3GPP TSG-RAN WG1 Meeting #106-e Tdoc R1-20xxxxx

e-Meeting, 16th – 20th August, 2021

Agenda Item: 7.2.2

Source: Moderator (Ericsson)

Title: FL Summary for [106-e-NR-NRU-01] Email discussion/approval on CORSET configuration for wideband operation

Document for: Discussion, Decision

# 1 Introduction

According to the chair notes, the following e-mail discussion thread has been allocated:

[106-e-NR-NRU-01] Email discussion/approval on CORESET configuration for wideband operation (Issue T3) until August 20 – Steve (Ericsson)

Two contributions have been submitted on this topic with very similar proposals [1], [2].

# 2 Problem Description

## 2.1 From [2]

The following description of the issue is provided in [2].

In 38.213 Section 10.1, there is a procedure for the UE to determine the frequency domain resources of a CORESET, and the procedure depends on whether or not the Rel-16 RRC parameter *rb-Offset* is provided to the UE. The relevant text is as follows:

For each CORESET in a DL BWP of a serving cell, a respective *frequencyDomainResources* provides a bitmap

- if a CORESET is not associated with any search space set configured with *freqMonitorLocations*, the bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP bandwidth of $N\_{RB}^{BWP}$ PRBs with starting common RB position $N\_{BWP}^{start}$, where the first common RB of the first group of 6 PRBs has common RB index $6⋅\left⌈N\_{BWP}^{start}/6\right⌉$ if *rb-Offset* is not provided, or the first common RB of the first group of 6 PRBs has common RB index $N\_{BWP}^{start}+N\_{RB}^{offset}$ where $N\_{RB}^{offset}$ is provided by *rb-Offset.*

- if a CORESET is associated with at least one search space set configured with *freqMonitorLocations*, the first $N\_{RBG,set0}^{size}$ bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in each RB set $k$ in the DL BWP bandwidth of $N\_{RB}^{BWP}$ PRBs with starting common RB position $RB\_{s0+k,DL}^{start,μ} $ [6, TS 38.214], where the first common RB of the first group of 6 PRBs has common RB index $RB\_{s0+k,DL}^{start,μ}+N\_{RB}^{offset}$ and k is indicated by *freqMonitorLocations* if provided for a search space set; otherwise, $k=0$. $N\_{RBG,set0}^{size}=\left⌊(N\_{RB,set0}^{size}-N\_{RB}^{offset})/6\right⌋$, $N\_{RB,set0}^{size}$ is a number of available PRBs in the RB set 0 for the DL BWP, and $N\_{RB}^{offset}$ is provided by *rb-Offset* or $N\_{RB}^{offset}=0$ if *rb-Offset* is not provided. If a UE is provided RB sets in the DL BWP, the UE expects

The intention of the yellow highlighted text is that for either a Rel-15 UE or for a Rel-16 UE operating in licensed spectrum, the frequency domain resources of the CORESET should be configured in the legacy (Rel-15) manner, i.e., always aligned with the boundaries of a 6-CRB grid. Note that for such a UE operating in licensed spectrum, no search space set is configured with *freqMonitorLocations*.

The yellow text is supposed to be executed for the case when *rb-Offset* is not provided. However, according to 38.331, this condition never happens for a Rel-16 UE since the physical layer is always provided with a value for *rb-Offset* due to the following field description in 38.331:

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| ***rb-Offset***Indicates the RB level offset in units of RB from the first RB of the first 6RB group to the first RB of BWP (see 38.213 [13], clause 10.1). When the field is absent, the UE applies the value 0. |

The field description in 38.331 states that when the field is absent – meaning when the UE is not signaled *rb-Offset* from higher layers – the UE should apply the value of 0 for *rb-Offset*. In other words, for a Rel-16 UE, the physical layer is always provided a value for *rb-Offset*. According to the text from 38.213 above, this means that the yellow text is never executed, and instead, the cyan text is executed. The consequence is that the frequency domain resources of the CORESET are aligned with the CRB corresponding to the start of the BWP rather than the boundaries of the 6-CRB grid as in Rel-15. This is counter to previous RAN1 agreements (see 1st paragraph of the relevant agreement in Appendix A), and is not backwards compatible, thus unnecessarily complicating gNB and UE implementations.

## 2.2 From [1]

The following description of the issue is provided in [1].

In RAN1 100 e-meeting, the following was agreed for CORESET and SS set configuration for NR-U wideband operation [1]:

|  |
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| Agreement:* If CORESET *p* is not configured with *rb-offset*, and is not associated with any search space set configured with*freqMonitorLocation-r16*,
	+ The bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$, where the first common RB of the first group of 6 consecutive RBs has common RB index $6∙\left⌈{N\_{BWP}^{start}}/{6}\right⌉$, i.e., same as in Rel-15.
* If CORESET *p* is not configured with *rb-offset*, and is associated with at least one search space set configured with *freqMonitorLocation-r16*,
	+ The bits of the first A bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$ , where the first common RB of the first group of 6 consecutive RBs has common RB index $N\_{BWP}^{start}+rb-Offset$, where the UE assumes the default value *rb-Offset* = 0.
* If CORESET *p* is configured with *rb-offset*, and is not associated with any search space set configured with*freqMonitorLocation-r16*,
	+ The bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$ , where the first common RB of the first group of 6 consecutive RBs has common RB index $N\_{BWP}^{start}+rb-Offset$.
* If CORESET *p* is configured with *rb-offset*, and is associated with at least one search space set configured with *freqMonitorLocation-r16*,
	+ The bits of the first A bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$ , where the first common RB of the first group of 6 consecutive RBs has common RB index $N\_{BWP}^{start}+rb-Offset$.
* Note: A bits in above bullets is defined as floor({the number of available PRBs in the first RB set (accounting for *rb-Offset*) for the BWP}/6), as per previous agreement.
* TS 38.213 editor to implement this agreement
 |

According to the yellow highlighted and cyan highlighted text above, the default value ‘*rb-Offset = 0’* highlightedby magenta above is assumed for a COREEST by UE if the following two conditions are both met:

* **Condition 1:** The CORESET is not configured with *rb-offset (yellow color)*.
* **Condition 2:** The CORESET is associated with at least one search space set configured with *freqMonitorLocation-r16. (cyan Color)*

In other words, the default value ‘*rb-Offset = 0’* should not be assumed by UE if only one of two conditions is met (e.g., Condition 1 only). In particular, this agreement intends to apply Rel-15 behaviour for CORESET resource if Condition 1 is met but Condition 2 is not fulfilled (i.e., neither ‘*rb-offset*’ nor ‘*freqMonitorLocation-r16*’ is configured for a legacy CORESET).

**Observation 1: Per RAN1 agreement, the default value ‘rb-Offset = 0’ is assumed only for CORESET that is associated with at least one search space set configured with freqMonitorLocation-r16 and when the field ‘rb-Offset’ is absent.**

However, we have found that the field description in TS 38.331 is not aligned with the RAN1 agreement cited above, which was quoted below:

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| ***rb-Offset***Indicates the RB level offset in units of RB from the first RB of the first 6RB group to the first RB of BWP (see 38.213 [13], clause 10.1). When the field is absent the UE applies the value 0. |

According to the ‘rb-offset’ field description highlighted with yellow color, UE applies the default value ‘0’ for rb-offset if *rb-offset* IE is not provided (i.e., Condition 1 above only.) As one consequence, for a legacy CORESET without *freqMonitorLocation-r16, ‘rb-offset = 0’* is applied by the UE for this CORESET, which is not aligned with RAN1 agreement.

**Observation 2: Based on TS 38.331, default value ‘rb-Offset = 0’ is applied for a CORESET as long as the field ‘rb-Offset’ is absent, even none of associated search space sets is configured with freqMonitorLocation-r16.**

The consequence of the current field description is that it is not supported to fallback to Rel-15 behaviour for a CORESET that is NOT configured with freqMonitorLocation-r16 field and ‘rb-Offset’ field, considering relevant context in TS 38.213:

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| For each CORESET in a DL BWP of a serving cell, a respective *frequencyDomainResources* provides a bitmap - if a CORESET is not associated with any search space set configured with *freqMonitorLocations*, the bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP bandwidth of $N\_{RB}^{BWP}$ PRBs with starting common RB position $N\_{BWP}^{start}$, where the first common RB of the first group of 6 PRBs has common RB index $6⋅\left⌈N\_{BWP}^{start}/6\right⌉$ if *rb-Offset* is not provided, or the first common RB of the first group of 6 PRBs has common RB index $N\_{BWP}^{start}+N\_{RB}^{offset}$ where $N\_{RB}^{offset}$ is provided by *rb-Offset.* - if a CORESET is associated with at least one search space set configured with *freqMonitorLocations*, the first $N\_{RBG,set0}^{size}$ bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in each RB set $k$ in the DL BWP bandwidth of $N\_{RB}^{BWP}$ PRBs with starting common RB position $RB\_{s0+k,DL}^{start,μ} $ [6, TS 38.214], where the first common RB of the first group of 6 PRBs has common RB index $RB\_{s0+k,DL}^{start,μ}+N\_{RB}^{offset}$ and *k* is indicated by *freqMonitorLocations* if provided for a search space set; otherwise, $k=0$. $N\_{RBG,set0}^{size}=\left⌊(N\_{RB,set0}^{size}-N\_{RB}^{offset})/6\right⌋$, $N\_{RB,set0}^{size}$ is a number of available PRBs in the RB set 0 for the DL BWP, and $N\_{RB}^{offset}$ is provided by *rb-Offset* or $N\_{RB}^{offset}=0$ if *rb-Offset* is not provided.If a UE is provided RB sets in the DL BWP, the UE expects that the RBs of the CORESET are within the union of the PRBs in the RB sets of the DL BWP. |

According to the context in TS 38.213 cited above, if rb-Offset is provided (including either IE is provided or IE is not provided and UE assumes ‘rb-offset = 0’), UE always use the magenta text to derive the frequency location for a CORESET that is not associated with any search space set configured with *freqMonitorLocations* since *‘*rb-offset’ is always provided by higher layers based on current TS 38.331. In other word, fallback to Rel-15 for COREST without IE of ‘*rb-offset’* and without ‘*freqMonitorLocations*’ being configured is not supported.

# 3 Proposed Solutions

Both [1] and [2] have proposed two potential fixes for the issue as follows:

## 3.1 Alt-1: RAN2 Fix to Field Description in 38.331

The first alternative requires a modification of the field description for the *rb-Offset* parameter in 38.331 and no change to RAN1 specifications. This alternative will require an LS to RAN2.

The proposed change is as follows where the parameter *rb-Offset* is defined within the *ControlResourceSet* IE in 38.331.

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| ***rb-Offset***Indicates the RB level offset in units of RB from the first RB of the first 6RB group to the first RB of BWP (see 38.213 [13], clause 10.1). ~~When the field is absent, the UE applies the value 0.~~ |

In both [1] and [2] it is observed that this has solution the benefit of removing duplication between RAN2 and RAN1 specifications. The key point is that 38.213 Section 10.1 (see extract in Section 2.1 above) fully defines the UE behavior for the cases when *rb-Offset* is not provided. In the 2nd paragraph, the default value 0 is assigned explicitly, hence there is no need to duplicate this in the field description of *rb-Offset* in 38.331. Furthermore, in the 1nd paragraph, no default value is needed since the frequency domain resource assignment does not depend on *rb-Offset* when the parameter is not provided. In both [1] and [2], it is observed that the Alt-1 solution is consistent with the RAN1 agreement shown in Appendix A.

## 3.2 Alt-2: RAN1 Fix to 38.213

The second alternative requires a modification of the text in 38.213 Section 10.1. Please see Appendix B for the draft CR / TP proposed in [1] and [2]. This alternative requries no change to RAN2 specifications, and provides a "work-around" for the duplication between RAN1 and RAN2 specs.

## 3.3 <First Round Discussion>

Please provide feedback on the following two questions

**Question 1:** Do you agree that a fix is needed? If not, then please provide rationale.

**Question 2**: If you answer 'yes' for Queestion 1, then please indicate your preference for Alt-1 or Alt-2, or modification(s) thereof.

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| **Company** | **View/Position** |
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# References

1. R1-2107712 Correction on Wideband Operation for NRU Apple
2. R1-2107049 Correction related to wideband operation Ericsson

# Appendix A – Relevant RAN1 Agreement

RAN1 agreed on the following in RAN1#100-e:

Agreement:

* If CORESET *p* is not configured with *rb-offset*, and is not associated with any search space set configured with*freqMonitorLocation-r16*,
	+ The bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$, where the first common RB of the first group of 6 consecutive RBs has common RB index $6∙\left⌈{N\_{BWP}^{start}}/{6}\right⌉$, i.e., same as in Rel-15.
* If CORESET *p* is not configured with *rb-offset*, and is associated with at least one search space set configured with *freqMonitorLocation-r16*,
	+ The bits of the first A bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$ , where the first common RB of the first group of 6 consecutive RBs has common RB index $N\_{BWP}^{start}+rb-Offset$, where the UE assumes the default value *rb-Offset* = 0.
* If CORESET *p* is configured with *rb-offset*, and is not associated with any search space set configured with*freqMonitorLocation-r16*,
	+ The bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$ , where the first common RB of the first group of 6 consecutive RBs has common RB index $N\_{BWP}^{start}+rb-Offset$.
* If CORESET *p* is configured with *rb-offset*, and is associated with at least one search space set configured with *freqMonitorLocation-r16*,
	+ The bits of the first A bits of the 45-bit bitmap *frequencyDomainResources* of the CORESET *p* have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP with the starting common RB position $N\_{BWP}^{start}$ , where the first common RB of the first group of 6 consecutive RBs has common RB index $N\_{BWP}^{start}+rb-Offset$.
* Note: A bits in above bullets is defined as floor({the number of available PRBs in the first RB set (accounting for *rb-Offset*) for the BWP}/6), as per previous agreement.
* TS 38.213 editor to implement this agreement

# Appendix B – Draft CR from [2] / TP#1 from [1]

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| --- |
| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
|  |
|  | **38.213** | **CR** |  | **rev** | Error! Unknown document property name. | **Current version:** | Error! Unknown document property name. |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
|  |

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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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|  |
| ***Title:***  | Correction on CORESET configuration when UE is not signaled rb-Offset |
|  |  |
| ***Source to WG:*** | Ericsson |
| ***Source to TSG:*** | TSG RAN WG1 |
|  |  |
| ***Work item code:*** | NR\_unlic-Core |  | ***Date:*** | 2021-08-16 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-16 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** | If a Rel-16 UE operates in licensed spectrum, no search space set is configured with *freqMonitorLocations*. Additionally, if the parameter *rb-Offset* is not signaled by higher layers, the UE assumes a default value of 0 according to 38.331; in other words, a value of *rb-Offset* is always provided to the physical layer. In this case, the frequency domain resources of a CORESET associated with the search space set(s) cannot be aligned with the boundaries of the 6-CRB grid as in Rel-15 unless the BWP also starts on the 6-CRB grid. This is counter to previous RAN1 agreements, incurs significant reduction in gNB flexibility, and is not backwards compatible to Rel-15. |
|  |  |
| ***Summary of change:*** | Change the wording "if *rb-Offset* is not provided" to "if *rb-Offset* is not signaled by higher layers" to ensure that legacy (Rel-15) CORESET configuration is achievable for a Rel-16 UE. |
|  |  |
| ***Consequences if not approved:*** | Frequency domain resources of a CORESET for a Rel-16 UE cannot be aligned to the 6-CRB grid as in Rel-15. |
|  |  |
| ***Clauses affected:*** | 10.1 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\*\*\* Unchanged text omitted \*\*\*

For each CORESET in a DL BWP of a serving cell, a respective *frequencyDomainResources* provides a bitmap

- if a CORESET is not associated with any search space set configured with *freqMonitorLocations*, the bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in the DL BWP bandwidth of $N\_{RB}^{BWP}$ PRBs with starting common RB position $N\_{BWP}^{start}$, where the first common RB of the first group of 6 PRBs has common RB index $6⋅\left⌈N\_{BWP}^{start}/6\right⌉$ if *rb-Offset* is not signaled by higher layers; otherwise, the first common RB of the first group of 6 PRBs has common RB index $N\_{BWP}^{start}+N\_{RB}^{offset}$ where $N\_{RB}^{offset}$ is provided by *rb-Offset.*

- if a CORESET is associated with at least one search space set configured with *freqMonitorLocations*, the first $N\_{RBG,set0}^{size}$ bits of the bitmap have a one-to-one mapping with non-overlapping groups of 6 consecutive PRBs, in ascending order of the PRB index in each RB set $k$ in the DL BWP bandwidth of $N\_{RB}^{BWP}$ PRBs with starting common RB position $RB\_{s0+k,DL}^{start,μ} $ [6, TS 38.214], where the first common RB of the first group of 6 PRBs has common RB index $RB\_{s0+k,DL}^{start,μ}+N\_{RB}^{offset}$ and *k* is indicated by *freqMonitorLocations* if provided for a search space set; otherwise, $k=0$. $N\_{RBG,set0}^{size}=\left⌊(N\_{RB,set0}^{size}-N\_{RB}^{offset})/6\right⌋$, $N\_{RB,set0}^{size}$ is a number of available PRBs in the RB set 0 for the DL BWP, and $N\_{RB}^{offset}$ is provided by *rb-Offset* or $N\_{RB}^{offset}=0$ if *rb-Offset* is not provided.If a UE is provided RB sets in the DL BWP, the UE expects that the RBs of the CORESET are within the union of the PRBs in the RB sets of the DL BWP.

\*\*\* Unchanged text omitted \*\*\*