can change aggregated bandwidth to extended channel bandwidth.

* Recommended WF
	+ 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

#### **Issue 1-2-3: Others**

* Proposals
	+ Proposal 1: For the case with adjacent operators and narrower UE channel bandwidth within BS channel bandwidth, if UE indicates support of Rel-19 MPR reduction, the reduced MPR for outer/edge RB regions cannot be smaller than the MPR requirement for inner RB region respective to each configuration of modulation order and OFDM waveform. Additionally, if UE indicates support of Rel-18 power boosting: (Huawei)
		- Alternative 1: Power boosting can be allowed for outer/edge RB regions only with QPSK DFT-s-OFDM waveform, i.e. PC3+1dB for all bands or PC2+0.5dB for TDD bands.
		- Alternative 2: Power boosting cannot be allowed for outer/edge RB regions.
	+ Proposal 2: With what have been specified in Rel-18 power boosting WI, do not consider further enhancement for inner RB regions in Rel-19. (Huawei)
	+ Proposal 3: Only transparent schemes can be considered but not pursue RAN1 and RAN4 specification impacts. (Huawei)
	+ Proposal 4: the feature ‘narrower UE channel BW within wider BS bandwidth’ is specified for RedCap UEs in bands with a maximum channel bandwidth greater than 20 MHz and is based on the requirements for the largest channel bandwidth (MHz) with a transmission bandwidth configuration less than or equal to the carrier bandwidth advertised in SIB1. (Ericsson)
	+ Proposal 5: 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 6: Companies to bring specific technical concerns with addressing Rel-18 power boosting similar to other legacy capabilities like Rel-16 TxD, Rel-16 dualPA-Architecture and Rel-15 2Tx coherence requirements for UL MIMO, in context of the Rel-19 WI to enhance UL power with relaxed emissions requirements. (Qualcomm)
	+ Proposal 7: If the starting point of the application range of ACLR and SEM is relaxed to the edge of the BS CBW, the inner and outer area ranges need to be redefined based on the relationship between RB allocation, UE CBW and the BS CBW.(vivo)
* Recommended WF
	+ Take the proposals into consideration when discuss the mechanisms of MPR reduction and/or power boosting.

#### **Issue 1-2-4: Simulation assumption for power boosting and/or MPR reduction**

* Proposals
	+ Proposal 1: Using previous MPR simulation assumptions to evaluate the MPR reduction as the starting point. (Xiaomi)
		- PA model calibration
			* DFT-s-OFDM QPSK 20MHz
			* 100RB0
			* 4dB post PA loss
			* 1dB MP
		- Carrier Leakage: 28dB
		- IQ Image: 28dBc
		- CIM3: 60dBc
		- EVM: 17.5%
		- ACLR: 30dB for PC3, 31dB for PC2
* Recommended WF
	+ Agree with the above preliminary simulation assumptions for following evaluation. Assumptions are subject to revisions with further study.

#### **Issue 1-2-5: 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: 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 3: Establish what mechanism should be used for “BS indication” to indicate to a UE or groups of UEs that power domain enhancement is possible. (Qualcomm)
	+ Proposal 4: BS to indicate signalling to the UE or groups of UEs regarding support of power domain enhancements during UE configuration. (Qualcomm)
	+ Proposal 5: The MPR reduction value and the range of inner region depend on the type and quantity of relaxed out-of-band emission requirements, whether to relax or not should be judged and indicated by the BS. (vivo)
* Recommended WF
	+ To discuss the signalling aspects after sufficient evaluation of power boosting and/or MPR reduction in terms of relaxed requirements.

### Sub-topic 1-3: MPR applicability for FR1 intra-band UL CA based on the UL CCs with activated cells

*Sub-topic description*

*Open issues and candidate options before meeting:*

#### **Issue1-3-1: Applicable MPR for FR1 intra-band contiguous UL CA based on the UL CCs with activated cells**

* Proposals
	+ Proposal 1: For PC3 and PC2 contiguous UL CA use the corresponding single CC MPR tables when only 1 CC is activated. (Qualcomm, Samsung, CATT, ZTE, Huawei)
		- 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
	+ Agree with proposal 1

#### **Issue 1-3-2: 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 1-4: MPR applicability for FR1 intra-band UL non-contiguous CA based on the UL CCs with activated cells

*Sub-topic description*

*Open issues and candidate options before meeting:*

#### **Issue 1-4-1: Applicable MPR for FR1 intra-band non-contiguous UL CA based on the UL CCs with activated cells**

* 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, Samsung, Huawei)
	+ Proposal 2: There is no justification to specify new MPR requirements/values based on the UL CCs with activated cells for NR intra-band non-contiguous UL CA configuration. (Samsung)
	+ Proposal 3: introduce a capability “single-CC-transmission-with-single-CC-MPR” for single-PA architecture (could also be indicated for dual-PA architecture) per band combination to indicate support of single-CC MPR with two configured non-contiguous carriers and one scheduled/activated. (Ericsson)
		- the capability applicable for a frequency separation ≤ 50 MHz for FDD and ≤ 100 MHz for TDD for a single-PA architecture to facilitate implementation with a single Tx chain.
	+ Proposal 4: RAN4 should first discuss whether need modify the MPR value for intra-band non-contiguous UL CA with only one UL CC activated. (Xiaomi)
		- If not, the applicable MPR for intra-band non-contiguous UL CA with only one UL CC activated doesn’t need further enhancement.
		- If needed, RAN4 need further discuss how to modify the MPR, i.e., allow LO shifting or reduce the allocation size B.
	+ Proposal 5: It’s up to UE implementation that the application of single-carrier MPR in 1CC scheduling for intra-band NC CA narrow B configuration. (vivo)
	+ Proposal 6: Whether MPR for single CC can be applied to these excluded cases requires input from operators. (ZTE)
		- There are some cases are excluded, e.g. B < 9 MHz where 5.5 dB MPR is used. These exclusions are defined for specific bands
* Recommended WF
	+ Check whether proposal 1 is agreeable, i.e. no further enhancement for MPR applicability based on the UL CCs with activated cells for FR1 intra-band UL non-contiguous CA, since current requirement is already scheduling based.
		- Note: MPR enhancement beyond applicability of existing requirement is not included in the current WI objective for the time being.

### Sub-topic 1-5: MPR applicability for FR2 intra-band UL CA based on the UL CCs with activated cells

#### **Issue 1-5-1: General considerations for FR2 MPR applicability enhancements for UL CA**

* Proposals
	+ Proposal 1: RAN4 should find a common understanding on how activation-based UL CA affects the architecture assumptions. (Apple)
	+ Proposal 2: Consider following way during the nominal working procedure: (Huawei)
		- Explicitly capture in specification (e.g., as a note for the UE capability) that the support of applicable intra-band contiguous UL CA MPR change subject to split PLL for Tx/Rx, or
		- Preclude PC3 UE from those UE types can indicate support of applicable intra-band contiguous UL CA MPR change from DL CABW dependent to UL carrier/CABW.
	+ Proposal 3: The Rel-19 FR2 MPR enhancement is based on targeting the UE architecture that uses LOs separately centred on the UL and DL CA aggregated BWs respectively (Qualcomm)
	+ Proposal 4: Encourage UEs to support the enhancements in FR2, define a first level of enhancement based on CA configuration, and then a second level of enhancements based on CC activation. (Qualcomm)
	+ Proposal 5: 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)
	+ Proposal 6: 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 (Samsung)
	+ Proposal 7: RAN4’s discussion for FR2 should just focus on intra-band UL contiguous CA and intra-band DL contiguous CA for the cases in last meeting WF. (Xiaomi)
	+ Proposal 8: Apply the MPR depending on the UL BW for all modulation schemes to obtain further MPR reductions in addition to the existing exceptions. In particular, the area of use is expected to be expanded for DFT-s-16QAM. (DCM)
* Recommended WF
	+ Discuss and determine the following general issues for FR2 MPR applicability enhancements for UL CA
		- Clarify power classes which could support the MPR enhancements for SC and UL CA
		- Clarify whether FR2 MPR enhancement for the single UL case is applicable for intra-band DL non-contiguous CA
		- Clarify the difference of two separate levels for ‘configuration based’ and ‘CC activation based’
		- Clarify the applicable modulation schemes for the FR2 MPR enhancements

#### **Issue 1-5-2: Applicable MPR for FR2 single carrier UL with DL intra band CA**

* Proposals
	+ Proposal 1: For FR2, enhance the case of intra-CA with single CC UL (configured or activated) by making the single CC MPR table applicable for a supporting UE. (Qualcomm)
	+ Proposal 2: 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 applies for UE supporting the new capability. (Samsung)
	+ Proposal 3: Single carrier UL with DL intra band contiguous CA and intra-band UL contiguous CA with only one UL CC activated can apply the single CC MPR requirements (in clause 6.2.2). (Xiaomi)
	+ Proposal 4: single carrier UL with DL intra-band CA could reuse the MPR requirements of single carrier with UE supporting LO-independent feature. (vivo)
	+ Proposal 5: For single UL CC with intra-band DL CA, it can use MPR for single CC based on power class, channel bandwidth and frequency range of single UL CC with UE capability. (ZTE)
* 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 applies with UE indication of independent LO for UL and DL.

#### **Issue 1-5-3: Applicable MPR for FR2 UL CA with DL intra band CA**

* Proposals
	+ Proposal 1: Intra-band UL contiguous CA with DL intra band contiguous CA can apply the MPR for intra-band contiguous CA in Table 6.2A.2.2.1 for PC1, Table 6.2A.2.3-2 for PC2, Table 6.2A.2.4-1 for PC2, PC3, PC4, PC5 and PC6 based on the UL aggregated channel bandwidth. (Xiaomi)
	+ Proposal 2: For sub-bullet 2: intra-band UL CA with DL intra band CA (configuration based), when UE supports corresponding LO-independent feature, the current MPR requirements of intra-band CA could be reused with changing CABW to UL aggregated BW. And a note could be added to the MPR table:
		- NOTE 3: When UE support [FR2IndependentLO-R19]，the CABW is replaced by UL aggregated BW (vivo)
	+ Proposal 3: For sub-bullet3: intra-band UL CA with DL intra band CA (CC activation based), when UE supports LO-independent feature, the MPR requirement should depend on the total aggregated BW of all the UL activated CCs. When only 1 UL CC is activated, the MPR requirements of single carrier could be reused. (vivo)
	+ Proposal 4: For FR2 intra-band UL CA, specify MPR requirement for CABW < 400 MHz (e.g., 200 MHz) to expand the cases where MPR reductions can be obtained. (DCM)
	+ Proposal 5: For case 2, if a UE supports LO switching or has separate LOs for Tx and Rx, it also can decouple intra-band UL CA and intra-band DL CA. In this case, applied MPR could change from CABW to intra-band UL CA with UE capability. If only one UL CC activation, we think single CC MPR can be utilized with UE capability, which is similar to case 1. If more than one UL CCs activation, it looks like case 2, applied MPR could change from CABW to intra-band UL CA with UE capability. (ZTE)
* Recommended WF
	+ In general, MPR based on UL BWchannel\_CA applies instead that based on cumulative aggregated channel BW (CABW) with UE indication of independent LO for UL and DL
		- If only 1 UL CC is activated, the MPR requirements of single carrier could be reused
		- FFS whether new MPR requirement could be defined for CABW < 400 MHz (e.g., 200 MHz). (moderator note: only MPR applicability is included in the current WID objective)

#### **Issue 1-5-4: Signaling aspects**

* Proposals
	+ Proposal 1: For FR2, define 2 UE capability that changes the BW basis of the CA MPR table from cumulative aggregated channel BW (CABW) to UL BWchannel\_CA . The first capability indicates that the UE can support the MPR applicability change based on configuration of CCs, and the second indicates that the UE can support the change based on activation status of the CCs with UL. (Qualcomm)
	+ Proposal 2: It is necessary to introduce to a new UE capability of changing applicable MPR from CABW dependent to UL carrier/CABW dependent. This new UE capability could be optional and release independent. (ZTE)
* Recommended WF
	+ FFS on details of capabilities based on conclusion for the applicability of FR2 MPR for SC and UL CA