**3GPP TSG RAN WG1 #106e R1-** **210xxxx**

**August 16th – 27th, 2021**

**Agenda item:** 7.2.5

**Source:** Moderator (Qualcomm)

**Title:** Summary of [106-e-NR-L1enh-URLLC-14] Discussion on Two PUCCH Capability

**Document for:** Discussion and Decision

# 1 Introduction

This document presents the companies proposals and discussions regarding the following email discussion:

* [106-e-NR-L1enh-URLLC-14] Discussion on two PUCCH capability (R1-2106407) by August 25 – Kianoush (Qualcomm)

In [1], RAN1 asked RAN2 whether the following statements for a UE configured with two slot-based HARQ codebooks are misplaced:

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| --- |
| ***twoPUCCH-Type5-r16***  Indicates whether the UE supports two PUCCH of format 0 or 2 for two HARQ-ACK codebooks with one 7\*2-symbol subslot based HARQ-ACK codebook. When simultaneously configured with two slot-based HARQ-ACK codebooks, the capability for each HARQ-ACK codebook is subjected to the capability reported by *twoPUCCH-F0-2-ConsecSymbols.*  ***twoPUCCH-Type6-r16***  Indicates whether the UE supports two PUCCH of format 0 or 2 in consecutive symbols for two HARQ-ACK codebooks with one 2\*7-symbol subslot based HARQ-ACK codebook. When simultaneously configured with two slot-based HARQ-ACK codebooks, the capability for each HARQ-ACK codebook is subjected to the capability reported by twoPUCCH-F0-2-ConsecSymbols.  ***twoPUCCH-Type8-r16***  Indicates whether the UE supports one PUCCH format 0 or 2 and one PUCCH format 1, 3 or 4 in the same subslot for HARQ-ACK codebooks with one 2\*7-symbol subslot based HARQ-ACK codebook. When simultaneously configured with two slot-based HARQ-ACK codebooks, the capability for each HARQ-ACK codebook is subjected to the capability reported by onePUCCH-LongAndShortFormat.  ***twoPUCCH-Type10-r16***  Indicates whether the UE supports two PUCCH transmissions in the same subslot for two HARQ-ACK codebooks with one 2\*7-symbol subslot which are not covered by *twoPUCCH-Type5-r16* and *twoPUCCH-Type7-r16*. When simultaneously configured with two slot-based HARQ-ACK codebooks, the capability for each HARQ-ACK codebook is subjected to the capability reported by *twoPUCCH-AnyOthersInSlot.* |

In [2], RAN2 responded with the following modifications:

| ***twoHARQ-ACK-Codebook-type1-r16***  Indicates whether the UE supports two HARQ-ACK codebooks with up to one subslot based HARQ-ACK codebook (i.e. slot-based + slot-based, or slot-based + subslot based) simultaneously constructed for supporting HARQ-ACK codebooks with different priorities at a UE. The capability signalling comprises the following parameters:  -     *sub-SlotConfig-NCP-r16* indicates the maximum number of actual PUCCH transmissions for HARQ-ACK within a slot for NCP with 2-symbol\*7 sub-slot configuration;  -     *sub-SlotConfig-ECP-r16* indicates the maximum number of actual PUCCH transmissions for HARQ-ACK within a slot for ECP with 2-symbol\*6 sub-slot configuration;  For the 7-symbol\*2 sub-slot configuration of NCP or the 6-symbol\*2 sub-slot configuration of ECP, the value of the maximum number of actual PUCCH transmissions for HARQ-ACK within a slot is {2}.  NOTE 1:   If the UE indicates support of this feature and is simultaneously configured with two slot-based HARQ-ACK codebooks:   * whether the UE supports two PUCCH of format 0 or 2 for each HARQ-ACK codebook is subjected to the capability reported by *twoPUCCH-F0-2-ConsecSymbols.* * whether the UE supports two PUCCH of format 0 or 2 in consecutive symbols for each HARQ-ACK codebook is subjected to the capability reported by *twoPUCCH-F0-2-ConsecSymbols.* * whether the UE supports one PUCCH format 0 or 2 and one PUCCH format 1, 3 or 4 in the same subslot for each HARQ-ACK codebook is subjected to the capability reported by *onePUCCH-LongAndShortFormat*. * whether the UE supports two PUCCH transmissions in the same subslot for each HARQ-ACK codebook is subjected to the capability reported by *twoPUCCH-AnyOthersInSlot.*     NOTE 2:   If a UE reports both *multiPUCCH-r16* and *twoHARQ-ACK-Codebook-type1-r16*, it can support two slot-based HARQ-ACK codebooks, and one slot-based and one-sub-slot-based HARQ-ACK codebooks. If a UE reports *twoHARQ-ACK-Codebook-type1-r16* but does not report *multiPUCCH-r16*, it can only support two slot-based HARQ-ACK codebooks. | FS | No | N/A | N/A |
| --- | --- | --- | --- | --- |

# 2 First Round of Discussions

This section summarizes the inputs from the companies on the potential edits required for NOTE 1 of *twoHARQ-ACK-Codebook-type1-r16* UE feature*.*

**Question 1: Do you agree that in the following two statements, “subslot” should be replaced by “slot”?**

* whether the UE supports one PUCCH format 0 or 2 and one PUCCH format 1, 3 or 4 in the same subslot for each HARQ-ACK codebook is subjected to the capability reported by *onePUCCH-LongAndShortFormat*.
* whether the UE supports two PUCCH transmissions in the same subslot for each HARQ-ACK codebook is subjected to the capability reported by *twoPUCCH-AnyOthersInSlot.*

|  |  |
| --- | --- |
| Company | Comment |
| Apple | Agree |
| Ericsson | Agree |
| HW/HiSi | Agree |
| ZTE | Agree |
| Qualcomm | Agree |

**Question 2: Do you agree that the first and the second sub-bullets are duplicated and keeping only the second one is sufficient?**

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| --- | --- |
| Company | Comment |
| Apple | Agree |
| Ericsson | Agree |
| HW/HiSi | Agree |
| ZTE | Agree |
| Qualcomm | Agree |

**Question 3: Do you agree to update the second sub-bullet (and the first sub-bullet in case it is kept) as follows:**

* whether the UE supports two PUCCH of format 0 or 2 for each HARQ-ACK codebook in the same slot is subjected to the capability reported by *twoPUCCH-F0-2-ConsecSymbols.*
* whether the UE supports two PUCCH of format 0 or 2 in consecutive symbols for each HARQ-ACK codebook in the same slot is subjected to the capability reported by *twoPUCCH-F0-2-ConsecSymbols.*

|  |  |
| --- | --- |
| Company | Comment |
| Apple | Agree |
| Ericsson | Agree |
| HW/HiSi | Agree |
| ZTE | Agree |
| Qualcomm | Agree |

**Question 4: Do you think any other modification is needed? Please share your view in the table below.**

|  |  |
| --- | --- |
| Company | Comment |
| Apple | We would like to propose an additional change to the last sub-bullet to avoid any potential confusion:   * whether the UE supports two PUCCH transmissions in the same ~~sub~~slot for each HARQ-ACK codebook not covered by *twoPUCCH-F0-2-ConsecSymbols* and *onePUCCH-LongAndShortFormat* is subjected to the capability reported by *twoPUCCH-AnyOthersInSlot.* |
| Ericsson | 1. We think the existing sentences incorrectly describe “two PUCCH … for each HARQ-ACK codebook …”. The following changes are suggested for below:  * whether the UE supports two PUCCH of format 0 or 2, one PUCCH for each HARQ-ACK codebook, in the same slot is subjected to the capability reported by *twoPUCCH-F0-2-ConsecSymbols.* * whether the UE supports two PUCCH of format 0 or 2 in consecutive symbols, one PUCCH for each HARQ-ACK codebook, in the same slot is subjected to the capability reported by *twoPUCCH-F0-2-ConsecSymbols.* * whether the UE supports one PUCCH format 0 or 2 and one PUCCH format 1, 3 or 4 in the same slot, one PUCCH for each HARQ-ACK codebook, is subjected to the capability reported by *onePUCCH-LongAndShortFormat*. * whether the UE supports two PUCCH transmissions in the same slot, one PUCCH for each HARQ-ACK codebook, is subjected to the capability reported by *twoPUCCH-AnyOthersInSlot.*   (Note: as discussed in Question 2, first bullet can be deleted)   1. We also agree with the clarification suggested by Apple/Huawei above |
| HW/HiSi | We have question regarding E/// comment mentioned in the email: “*We also suggested an additional change to avoid the confusion that there are 4 PUCCH in the slot. My understanding is, there is one PUCCH for each HARQ-ACK codebook, for a total of two PUCCH, in the same slot. Please let me know if you share the same understanding*.”  Actually we have this 4 PUCCH confusion mentioned by Ericsson. Isn’t it so that If the UE reports this capability, then it supports two PUCCHs for each priority? But only one PUCCH from each priority is used for HARQ-ACK, but there could more PUCCHs carrying e.g. CSI or SR?  It would be great to hear the views from other companies on this. |
| ZTE | Agree with the clarification suggested by Apple.  Regarding the comment from Ericsson, we have similar understanding as HW/HiSi. For this UE capability, a UE can support two PUCCHs for each HARQ-ACK codebook, in total of 4 PUCCHs. |
| Qualcomm | Agree with the proposal on the addition of “not covered by twoPUCCH-F0-2-ConsecSymbols and onePUCCH-LongAndShortFormat” to the last bullet. |
| Nokia/NSB | Agree to the additional clarifications by Apple, but not with the additions by Ericsson with the same understanding as HW/HiSi & ZTE |
| Ericsson2 | Regarding 4 PUCCH total or 2 PUCCH total:   * We can all agree there are a total of 2 PUCCH for HARQ-ACK, with 1 per priority. * The confusion is about PUCCH for other UCI (e.g., CSI, SR) then.   1. Ericsson view is, the bullets in notes only address PUCCH carrying HARQ-ACK. Total PUCCH in a slot = {2 PUCCH for HARQ-ACK (1 for each priority), X PUCCH for other UCI},. X is not addressed in the bullets.      + Hence, for example, in bullet 3, *onePUCCH-LongAndShortFormat* is for the two PUCCH for HARQ-ACK, one long, one short.      + Bullet 3: “whether the UE supports one PUCCH format 0 or 2 and one PUCCH format 1, 3 or 4 in the same slot, one PUCCH for each HARQ-ACK codebook, is subjected to the capability reported by *onePUCCH-LongAndShortFormat*.”  | ***onePUCCH-LongAndShortFormat***  Indicates whether the UE supports transmission of one long PUCCH format and one short PUCCH format in TDM in the same slot. | | --- |  * 1. The other view is, the bullets address PUCCH for ACK as well as PUCCH for other UCI. Total PUCCH in a slot = { 2 \* [1 PUCCH for HARQ-ACK, 1 PUCCH for other UCI] } = {2 PUCCH for HARQ-ACK (1 for each priority), 2 PUCCH for other UCI}.   Based on 11-4 description (copied from R1-2104120) below, (b) is not valid. 11-4 clearly says: “The number of PUCCHs for CSI reporting per slot is not impacted compared with Rel-15 by introducing the new HARQ-ACK CBs”. Thus 11-4 does not require the UE to be able to report 2 PUCCH for CSI in a slot, in addition to 2 PUCCH for HARQ-ACK in the slot. |

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| 11.  NR\_L1enh\_URLLC | 11-4 | Two HARQ-ACK codebooks with up to one sub-slot based HARQ-ACK codebook (i.e. slot-based + slot-based, or slot-based + sub-slot based) simultaneously constructed for supporting HARQ-ACK codebooks with different priorities at a UE | 1. Supports two HARQ-ACK codebooks with different priorities to be simultaneously constructed with the restriction up to one sub-slot based HARQ-ACK codebook. 2. Supports separate PUCCH configuration for different HARQ-ACK codebooks 3. Supports 2-level priority of HARQ-ACK for dynamically scheduled PDSCH and SPS PDSCH. 4. Supports a DCI format (from the formats 1\_1/1\_2) scheduling PDSCH with different HARQ-ACK priorities when only DCI format 0\_1/1\_1 is configured or only DCI format 0\_2/1\_2 is configured per BWP 5. Supports separate configuration of parameters PDSCH-HARQ-ACK-Codebook, UCI-OnPUSCH and ‘codeBlockGroupTransmission” for different HARQ-ACK codebooks. 6. Supported maximum number of actual PUCCH transmissions for HARQ-ACK within a slot   Candidate values for the component 6 of FG11-4 is: For NCP, {4, 5, 6, 7} for 2-symbol\*7 sub-slot configuration; For ECP, the candidate value is {4,5,6} for 2-symbol\*6 sub-slot configuration. | Per FS  Per FS is selected because in bands or BCs with large number of carriers or large BW, the UE’s procesing power is spent on PDCCH/PDSCH decoding, and hence in some cases the support of the new codebook or some codebook configurations may not be possible | If a UE reports both 11-3 and 11-4, it can support two slot-based HARQ-ACK codebooks, and one slot-based and one-sub-slot-based HARQ-ACK codebooks. If a UE reports 11-4 but not 11-3, it can only support two slot-based HARQ-ACK codebooks.  The number of PUCCHs for CSI reporting per slot is not impacted compared with Rel-15 by introducing the new HARQ-ACK CBs  Component 6 is applied to the sub-slot HARQ-ACK codebook. It is assumed that only 1 actual PUCCH transmission for HARQ-ACK within a slot for slot-based HARQ-ACK codebook.   * Component 6 is reported for 2-symbol\*7 sub-slot configuration. For 7-symbol\*2 sub-slot configuration, the value of component 6 is {2} for both NCP and ECP cases. * For component 6, maximum of 1 actual PUCCH transmission for HARQ-ACK within a slot for slot-based HARQ-ACK codebook. Thus value reported for component 6 has no meaning for “slot-based + slot based”. |

## 2.2 A summary of the First Round of Discussions

TBD

# 3 Second Round of Discussions

TBD

## 3.2 A Summary of the Second Round of Discussions

TBD

# 4 References

**[1] R1-2104121, “LS on updated Rel. 16 RAN1 UE feature lists for NR after RAN1#104bis-e,” RAN1**

**[2] R1-2106407, “LS response on two PUCCH capability,” RAN2**