3GPP TSG-RAN WG2 #109-e R2-200xxxx

**Electronic meeting, 24th February – 6th March, 2020**

Agenda Item: 6.22.3

Source: Ericsson

Title: Summary on [AT109e][064][URLLC] MAC CEs (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This document summarizes the outcome of the following at-meeting email discussion

* **[AT109e][064][URLLC] MAC CEs (Ericsson)**

Intended outcome: Treat R2-2000799, resolve issues, if any. Find OIs, if any.

Deadline: Mar 3 1200 CET

# 2 Discussion

RAN1 has introduced a parameter list for eURLLC WI [2] and they are discussed in the RRC running CR [3][4]. There are MAC CEs that identified to be impacted by this parameter list, discussed in the paper [1].

In what below, we invite companies to provide views on the two identified MAC CEs.

## 2.1 Aperiodic CSI Trigger State Subselection MAC CE

To support mixed traffic of URLLC and eMBB, two new DCI formats are introduced in eURLLC WI: DCI format 0\_2 for uplink scheduling and DCI format 1\_2 for downlink scheduling. Similar to the existing non-fallback DCI format 0\_1, DCI format 0\_2 can also be used to trigger CSI reporting. The “CSI request” field is included in DCI format 0\_2, where the “CSI request” field width (0, 1, 2, 3, 4, 5, or 6 bits) is determined by higher layer parameter *reportTriggerSize-ForDCIFormat0\_2*. Procedure similar to that of DCI format 0\_1 is also to apply to CSI request of DCI format 0\_2.

In the RAN1 parameter list [2], eURLLC WI introduces another list, named *aperiodicTriggerStateListForDCI-Format0-2-r16*, of these aperiodic trigger states in addition to the original list named *aperiodicTriggerStateList*. This new field is added in the IE *CSI-MeasConfig*.

There is a MAC CE on aperiodic CSI trigger state sub-selection (see subclause 6.1.3.13, TS 38.321). The fields are:

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| - Serving Cell ID: This field indicates the identity of the Serving Cell for which the MAC CE applies. The length of the field is 5 bits;  - BWP ID: This field indicates a DL BWP for which the MAC CE applies as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9]. The length of the BWP ID field is 2 bits;  - Ti: This field indicates the selection status of the Aperiodic Trigger States configured within *CSI-aperiodicTriggerStateList*, as specified in TS 38.331 [5]. T0 refers to the first trigger state within the list, T1 to the second one and so on. If the list does not contain entry with index i, MAC entity shall ignore the Ti field. The Ti field is set to 1 to indicate that the Aperiodic Trigger State i shall be mapped to the codepoint of the DCI *CSI request* field, as specified in TS 38.214 [7]. The codepoint to which the Aperiodic Trigger State is mapped is determined by its ordinal position among all the Aperiodic Trigger States with Ti field set to 1, i.e. the first Aperiodic Trigger State with Ti field set to 1 shall be mapped to the codepoint value 1, second Aperiodic Trigger State with Ti field set to 1 shall be mapped to the codepoint value 2 and so on. The maximum number of mapped Aperiodic Trigger States is 63;  - R: Reserved bit, set to 0.    Figure 6.1.3.13-1: Aperiodic CSI Trigger State Subselection MAC CE |

There are two lists in one BWP and the UE might be configured to monitor both DCI formats, i.e., DCI format 0\_1 and DCI format 0\_2 (see the field dci-FormatsExt-r16 in RRC running CR). Rel-15 MAC CE cannot distinguish which list the MAC CE refers to. We first need to reach a common understanding that whether this is an issue that needs to be solved.

**Question 1: Do companies agree the following observations: 1) both lists for aperiodic trigger state can be in-use simultaneously; 2) current MAC CE cannot distinguish which list the MAC CE refers to? If not, please explain the operation with the two lists.**

|  |  |  |
| --- | --- | --- |
| Company | [yes/no] | Comment |
| HW | Yes | According to RAN1 agreement, both DCI format 0\_1 and 0\_2 can be used to trigger a-CSI reporting on corresponding PUSCH where each DCI can be configured with an a-CSI trigger state lists. It is possible the case that UE is configured to monitor both DCI for one BWP for mixed traffic. |
| Qualcomm | Yes | We have the same understanding as HW. |
| Ericsson | Yes |  |
| Nokia | Yes | RAN1 agreed to have different *reportTriggerSize* for CSI reporting on PUSCH that is separately configurable for DCI format 0\_2 Therefore, the number of bits of the CSI request field in DCI format 0\_2, which is used to trigger A-CSI and semi-persistent CSI reporting on PUSCH, may be smaller or larger CSI request field for DCI format 0\_2 compared to DCI format 0\_1. Therefore, identification of the targeted DCI format is needed in the MAC CE. |
| CATT | Yes | Observation 1 is a RAN1 assumption. Observation 2 is incurred by observation 1. |
| Samsung | Yes |  |

If the Question 1 is agreed, then there is a need to update the Rel-15 Aperiodic CSI Trigger State Subselection MAC CE. Some options have been discussed in [1][3] and listed below

1. Introduce a new MAC CE to indicate format 0\_2
2. Reuse one reserved bit in Rel-15 MAC CE to indicate one of the two lists
3. Change the field description in Rel-15 MAC CE so that one MAC CE is used to control Aperiodic Trigger State Lists for both DCI formats. This may lose the flexibility of the separate configurations of this list for both DCI formats

**Question 2: If Question 1 is agreed, which option do companies prefer to solve this issue?**

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| --- | --- | --- |
| Company | Option | Additional comments if any |
| HW | 3 or nothing | The critical intention of introducing DCI format 0\_2 is for a compact DCI with a reduced size for enhanced reliability. In our understandings, separate configuration of a-CSI triggers lists is a bit over-designed for a separate DCI. So far we haven’t seen a strong need to have a separate MAC CE to control different DCI format, which also breaks the principle we follow that the MAC spec is agonistic to the DCI format. Given the field size of “CSI request” can be different for DCI 0\_1 and 0\_2 by configurations, we can simply keep one MAC CE to control both lists following the same codepoint rule. We believe it is sufficient in this release. |
| Qualcomm | 2 | We prefer Option 2, because it offers more flexibility than Option 3 and less complexity than Option 1. |
| Ericsson | 2 | RAN1 has agreed to introduce two lists and so we prefer not putting any restriction how these are used in RAN2, as in option 3.  Between option 1 and option 2, we prefer option 2 since there is a reserved bit. |
| Nokia | 2 | Option 2 is more flexible for the UE to identify which DCI format that this MAC CE is targeting at. Option 1 also works but it would take another LCID, so we prefer Option 2. |
| CATT | 2 | Considering different MAC list corresponds to different RRC list, option 3 is not a reasonable way. Option 2 is preferred since it doesn’t occupy another LCID value. |
| Samsung | 1 or 2 | Since LCID space is going to be extended, 1 seems clean solution. We are also fine with Option 2. |

## 2.2 PUCCH spatial relation Activation/Deactivation MAC CE

RAN1 has the following agreement:

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| --- |
| Agreements:  When at least two HARQ-ACK codebooks are simultaneously constructed for supporting different service types for a UE, following can be separately configured for different HARQ-ACK codebooks:   * *PUCCH-SpatialRelationInfo* * Sub-slot configuration (only applied for the sub-slot-based HARQ-ACK codebook)   FFS whether or not to support the case when there are at least two HARQ-ACK codebooks configured with sub-slots, with the same or different sub-slot configurations |

PUCCH spatial relation Activation/Deactivation MAC CE (see subclause 6.1.3.18 in TS 38.321) is used to indicate which element of the list can be activated per PUCCH resource.

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| --- |
| The PUCCH spatial relation Activation/Deactivation MAC CE is identified by a MAC subheader with LCID as specified in Table 6.2.1-1. It has a fixed size of 24 bits with following fields:  - Serving Cell ID: This field indicates the identity of the Serving Cell for which the MAC CE applies. The length of the field is 5 bits;  - BWP ID: This field indicates a UL BWP for which the MAC CE applies as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9]. The length of the BWP ID field is 2 bits;  - PUCCH Resource ID: This field contains an identifier of the PUCCH resource ID identified by *PUCCH-ResourceId* as specified in TS 38.331 [5]. The length of the field is 7 bits;  - Si: If there is a PUCCH Spatial Relation Info with *PUCCH-SpatialRelationInfoId* as specified in TS 38.331 [5], configured for the uplink bandwidth part indicated by BWP ID field, Si indicates the activation status of PUCCH Spatial Relation Info with *PUCCH-SpatialRelationInfoId* equal to i+1, otherwise MAC entity shall ignore this field. The Si field is set to 1 to indicate PUCCH Spatial Relation Info with *PUCCH-SpatialRelationInfoId* equal to i+1 shall be activated. The Si field is set to 0 to indicate PUCCH Spatial Relation Info with *PUCCH-SpatialRelationInfoId* equal to i+1 shall be deactivated. Only a single PUCCH Spatial Relation Info can be active for a PUCCH Resource at a time;  - R: Reserved bit, set to 0.    **Figure 6.1.3.18-1: PUCCH spatial relation Activation/Deactivation MAC CE** |

The PUCCH spatial relation Activation/Deactivation MAC CE indicates the activation status of the elements in PUCCH spatial relation info list. Now there are two PUCCH spatial relation lists for two different HARQ ACK codebooks, and thus it needs further discussion which list the MAC CE refers to. Similar to above, we first need to reach a common understanding that whether this is an issue that needs to be solved.

**Question 3: Do companies agree the following observations: 1) both PUCCH spatial relation lists can be in-use simultaneously; 2) current MAC CE cannot distinguish which list the MAC CE refers to? If not, please explain the operation with the two lists.**

|  |  |  |
| --- | --- | --- |
| Company | [yes/no] | Comment |
| HW | Yes with minor update to MAC CE description | It depends on whether the PUCCH Resource ID is sufficient to identify a PUCCH spatial relation list, i.e. it is unique across two PUCCH configuration lists and cannot be the same. In this case, it is clear to determine the corresponding PUCCH spatial relation list based on the PUCCH Resource ID indicated in the MAC CE. As far as I am concerned, RAN1 initiated the email discussion [02] on the clarifications for the two HARQ-ACK codebooks and it already covers the PUCCH Resource ID issue. So we suggest to hold the discussions in RAN2 and wait for further inputs from RAN1 to avoid redundancy. If so, maybe we only need to have minor update to the MAC CE description, e.g. If there is a PUCCH Spatial Relation Info with *PUCCH-SpatialRelationInfoId* corresponding to the PUCCH Resource ID |
| Qualcomm | Yes | Agree with HW’s suggestion to wait until RAN1 finishes their discussion. |
| Ericsson | Yes |  |
| Nokia | Yes |  |
| CATT | Yes |  |
| Samsung | Yes |  |

If companies agree on the above question, in a parallel discussion on NR eMIMO WI, extension on PUCCH *spatialRelatoinInfoToAddMostList* is mentioned. Paper [1] proposes to design one MAC CE to include both extensions. Details on how to sort these out can be further discussed among session chairs, WI rapporteurs and spec rapporteurs.

**Question 4: Do companies agree to jointly design PUCCH spatial relation activation/de-activation MAC CE for Rel-16 eURLLC WI and Rel-16 eMIMO WI, if both are identified to be needed?**

|  |  |  |
| --- | --- | --- |
| Company | [yes/no] | Comment |
| HW | Yes but | On condition that we need to update the MAC CE for URLLC. |
| Qualcomm | Yes | We prefer to have a single MAC CE to support new extentions. |
| Ericsson | Yes |  |
| Nokia | Yes | It makes more sense to have a common MAC CE |
| CATT | Yes |  |
| Samsung | Yes | One WI should lead the discussion to avoid the duplicated discussion. |

In the RRC running CR email discussion, companies are aligned that this is an issue that needs to be resolved. But there are different proposals on how to resolve this issue, due to different understanding of RAN1 agreements. An RAN2 agreement without RAN1 input might be contentious. We would first like to understand if companies are aligned that a clarification is needed and then aim to have a better understanding of each option discussed in [1][3].

In the RAN1 parameter list, it is agreed to have two PUCCH-Config to support two lists of PUCCH spatial relation info, see comments below.

|  |
| --- |
| *Rapporteur Note: We don’t have agreement on whether to do separate configuration for schedulingRequestResourceToAddModList and multi-CSI-PUCCH-ResourceList yet. However, we agreed to do separate configuration for all the remaining RRC parameter. From RRC parameter implementation perspective, it seems easier to introduce separate PUCCH-Confi for different HARQ-ACK codebooks. If there is no need to do separate configuration for schedulingRequestResourceToAddModList and multi-CSI-PUCCH-ResourceList, the corrsponding configuration can not include these two optional parameters and then in RAN1 spec can indicate that SR PUCCH resource and multi-CSI PUCCH resource can just follow the configuration in one of the PUCCH configurations****.*** |

Thus, it is not clear whether the maximum number of PUCCH resources in one BWP (i.e., maxNrofPUCCH-Resources=128) is also doubled or the maximum number of PUCCH resources in one BWP is not doubled but rather kept the same as in Rel-15. This is not clearly discussed in RAN1.

Because this has relation to the one of the options in the MAC CE discussion, and also RRC implementation impact on the *PUCCH-CSI-Resource, SchedulingRequestResourceConfig, SPS-Config* which also refer to the PUCCH ID, the paper [1] proposes to send an LS to RAN1 to ask for further clarification on the maximum number of PUCCH resource per BWP when two HARQ-ACK codebooks are configured.

**Question 5a: Do companies agree that RAN1 needs to clarify the maximum number of PUCCH resource per BWP when two HARQ-ACK codebooks are configured?**

|  |  |  |
| --- | --- | --- |
| Company | [yes/no] | If no, why |
| HW | Yes |  |
| Qualcomm | Yes |  |
| Ericsson | Yes |  |
| Nokia | Yes |  |
| CATT | Yes |  |
| Samsung | Yes |  |

**Question 5b: Do companies agree to send an LS to RAN1 to ask for clarification?**

|  |  |  |
| --- | --- | --- |
| Company | [yes/no] | If no, why |
| HW |  | As commented above, RAN1 has initiated the relevant email discussions. Can wait for the conclusions.  From RAN2 perspective, we suggest to keep the maximum number as it was because the upper bound of 128 is sufficient large from our understanding for one BWP. Otherwise we may need to introduce the capability signaling and it will make the RRC spec more complex by indicating the corresponding PUCCH config list in many IEs everywhere applicable without any clear benefit. |
| Qualcomm | No | Wait for RAN1 input, since RAN1 is already discussing it |
| Ericsson |  | We are fine to wait for RAN1 input to see if a LS is needed. |
| Nokia |  | Wait for RAN1 |
| CATT | No | Wait for RAN1 |
| Samsung | No | RAN1 discussion is ongoing. |

Lastly, we would like to collect views to have a better understanding of each option discussed in [1][3].The following two options are mentioned:

**Option 1**: The PUCCH resource ID is unique across two PUCCH configurations for two HARQ-ACK codebooks, and thus the UE can determine the corresponding PUCCH Spatial Relation Info List based on the associated PUCCH resource ID indicated in the MAC CE.

* + This option requires that RAN1 replies that the maximum number of PUCCH resource per BWP is the same as Rel-15 when two HARQ-ACK codebooks are configured. For RAN2, it requires RRC field description clarification that the PUCCH resource ID is unique.

**Option 2:** Introduce an explicit indication for one of the two lists, e.g., by a new MAC CE, or using a reserved bit in the MAC CE, or a joint-design with Rel-16 eMIMO MAC CE and etc.

* + This option does not require RAN1 clarification. It is cleaner to write the spec, but it needs one-extra-bit indication compared to option 1 in case RAN1 reply that the maximum number of PUCCH resource per BWP is the same as Rel-15 when two HARQ-ACK codebooks are configured.

**Question 6: Companies are invited to provide inputs on the above two options. Further options can be added in the table.**

|  |  |  |
| --- | --- | --- |
| Company | Option | Support or not, comments, etc |
| HW | Option 1 | Wait for more RAN1 input based on RAN1 on-going email discussions.  From RAN2 perspective, we believe Option 1 is sufficient with comments above. |
| Qualcomm | - | Wait for RAN1’s decision. |
| Ericsson | Option 2 | We prefer option 2, but we are okay to wait for RAN1 input. |
| Nokia |  | Wait for RAN1 |
| CATT |  | Wait for RAN1 |
| Samsung |  | Wait for RAN1 |

# 4 Conclusion

# 5 References

1. R2-2000799, on MAC CE design for eURLLC, Ericsson
2. R1-1913674, Updated consolidated parameter list for Rel-16 NR
3. R2-2001356, Report of [108#112][URLLC] RRC running CR, Huawei
4. R2-2001357, Running 38.331 CR for NR\_L1enh\_URLLC, Huawei