

# Clarification on DC location reporting for intra-band UL CA



Huawei, HiSilicon

# Background

- In RAN #89-e, following agreement reached:

*Proposal: a mechanism of DC location reporting for intra-band UL CA **should be specified in Rel-16***

- *RAN2 is tasked to provide at least one RAN2-based signalling solution for **at least 2 UL CCs** of intra-band UL CA in FR1 to RAN#90, considering forward compatibility to other combinations (more than 2 UL CCs and/or FR2)*
- *Other solutions are not precluded and can be discussed in RAN1, RAN2 and RAN4. Selection between solutions can be discussed at RAN#90 or later (if possible).*

*Conclusion: proposal is endorsed*

# Discussion status in RAN2 and RAN4

- **RAN4 side:**
  - Only 2UL CCs contiguous CA configurations and requirements are defined for FR1 in Rel-16
  - Already agrees to focus on the affecting factors in Rel-16 captured in R4-2016817
    - The lowest and the highest CC configured
    - The lowest and the highest CC activated
    - active BWPs in the lowest and the highest CC activated
    - configured BWPs in the lowest and the highest CC

*Note: One example is provided in Annex*

- Further discuss other potential factors which have impact on DC location in Rel-17
- In R4-2016817, the baseline reporting method in Rel-16 was agreed as: report each TX DC location based on permutations of all possible simultaneously activated BWPs within configured BWPs.
- Potential advanced solutions to reduce the signaling overhead were also discussed in RAN4[1][2][3], but no consensus was reached yet and signaling design is out of RAN4's work range

***Observation 1: from RAN4's agreement on affecting factors of DC location, the RRC based signaling overhead for N UL CCs can be optimized at least to  $C_N^2 * 16$ , which is acceptable from RRC signaling design perspective.***

# Discussion status in RAN2 and RAN4-con'd

- **RAN2 side:**
  - RRC based signaling was considered as a common understanding in 1st week RAN2 discussion
  - RAN4's input on RF architecture impact to DC location is required by RAN2, but information is difficult to elaborate especially for >2 UL CCs case
    - For >2 UL CCs and UE indicates dual PA architecture cases, the relation between PA and how CCs/BWPs distributes are needed
    - In RAN2 discussion there is misunderstanding: if DC location is affected by activated CCs/BWPs, then reporting method cannot be by RRC based signaling
    - More info need to be clearly elaborated between RAN2 and RAN4 for >2 UL CCs case ...

***Observation2 : DC location reporting for >2 UL CCs cases need more time for RAN2 and RAN4 further study and collaborating with each other, the delay may have impact on commercialization of 2UL CCs case.***

# Proposals

*Proposal 1: Adopts RRC based signaling method for DC location reporting in Rel-16.*

*Proposal 2: Target to complete the Rel-16 RRC based DC location reporting signaling for 2 UL CCs in RAN#91e.*

*Proposal 3: For more than 2 UL CCs, advanced methods for signaling overhead reduction will be further discussed in Rel-17.*

*Add an objective(s) into Rel-17 FR1 UE RF requirement enhancement WI.*

# Reference

[1] R4-2015212, “More on DC location reporting for Intra band UL CA”, Nokia

[2] R4-2014714, “DC location future compatible proposal”, Qualcomm

[3] R4-2016514, “on FR1 UL CA DC location”, Huawei, HiSilicon

# Annex: One example method on RRC based signaling compression

## RRC based Signaling overhead calculating

### Before compression

- For **N UL CCs**, if Report Permutations of all possible simultaneously activated BWPs, The overhead is:

$$4^n + \underbrace{C_n^{n-1} 4^{n-1}}_{N=2} + \underbrace{C_n^{n-2} 4^{n-2} + \dots + C_n^2 4^2}_{N=3} \text{ when } n \geq 3$$

where 4 is number of BWPs for a CC

- $4^n$ : DC is affected by BWPs in N UL CCs
- $C_n^{n-1} 4^{n-1}$ : DC affected by BWPs in N-1 UL CCs
- $C_n^{n-2} 4^{n-2}$ : DC affected by BWPs in N-2 UL CCs
- ...
- $C_n^2 4^2$ : DC affected by BWPs in 2 UL CCs

### After compression

- Since RAN4 agrees that **the DC location is affected by lowest CC and highest CC**(BWP in lowest CC and BWP in highest CC)
- Assume the UE indicates DC location for CC1/CC4 pair, all the subset combinations with CC1/CC4 as lowest and highest bound (e.g. CC1/CC2/CC4, CC1/CC2/CC3/CC4, and CC1/CC3/CC4) will use the same DC location.
- For **N UL CCs**, the UE indicates possible DC locations for all the 2CCs pairs within the configured CA band combination and for each CC pair, and the UE indicates DC locations for all possible BWP pairs across CCs.

The signaling overhead after compression would be  $[C_n^2 * 4^2]$

2CC pairs	DC location for BWP pair1	DC location for BWP pair2	...	DC location for BWP pair16
CC1/CC2	Value	Value		Value
CC1/CC3	Value	Value		---
CC1/CCN	Value	Value		--
CC2/CC3	Value	Value		--
...	--	--		--

$C_N^2$

**Total signaling number =  $C_N^2 * 16$**

→ 16

Number of UL CC	Signaling overhead calculating	
	Before compression	After compression
2	16	16
3	112	48
4	480	96
...	...	
8	390592	448

# Thank you.

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