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

**e-Meeting, August 16th – 27th, 2021**

**Source: Moderator (vivo)**

**Title: Summary of [106-e-NR-5G\_V2X-05] Discussion on R1-2107979: Clarification on PUCCH Power control when the number of SL HARQ-ACK bits larger than 11**

**Agenda Item: 7.2.4**

**Document for: Discussion and Decision**

**Introduction**

The document is to collect companies’ inputs and provide a summary for the email discussion thread [106-e-NR-5G\_V2X-05] Discussion on [R1-2107979](file:///C:\Users\Docs\R1-2107979.zip): Clarification on PUCCH Power control when the number of SL HARQ-ACK bits larger than 11 by August 20 – Siqi (vivo)

The 1st point is planned as following, companies are highly appreciated to provide their inputs before this check point:

* **1st check point: August 17, UTC 23:59 pm**

The 2nd check point: [TBD]

**Discussion**

## Issue#1 PUCCH power when there are more than 11 SL HARQ-ACK bits

The transmission power of PUCCH on active UL BWP  of carrier  of primary cell  is determined based on the following formula, where  is a PUCCH transmission power adjustment component which is depended on the PUCCH format as well as the number of UCI bits to be transmitted:

 [dBm]

|  |
| --- |
| 7.2.1 UE behaviour - For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits larger than 11, , where  -  -  -  is a number of HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 for Type-2 HARQ-ACK codebook, or as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a HARQ-ACK information bit in the PUCCH transmission; otherwise,  -  is a number of SR information bits that the UE determines as described in clause 9.2.5.1  -  is a number of CSI information bits that the UE determines as described in clause 9.2.5.2 |

If a PUCCH format2/3/4 is used for SL HARQ-ACK reporting and the number of SL HARQ-ACK bits is larger than 11, **the current spec is not clear on how to determine the  for PUCCH power control as in the current spec the  is defined as the number of HARQ-ACK bits generated for PDSCH** as described in clause 9.1.2.1 for Type-1 HARQ-ACK codebook or as described in clause 9.1.3.1 or 9.1.3.3 for Type-2 HARQ-ACK codebook, or as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. It also seems to imply that SR, CSI should be considered for .

Thus, the UE behavior in the case of reporting more than 11 SL HARQ-ACK bits should be clarified, i.e.,  and  should be set to 0 since multiplexing between SL HARQ-ACK and CSI/SR in a PUCCH is not allowed, and  should be set to the number of the SL HARQ-ACK bits determined in Clause 16.5.1 for type1 codebook or Clause 16.5.2 for type2 codebook.

In [1], following changes are proposed:

***================proposed changes in [1] ===================***

|  |
| --- |
| 16.5.1.1 Type-1 HARQ-ACK codebook in physical uplink control channel  ====omitted====  If , the UE determines a number of HARQ-ACK information bits  for obtaining a transmission power for a PUCCH, as described in clause 7.2.1, as where is a number of HARQ-ACK information bits determined for corresponding PSSCH transmissions with corresponding PSFCH reception occasions in PSFCH reception occasion .  If , and if the PUCCH transmission uses PUCCH format 2 or PUCCH format 3 or PUCCH format 4, the UE determines a transmission power for the PUCCH, as described in Clause 7.2.1, except that  -  =.  - =0  - =0  ====omitted==== |

|  |
| --- |
| 16.5.2.1 Type-2 HARQ-ACK codebook in physical uplink control channel  ====omitted====  If , the UE determines a number of HARQ-ACK information bits for obtaining a transmission power for a PUCCH, as described in clause 7.2.1, as  where  - is a value of a counter SAI field in a last DCI format 3\_0 scheduling PSSCH transmissions associated with PSFCH reception occasions that the UE detects within the PDCCH monitoring occasions  - if the UE does not detect any DCI format 3\_0 scheduling PSSCH transmissions associated with PSFCH reception occasions in any of the PDCCH monitoring occasions  - is a total number of DCI format 3\_0, scheduling PSSCH transmissions associated with PSFCH reception occasions, that the UE detects within the PDCCH monitoring occasions. if the UE does not detect any DCI format 3\_0 scheduling PSSCH transmissions with associated PSFCH reception occasions in any of the PDCCH monitoring occasions  - is a number of DCI format 3\_0 scheduling PSSCH transmissions with associated PSFCH reception occasions that the UE detects in PDCCH monitoring occasion  - is a number of SL configured grants for which the UE transmits corresponding HARQ-ACK information in a same PUCCH as for HARQ-ACK information corresponding to PSFCH reception occasions within the PDCCH monitoring occasions  If , and if the PUCCH transmission uses PUCCH format 2 or PUCCH format 3 or PUCCH format 4, the UE determines a transmission power for the PUCCH, as described in Clause 7.2.1, except that  -  =.  - =0  - =0  ====omitted==== |

## Company views

Please kindly provide your views in the table below.

**Question 1: Do you agree that issue#1 should be addressed(i.e., power control for PUCCH with more than 11 SL HARQ-ACK bits should be specified)?**

* **If no, please provide the reasons and your suggestions, if any.**

|  |  |  |
| --- | --- | --- |
| Company | Agree or not | Comment |
| vivo | agree | For the case with more than 11 SL HARQ-ACK bits, the power control procedure is not defined in the current specification. If this issue is not addressed, it will prevent more than 11 SL HARQ-ACK bits in a PUCCH. |
| Intel | Agree | We admit that > 11 bit case is not captured. This omission should be fixed. |
| NTT DOCOMO | Not agree | The specification part is used not to determine transmit power but to determine the number of HARQ-ACK bits for transmit power determination. The mechanism is needed only in case of O\_ACK < = 11, so the above addition is unnecessary.  Regarding O\_SR(i) and O\_CSI(i), they shall be zero when no multiplexing. This is the existing rule in Uu in our understanding. For example, when HARQ-ACK and SR are multiplexed on a PUCCH, there is no text for O\_CSI(i), which means O\_CSI(i) = 0 automatically.  Note that there is no corresponding text in 9.1.2.1 of 213.  [vivo reply-2021/8/18]  The reason why SL needs addition text is that **some parameters in 7.2.1 cannot be directly reused for SL as they declared to be DL-HARQ-CK-related parameters**.  To be more specific, when ther number of SL HARQ-ACK is larger than 11bit, the following formula in 7.2.1 is expected to be used to determine the TX power of PUCCH. However, the parameters  **now is defined as the number of DL HARQ-ACK bits** and it is determined by 9.1.2.1, 9.1.3.1, 9.1.3.3, 9.1.4. **How to determine  for PUCCH with SL HARQ-ACK is missing and should be specified.**  **==spec=**  - *For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits larger than 11, , where*  *-*  *-*  *-  is a number of HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 for Type-2 HARQ-ACK codebook, or as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of pdsch-HARQ-ACK-Codebook, pdsch-HARQ-ACK-Codebook-r16, or pdsch-HARQ-ACK-OneShotFeedback,  if the UE includes a HARQ-ACK information bit in the PUCCH transmission; otherwise,*  Thus, [1] proposed changes that the value of  is the number of SL HARQ-ACK bits by introducing ‘ =’ in 16.5.1.1 and 16.5.2.1. regarding the zero value for the O\_SR and O\_CSI part, we don’t have a strong value.  We noticed that LG proposed an alternative modification clarifying that  is determined according to 16.5.1.1 or 16.5.2.1 in 7.2.1 in their reply in Q2, which also works |
| Ericsson | Agree | The current specification prevent simultaneous transmission of UCI and SL HARQ-ACK but does not prevent having 12 or more SL HARQ-ACK bits. For the latter case, this power control aspect is not defined in the specification. |
| LG | Not agree | When we make specification description for the SL HARQ-ACK codebook, description for DL HARQ-ACK codebook was a baseline. In my readling of the current spec for the DL HARQ-ACK codebook, this part also does not mention for the case when the number of DL HARQ-ACK bits is larger than 11. In our perspective, there is no reason to have special description for SL HARQ-ACK codebook. For the case when the number of HARQ-ACK bits is lareger than 11 bits, the relevant descritption can be found in section 7.2.1 as follows:  - For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits larger than 11, , where  Meanwhile, it seems that we need to modify 7.2.1 section by adding section number of SL HARQ-ACK codebooks. (Please see our answer of Q2).  [vivo reply-2021/8/18]  So I guess LG actually are fine with clarifying the power determination for PUCCHs with more than 11 SL HARQ-ACK bits, but LG prefers to modify 7.2.1 instead of 16.5.x.1, is it correct understanding ? The modification you suggest can also resolve the ambiguity about the value of . |
| NEC | Not | Also, we didn’t understand the difference with DL HARQ-AC case. Why only SL needs changes? We think current spec is clear.  In 7.2.1, when UCI bits smaller than or equal to 11, instead of  is used to derive the . Hence, in 9.1.2.1, TS captures how to derive when UCI bits smaller than or equal to 11;  On the other hand, when UCI bits > 11,  is used to derive the and  is already derived from the pseudo-code. No additional text is needed.  Regarding the second point, “multiplexing between SL HARQ-ACK and CSI/SR in a PUCCH is not allowed”, in our understanding,  and  are already implicity set to 0 in the TS because 16.5.1.1 captures “If …” but not “If …”, which seems assume  and  = 0.  [vivo reply-2021/8/18]  now is defined as the numer of **DL** HARQ-ACK bits, so it is not clear how to determine  when the PUCCH carries >11 SL HARQ-ACK bits. That’s why we need to clarify that is set to the number of SL HARQ-ACK bits determined in 16.5.1.1 and 16.5.2.1. |
| Huawei, HiSilicon | No | We share similar view with DCM that this part refers to the HARQ bit number for transmission power dertmination, and dedicated PUCCH power control procedure should refer to Section 7.2, which both smaller and larger than 11bits cases are included.  [vivo reply-2021/8/18]  Please check my reply to DCM and NEC |
| ZTE,Sanechips | Yes |  |
| OPPO | NO | share similar view as DCM and Huawei  [vivo reply-2021/8/18]  Please check my reply to DCM and NEC |
| Samsung | No | We share similar view with DCM. O\_ACK<11 bits is captured in Section 16.5.1 since generation of HARQ-ACK information bits needs additional operation, not for PUCCH power control. PUCCH power control is captured in Section 7.2, and follow legacy understanding, O\_SR(i) and O\_CSI(i) is setting to zero when no multiplexing, thus no explicit clarification is needed.  [vivo reply-2021/8/18]  Please check my reply to DCM and NEC |
| Nokia, NSB | Yes | It looks like a borderline case: Without this change, one can still guess what the required behaviour is, but it seems unnecessarily confusing. The proposed text improves the situation.  Regarding the difference to the DL HARQ-ACK case: In our understanding, for DL HARQ-ACK, the description of O\_ACK(i) in clause 7.2.1 is directly applicable, since it refers to the clauses for DL HARQ ACK; while for SL HARQ-ACK, so far nothing states explicitly that O\_ACK(i) in 7.2.1 now corresponds to O\_ACK in 16.5.\*.1 |
| Qualcomm | Yes with comments | We agree with Nokia that this is a good clarification of the specification text because Sub-clause 7.2 references 9.1 but not 16.5. Though one could argue that the UE behavior can be implicitly determined from existing text. |

**Question 2: Do you agree with the proposed changes for issue#1?**

* **If no, please provide the reasons and your suggestions, if any.**

|  |  |  |
| --- | --- | --- |
| Company | Agree or not | Comment |
| vivo | agree |  |
| Intel | agree |  |
| NTT DOCOMO | Not agree | As commented in Q1. |
| Ericsson | Agree |  |
| LG | Comment | We do not need to have the changes proposed by vivo.  nstead, we can add power control part directly in 7.2.1 as follows:  - For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits smaller than or equal to 11, , where  -  -  is a number of HARQ-ACK information bits that the UE determines as described in Clause 9.1.2.1 for Type-1 DL HARQ-ACK codebook and as described in Clause 9.1.3.1 or 9.1.3.3 for Type-2 DL HARQ-ACK codebook.is the same as  as described in Clause 9.1.4 for Type-3 DL HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a DL HARQ-ACK information bit in the PUCCH transmission; otherwise,  -  is a number of HARQ-ACK information bits that the UE determines as described in Clause 16.5.1.1 for Type-1 SL HARQ-ACK codebook and as described in Clause 16.5.2.1 for Type-2 SL HARQ-ACK codebook.  […]  - For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits larger than 11, , where  -  -  -  is a number of HARQ-ACK information bits that the UE determines as described in Clause 9.1.2.1 for Type-1 DL HARQ-ACK codebook and as described in Clause 9.1.3.1 or 9.1.3.3 for Type-2 DL HARQ-ACK codebook, or as described in Clause 9.1.4 for Type-3 DL HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a DL HARQ-ACK information bit in the PUCCH transmission; otherwise,  -  is a number of HARQ-ACK information bits that the UE determines as described in Clause 16.5.1.1 for Type-1 SL HARQ-ACK codebook and as described in Clause 16.5.2.1 for Type-2 SL HARQ-ACK codebook  [vivo reply-2021/8/18]  Thank you for your suggestion, the suggested wording is fine from my side, and I would like to check more companies views on this change. |
| NEC | No | As commented for Q1 |
| Huawei, HiSilicon | No | See comments in Q1. |
| ZTE,Sanechips | Yes with comments | We think and should be clarified for both the cases of no more than and more than 11 SL HARQ-ACK bits. |
| OPPO | No |  |
| Samsung | No | As commented in Q1. |
| Nokia, NSB | Yes with comments | Agree with ZTE, Sanechips |
| Qualcomm | Yes |  |

**Summary**

According to the comments and email replies,

* 9 companies think this issue is valid and how to determine O\_ACK is not clear.
* 6 companies think the current 7.2.1 is clear for power determination

It can be seen that the majority view is that issue#1 is valid. After double-checking the spec, nothing specifying how to determine O\_ACK for PUCCH with SL HARQ-ACK can be found so we believe that the legacy procedure has ambiguity. It has been a few hours since the last email from vivo and LG elaborating on this issue and no objections have been received. Therefore, from the moderator's point of view, we think it's reasonable to conclude that the issue is valid and should be fixed.

**Round2**

Some companies commented that they would like to modify 7.2.1 rather than 16.5.x.1 to avoid potential impact to the codebook part, so I have prepared a draft CR of 7.2.1 for discussion.

According to LG’s comment, a similar ambiguity also exists for <=11 bits case. In clause 7.2.1,  representing the DL HARQ-ACK is used for power determination but it is no specified that whether  should be set to for SL case, which may lead to the misunderstanding that number of DL HARQ-ACK bits is used for PUCCH with SL HARQ-ACK. Morover, a similar text can be found in the case for power control for PUCCH with DL HARQ-ACK. From this point of view, the propsed change from LG is reasonable.

**===============================draft CR================================**

- For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits smaller than or equal to 11, , where

- 

-  is a number of HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 for Type-2 HARQ-ACK codebook.is the same as  as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a DL HARQ-ACK information bit in the PUCCH transmission; otherwise, ; or

-  is a number of SL HARQ-ACK information bits that the UE determines as described in Clause 16.5.1.1 for Type-1 SL HARQ-ACK codebook and as described in Clause 16.5.2.1 for Type-2 SL HARQ-ACK codebook

-  is a number of SR information bits that the UE determines as described in clause 9.2.5.1

-  is a number of CSI information bits that the UE determines as described in clause 9.2.5.2

-  is a number of resource elements determined as , where  is a number of subcarriers per resource block excluding subcarriers used for DM-RS transmission, and  is a number of symbols excluding symbols used for DM-RS transmission, as defined in clause 9.2.5.2, for PUCCH transmission occasion on active UL BWP  of carrier  of primary cell

- For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits larger than 11, , where

- 

- 

-  is a number of DL HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 for Type-2 HARQ-ACK codebook, or as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a DL HARQ-ACK information bit in the PUCCH transmission; otherwise, ; or

-  is a number of SL HARQ-ACK information bits that the UE determines as described in Clause 16.5.1.1 for Type-1 SL HARQ-ACK codebook and as described in Clause 16.5.2.1 for Type-2 SL HARQ-ACK codebook

-  is a number of SR information bits that the UE determines as described in clause 9.2.5.1

-  is a number of CSI information bits that the UE determines as described in clause 9.2.5.2

-  is a number of CRC bits that the UE determines as described in clause 9.2

-  is a number of resource elements that the UE determines as , where  is a number of subcarriers per resource block excluding subcarriers used for DM-RS transmission, and  is a number of symbols excluding symbols used for DM-RS transmission, as defined in clause 9.2.5.2, for PUCCH transmission occasion on active UL BWP  of carrier  of primary cell.

**===============================draft CR================================**

***Question3. Do you support the draft CR or not, if not, please provide your suggestions in the following table if any.***

|  |  |  |
| --- | --- | --- |
| Company | Support or not | Comment |
| NEC | Support | Thank you for response, we support the draft CR in general.  One small comment for spec consistency may be. i.e., why not also add “DL” in the the following text:  -  is a number of DL HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 for Type-1 HARQ-ACK codebook  OR delete the other two “SL” and one “DL” in the according places. |
| NTT DOCOMO | Generally fine | “SL” HARQ-ACK codebook is new terminology, so it should be avoided. Just type-1 HARQ-ACK codebook and type-2 HARQ-ACK codebook should be OK. |
| Samsung | Generally fine | We are generally OK to clarify DL and SL HARQ-ACK information bits in Section 7.2.1. Similar view as DCM to avoid SL HARQ-ACK codebook in the CR. |
| LG | Support | It seems necessary to update the PUCCH power control to follow the parameters related to SL HARQ-ACK feedback when the PUCCH carries SL HARQ-ACK feedback. If this is not fixed, the transmit power of PUCCH carrying SL HARQ-ACK reporting could be underestimated, and it will result serious problem on the ACK-to-NACK error and NACK-to-ACK error for SL HARQ-ACK reporting.  If companies do not want to change spec descition for the DL HARQ-ACK feedback, alternatively, we can say “For PUCCH transmissions with SL HARQ-ACK reports, n or O\_ACK is replaced with …”. |
| OPPO | Basically fine | Support the principle of the proposed draft CR, however the wording shoud be refined:  1. for DL HARQ-ACK feedback, there is no need to add “DL”, as the refered section or RRC parameters are for DL.  2. for clarity, it it better to add “if DL HARQ-ACK information bit(s) are included in the PUCCH transmission ” at the beginning of the paragraph for DL, and add “if SL HARQ-ACK information bit(s) are included in the PUCCH transmission ” for SL. |
| Huawei, HiSilicon | Ok with the direction, but provide another CR | We are ok with the spirit of the CR, but actually as commented by other companies, it will introduce some new terminologies like “DL HARQ” or “SL HARQ”. So we think it would be simplest to keep using type 1/type 2 codebook, but cross-reference the clause 16.5.1.1 and 16.5.2.1 directly in 7.2.1 power control. Proposed CR as below:  ------------------------------------------------------------------------------------------  For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits smaller than or equal to 11, , where  -  -  is a number of HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 or caluse 16.5.1.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 or 16.5.2.1 for Type-2 HARQ-ACK codebook.is the same as  as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a HARQ-ACK information bit in the PUCCH transmission; otherwise,  -  is a number of SR information bits that the UE determines as described in clause 9.2.5.1  -  is a number of CSI information bits that the UE determines as described in clause 9.2.5.2  -  is a number of resource elements determined as , where  is a number of subcarriers per resource block excluding subcarriers used for DM-RS transmission, and  is a number of symbols excluding symbols used for DM-RS transmission, as defined in clause 9.2.5.2, for PUCCH transmission occasion on active UL BWP  of carrier  of primary cell  - For a PUCCH transmission using PUCCH format 2 or PUCCH format 3 or PUCCH format 4 and for a number of UCI bits larger than 11, , where  -  -  -  is a number of HARQ-ACK information bits that the UE determines as described in clause 9.1.2.1 or clause 16.5.1.1 for Type-1 HARQ-ACK codebook and as described in clause 9.1.3.1 or 9.1.3.3 or clause 16.5.1.1 for Type-2 HARQ-ACK codebook, or as described in clause 9.1.4 for Type-3 HARQ-ACK codebook. If the UE is not provided any of *pdsch-HARQ-ACK-Codebook*, *pdsch-HARQ-ACK-Codebook-r16*, or *pdsch-HARQ-ACK-OneShotFeedback*,  if the UE includes a HARQ-ACK information bit in the PUCCH transmission; otherwise,  -  is a number of SR information bits that the UE determines as described in clause 9.2.5.1  -  is a number of CSI information bits that the UE determines as described in clause 9.2.5.2  -  is a number of CRC bits that the UE determines as described in clause 9.2  -  is a number of resource elements that the UE determines as , where  is a number of subcarriers per resource block excluding subcarriers used for DM-RS transmission, and  is a number of symbols excluding symbols used for DM-RS transmission, as defined in clause 9.2.5.2, for PUCCH transmission occasion on active UL BWP  of carrier  of primary cell. |

**Reference**

1. R1-2107979, Clarification on PUCCH Power control when the number of SL HARQ-ACK bits larger than 11, vivo