**3GPP TSG-RAN WG4 Meeting #112-bis R4-2417111**

**Hefei, China, 14th -18th Oct, 2024**

**Title:** WF on power domain enhancements

**Agenda Item:** 6.1.3

**Source: Huawei, HiSilicon**

**Document for:** Approval

# Topic #1: Power domain enhancements for single carrier

#### **Issue 1-1-1: Approaches for scenarios 1-1 and 1-2 (see Reference for description of scenarios)**

* WF
	+ Strive for a unified solution which can accommodate both scenario 1 and scenario 2 under the framework of converting outer RB allocation to inner RB allocation.
		- It does not preclude separate solutions for each applicable scenario
		- No relaxation of ACLR/SEM/SE values

**Issue 1-2-1: Clarification of multi-CC scenario**

* WF
	+ The approach of converting outer RB allocation to inner RB allocation for MPR reduction should consider multi-carrier spectrum scenario from NW perspective while the UE is configured for single CC operation.

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

* WF
	+ The approach should consider the following aspects
		- unified solution could be applicable for both scenarios 1 and scenario 2
		- unified solution considering the spectrum allocation status of operators, e.g multi-CC case from NW perspective, to better leverage the feature of MPR reduction
		- Solution could benefit RedCap and non-RedCap with UE CBW less or even identical to BS CBW
		- Solution could include both symmetric and asymmetric CBW extension
		- Whether the extended UE CBW could exceed the BS CBW for different scenarios
		- Signalling overhead is considered for the proposed approach(s)

#### **Issue 1-2-3: Where to use IBE in the larger BS CBW**

* WF
	+ IBE should be used between edges of UE CBW and extended UE CBW
		- FFS whether IBE could be used in the guard band of UE CBW
		- FFS the full RB allocation scenario
		- FFS the impact to testability

#### **Issue 1-2-4: 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.
	+ Proposal 2: ACLR, SEM and spurious emissions would be defined based on BS channel bandwidth.
* WF
	+ FFS in next meeting
		- ITU regulation of 250% necessary bandwidth should be considered in further analysis

#### **Issue 1-2-5: Boundary to apply SE**

* Proposals
	+ Proposal 1: The application range of SE should be altered with the shifting of the edge of the UE CBW.
	+ Proposal 2: SE is applied at BS channel bandwidth.
* WF
	+ FFS in next meeting
		- ITU regulation of 250% necessary bandwidth should be considered in further analysis

#### **Issue 1-2-6: Which CBW is utilized as the basis for the OOBE requirement and the applicable boundary**

* Proposals
	+ Proposal 1: The OOBE requirement and applicable boundary should be based on UE CBW.
	+ Proposal 2: The OOBE requirement and applicable boundary is based on BS CBW.
* WF
	+ FFS in next meeting

#### **Issue 1-2-7: Ratio of extended CBW to UE CBW and to larger BS channel BW**

* WF
	+ To discuss the following aspects for the extended UE CBW:
		- Whether the extended CBW with new boundary of FOOB should comply with the recommendation by ITU-R on necessary bandwidth in terms of SE for the original UE BW
		- Whether default or fixed extension, e.g. 1/2 UE CBW could be stipulated in the spec or the extension ratio could be a UE capability to fulfil the conversion of outer to inner
		- Whether the extended UE CBW could belong to the regular defined channel bandwidth
		- Whether some premise should be established for the extension size, e.g.
			* minimum extended CBW compared to original UE CBW
			* minimum BS CBW compared to UE CBW
			* frequency separation of the RB allocation to the BS edge
		- Other identified issues are not precluded

#### **Issue 1-2-8: Asymmetrical extended CBW approach**

* WF
	+ Asymmetrical extension is considered, FFS the solution.

#### **Issue 1-2-10: Signaling aspects**

* WF
	+ To further discuss the signalling aspects in conjunction with the solution to be adopted for MPR reduction.
		- Companies are encouraged to provide thinking on signalling impact together with the proposed solution

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

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

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

* WF
	+ For PC3/PC2 intra-band contiguous carrier aggregation with single CC with activated cell, the following MPR requirements are applied
		- 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 and/or UL-MIMO capability are indicated
		- MPR defined in Table 6.2.2-2 applies for power class 2 CA bandwidth classes B and C when TxD and/or UL-MIMO capability are absent.
		- The Rel-18 power boosting feature can be supported depending on UE capability
			* Feature group description shall clarify the interaction between Rel-18 power boosting capabilities and Rel-19 MPR applicability enhancement capability.
	+ FFS PC1.5 MPR enhancement as intra-band CA MPR requirements for PC1.5 are not available yet

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

* Proposals
	+ Proposal 1: activated CC CBW or aggregated CBW adopted for integral region and boundary of spurious emissions/ACLR/SEM depending on *dualPA-Architecture* IE indication.
	+ Proposal 2: Emission requirements are based on aggregated channel bandwidth also in case that only one CC is activated.
* WF
	+ FFS in next meeting

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

* Proposals
	+ Proposal 1: CA requirements of ACLR/SEM/SE should be applied for intra-band contiguous CA with single activated cell.
	+ Proposal 2:
		- For UE supporting contiguous ULCA with the dualPA IE:
			* The applicable SEM, ACLR and spurious emissions are the **single CC emissions** defined in Table 6.5.2.2-1, Table 6.5.2.4.1-1 and Table 6.5.3.1-2 respectively.
		- For UE supporting contiguous ULCA without signalling the dualPA IE or signalling PC1.5 or TxD or UL MIMO support:
			* The applicable SEM, ACLR and spurious emissions are the **configured contiguous ULCA**
	+ Proposal 1: After the initial configuration of contiguous ULCA, upon SCELL deactivation with only 1CC active, the applied SEM mask should be the aggregated CA BW SEM as stated in sub-clause 6.5A.2.2.1 in TS38.101-1. **Further discuss SEM mask for single CC fall back only if dualPA-architecture is supported**
	+ Proposal 3: Apply single carrier spurious emission/ACLR/SEM requirements for contiguous UL CA with only 1 CC transmitted.
* WF
	+ FFS in next meeting

#### **Issue 2-1-4: Whether UL interruption is allowed for intra-band contiguous CA with single activated cell**

* Proposals
	+ Proposal 1: No interruptions are allowed for enabling single carrier MPR for the case when only one CC is activated in intra-band contiguous UL CA.
* Agreement in AH
	+ Proposal 1

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

#### **Issue 2-2-1: Applicable MPR for FR1 intra-band non-contiguous UL CA**

* Proposals

**Option 1**: No spec impact or minimum spec impact with some clarification but no changes of requirements

* + 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**.
	+ Proposal 2: adding 1CC activation as a supplementary scenario in the spec but no changes of the requirements
	+ Proposal 3: **single CC MPR applied with single CC emission requirements**:

**Option 2**: Single CC MPR/SEM applied on indication of dualPA IE

* + Proposal 4: To apply **non-CA (single CC) MPR based on indication of dualPA IE**
	+ Proposal 5: After the initial configuration of non-contiguous ULCA, upon SCELL deactivation with only 1CC active, **the applied SEM mask should be the composite SEM** of the 2CCs as stated in sub-clause 6.5A.2.2.2 in TS38.101-1. Further discuss to support the single CC SEM only if dualPA-architecture is supported.

**Option 3**: Possible spec impact on LO retuning

* + Proposal 6: Discuss impact on requirements if LO needs to be re-configured to support single CC MPR. This discussion would be required for intra-band contiguous and non-contiguous carrier aggregation
* WF (to be discussed in main session)
	+ FFS on whether for PC2 and PC3, no MPR requirements to be changed.
	+ FFS PC1.5 when NC CA requirements are available
	+ FFS clarification for the applicable emission requirements whether they are single CC based or composite based
	+ ~~Further check whether LO retuning is out of WI scope, if not included, drop the corresponding discussion in Rel-19~~

Agreement:

* Drop the discussion for LO retuning for FR1 since it is out of WI scope.

Skyworks: We suggest for NC we could you single CC or composite ACLR.

Ericsson: Skyworks for Dual UL.

Huawei: for the first one, it was discussed for many meetings. Most of people think that there should be no change.

Ericsson: “no MPR” means what?

Huawei: There is requriements. And there is no differentiation between single Ul and dual UL. Ericsson proposed to distinguish the requirements for dual UL

# Topic #3: MPR applicability for FR2

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

Agreement in main session:

* + In general, with UE indication of new capability [FR2 MPR enhancements-R19] for MPR improvement, 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.
		- A note should be added to the MPR table, e.g.



* + For FR2-1, for 200MHz BW granularity, RAN4 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.

#### **Issue 3-2-1: Optional UE capability**

Agreement in main session:

* + An optional per UE capability for FR2 is introduced
		- The capability is implementation agnostic
		- Supporting FR2 MPR enhancement is applicable only from Rel-19

#### **Issue 3-2-2: CC activation-based MPR improvement**

* WF
	+ Further discuss activated based MPR improvement.
		- FFS using common UE capability between configuration based and activation based, or another UE capability for activated-based improvements.
		- FFS MPR can be determined based on activated UL CCs BW instead of Cumulative aggregated channel bandwidth (CABW). (i.e., activation based also applies to UL CA case)
		- FFS limitation the enhancement to cases where the activated UL CCs form a contiguous block.

# Reference: Description of scenarios from Topic #1

***Scenarios 1:***

***- 1-1****: Scenario with no adjacent in-band/out-of-band co-existence issue (single operator)*

*-* ***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*