**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-04] Discussion on R1-2107977: Correction on HARQ reporting for multiple pools with PSFCH**

**Agenda Item: 7.2.4**

**Document for: Discussion and Decision**

**Introduction**

The document is to collect companies’ views and provide a summary for the email discussion thread [106-e-NR-5G\_V2X-04] Discussion on R1-2107977: Correction on HARQ reporting for multiple pools with PSFCH by August 20 – Siqi (vivo) based on the inputs from the preparation phase and [1][2].

The 1st check 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]

**Discussions**

gNB can configure multiple resource pools containing PSFCH for some purposes. For example, resource pools with different PSFCH periodicities can be used to meet the needs of services with different PDB. According to the spec, there are two types of SL HARQ-ACK codebook:

* **For type2 SL HARQ-ACK codebook, UE already supports type2 codebook for multiple pools** since the pseudo-code for type2 codebook construction is dependent on SAI and is irrelevant to pool id.
* **For type1 SL HARQ-ACK codebook,** the current specification only specifies how the UE generates HARQ-ACK codebook for one pool, **it is not clear how to report SL HARQ-ACK for multiple pools**.

From the highlighted part in 38.213, it can be seen that the pseudo-code applies to a specific pool(i.e., ’the sidelink resource pool’), and the set of of only includes the PSSCH occasion corresponding to a PSFCH occasion in the specific pool.

==============================38.213==============================

Set to the value of the period of PSFCH transmission occasion resources for the sidelink resource pool

while C

if

Set – index of a SL slot within an UL slot

while

if slot starts at a same time as or after a slot for an active UL BWP change on the PCell and slot is before the slot for the active UL BWP change on the PCell

;

else

if slot belongs to the sidelink resource pool and includes PSFCH resources as indicated by a sidelink resource pool bitmap and *sl-PSFCH-Period*, where is the *k*-th slot timing value in set

Set – index of a SL slot within an PSFCH period

while

;

;

;

end while

end if

;

end if

end while

end if

;

end while

==============================end==============================

Therefore, if there are multiple pools with PSFCH, it is not clear which one is ‘the sidelink resource pool’ in pseudo-code. Even if each pool with PSFCH can be assumed as ‘the sidelink resource pool’, and the corresponding set of and SL HARQ-ACK bits can be determined, it is not specified how to handle these multiple sets of and SL HARQ-ACK bits. Even for the case where these pools with PSFCH are configured in a pure TDM manner, the type1 codebook with SL HARQ-ACK for more than one pool still does not work with current specification. As shown in the figure below, pool1 and pool2 are TDM and F denotes PSFCH occasions, K1={2,6}. If ‘the sidelink resource pool’ is pool1, with the pseudocode, only the PSSCH occasions associated with PSFCH in slot n+10 of pool1 will be included in the set of , and if ‘the sidelink resource pool’ is pool2, only the PSSCH occasions associated with PSFCH in slot n+6 of pool2 will be included in the set of . How to handle the two sets is not specified.



Figure 1.Example of TDMed pools with PSFCH

Based on the inputs in the preparation phase, there are two options to handle the type1 codebook if there are multiple pools with PSFCH:

1. **Option1.support SL HARQ-ACKs reporting for multiple pool in a type1 codebook**

If we go with this option, some spec changes are needed. [1] [2] provide some changes for reference in the appendix.

1. **Option2.not support SL HARQ-ACKs reporting for multiple pool in a type1 codebook**

One way is that gNB always assigns different and non-overlapped PUCCH resources for different pools configured with PSFCH and ensure that SL HARQ-ACK for these pools will not be involved in a same codebook. Alternatively, the number of configured one pool with PSFCH should be no larger than one if type1 codebook is used.

Company views

Please kindly provide your views in the table below.

**Question 1: whether Type1 SL HARQ-ACK codebook for multiple resource pools configured with PSFCH should be supported in R16?**

* **Option1.Support, and spec changes are needed**
* **Option2.Not support**
* **please provide the reasons and your suggestions, if any.**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| vivo | We prefer Option1 | Since type2 codebooks for multiple pools are already supported in R16, it would be strange for type1 codebooks to be defined per pool without multiplexing between pools.  Regarding the concerns on the overhead of the multiplexed codebook mentioned by some companies, if the gNB predicts that the multiplexed codebook size will be too large, it can assign different PUCCHs to be associated with different resource pools so that the SL HARQ-ACK for different pools will be handled separately. If the size of multiplexed codebook will not be large, gNB can indicate the same PUCCH resource for SL HARQ-ACK reporting for multiple pools. |
| ASUSTeK | We prefer Option1 | We share the same view with vivo. |
| NTT DOCOMO | Slightly prefer Option 1 | Multiple resource pools with PSFCH would be a valid situation. Type-1 HARQ-ACK CB should be available in this case. Our preference is option 1, but option 2 for Rel-16 is also fine with TEI discussion in Rel-17. |
| ZTE,Sanechips | We prefer Option 1. | The candidate PSSCH transmissions may be scheduled by more than one DCI format 3\_0 or sl-PSFCH-ToPUCCH-CG-Type1, which would be associated to more than one resource pools. And the corresponding spec changes are needed . More details were expressed in R1-2105611. |
| Intel | Option 2 | Although the intention is understood, we think this is not a correction rather a functional change. At this stage these changes are unwelcome. What we can do is to state the conditions how UE can handle the CB construction for a single RP. |
| LG | Option 2 | Currently, there is no implicit/explicit rule to make associations between TX resource pool(s) and RX resource pool(s). If there are more than RX pool with PSFCH, PSFCH reception timing or PSFCH resource determination at TX UE side would be ambiguous. In maintenance phase, it would not be desirable to spend much time to support this new functionality. |
| Huawei, HiSilicon | Option 2 | We disagree with Vivo that Type 2 codebook has already supported reporting HARQ from multiple resource pools on the same PUCCH. Whether to report type 2 HARQ codebook from different pools on the same PUCCH is up to gNB indication, it does not imply it has already supported. However, in fact, RAN1 has no agreement or even no discussion on whether/how to report SL HARQ from multiple resource pools on the same PUCCH. We agree with companies that it is not only a simple correction, but a functionality change which is not appropriate nor essential in Rel-16 CR stage. |
| Apple | Option 2 | Option 1 seems to expand the functionality of supporting Type 1 codebook for HARQ feedback from multiple resource pools, which we did not have explicit agreements. We prefer not to modify the specifications for the new functionality at this stage. |
| Ericsson | Option 1 |  |
| Qualcomm | Option 2 | We prefer to not introduce Option 1 at this late stage. |
| Sharp | Option 2 |  |
| NEC | Option 2 | We understand it’s a valid case and current spec cannot support it. While it’s also a new feature that wasn’t touched before, we prefer not to add this new feature in maintenance stage. |
| CATT, GOHIGH | Option 2 | RAN1 has no agreement on this issue, we prefer not to introduce new feature in CR phase. |
| Samsung | Option 2 | We also consider it as functionality change rather than correction, thus is inappropriate at the late stage. |
| OPPO | Option 2 | prefer not to introduce such new functionality at maintenance stage |

**Question 2: If option1 in Question1 is agreed, which option for spec changes do you prefer? Option1 in appendix1 or option2 in appendix2?**

* **please your suggestions (e.g., suggested CR), if any.**

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| --- | --- | --- |
| Company | option | Comment |
| vivo | Option1 in appendix1 | It is straightforward to iterate through all the resource pools containing PSFCHs in the order of their pool IDs, then determining the HARQ-ACK bits corresponding to each pool separately, and concatenating these HARQ-ACK bits. |
| ASUSTeK | Either Option1 or Option2 in appendix1 | We see less difference between Option1 and option2 in appendix1 and either one is fine to us. |
| NTT DOCOMO | Either is OK | Outcome would be the same. |
| ZTE, Sanechips | Option 1. | Similar proposed correction in R1-2105611. |
| LG | Nether option 1 nor option 2 | If Q1 is agreed, one simple solution is that the network ensures TDM between SL HARQ-ACK reporting of different resource pools. In this case, since the current specification already covers the SL HARQ-ACK codebook for a certain resource pool, further change would not be needed. Or, minimally, it can be considered to specify that “UE does not expect to multiplex SL HARQ-ACK information of different resource pool in a PUCCH or a PUSCH”. |
| Ericsson | Option 1 |  |

**Question 3: If option2 in Question1 is agreed, which option do you prefer?**

* **Option1.draw a RAN1 conclusion that type1 SL HARQ-ACK codebook for multiple pools configured with PSFCH is not supported in R16**
* **Option2.capture in RAN1 spec that UE is not expected to transmit a type1 SL HARQ-ACK codebook for multiple pools configured with PSFCH in R16**
* **Option3.capture in RAN2 RRC spec that type1 SL HARQ-ACK codebook for multiple pools configured with PSFCH is not supported in R16**

|  |  |  |
| --- | --- | --- |
| Company | option | Comment |
| vivo | option2 | If option 2 in Question 1 is agreed, we prefer to explicitly prevent UE from supporting type1 codebooks for more than one pools in the RAN1 specification. |
| ASUSTeK | Either option1 or option 2 |  |
| NTT DOCOMO | Slightly prefer Option 2 | Other option is also OK for us. |
| LG | Option 1 | Similar with other discussion, if the network can avoid this situation, we do not need to specify it explicitly. |
| Huawei, HiSilicon | Option 2 | It is fine for us to capture the conclusion in the spec if this is the majority view. |
| Apple | Either Option 1 or Option 2 |  |
| Qualcomm | Option 1 or Option 2 | If Option 2 is selected, the wording needs to be updated so that the UE is not expected “to be scheduled or configured” to transmit a Type 1 SL HARQ-ACK codebook for multiple pools. The wording in Q3 would imply that the UE has to drop the PUCCH instead of this being an unsupported case. |
| Sharp |  | We prefer to draw a RAN1 conclusion, but the description of Option1 above is confusing. Use of Type-1 HARQ-ACK should be OK even if multiple resource pools are configured with PSFCH. It would be up to gNB to avoid any problematic case.  In our view, we should conclude like “Type-1 HARQ-ACK codebook with HARQ-ACK bits corresponding to PSSCH transmissions in more than one resource pool is not supported”. |
| NEC | Option 1 | Option 1 without spec changes |
| CATT, GOHIGH | Option 1 |  |
| Samsung | Option 1 or 2 | If option 2 is selected, we’re fine to update specification wording to explicitly avoid the case. |
| OPPO | Option 1 |  |

**Summary**

[Based on the discussion, we conclude that ……TBD]

**Reference**

1. R1-2107977, Correction on HARQ reporting for multiple pools with PSFCH, vivo
2. R1-2108112, Discussion on Type-1 HARQ codebook regarding multiple resource pools, ASUSTeK

**Appendix1: Option1.proposed changes in [1]**

16.5.1.1 Type-1 HARQ-ACK codebook in physical uplink control channel

====Omitted====

For the set of slot timing values, the UE determines a set of occasions for candidate PSSCH transmissions with corresponding PSFCH reception occasions according to the following pseudo-code.

Set - index of occasion for candidate PSSCH transmissions with corresponding PSFCH reception occasions

Set

Set C to the cardinality of set

Set – index of slot timing values , in descending order of the slot timing values, in set

Set to the number of resource pools containing PSFCH in the set of resource pools provided by *sl-TxPoolScheduling*

Set – index of resource pool, in ascending order of the sidelink resource pool id provided by *sl-ResourcePoolID* of resource pool, in the set of resource pool containing PSFCH

while

Set to the value of the period of PSFCH transmission occasion resources for the sidelink resource pool

while C

if

Set – index of a SL slot within an UL slot

while

if slot starts at a same time as or after a slot for an active UL BWP change on the PCell and slot is before the slot for the active UL BWP change on the PCell

;

else

if slot belongs to the sidelink resource pool and includes PSFCH resources as indicated by a sidelink resource pool bitmap and *sl-PSFCH-Period*, where is the *k*-th slot timing value in set

Set – index of a SL slot within an PSFCH period

while

;

;

;

end while

end if

;

end if

end while

end if

;

end while

;

end while

**Appendix2: Option2.proposed changes in [2]**

|  |
| --- |
| 16.5.1.1 Type-1 HARQ-ACK codebook in physical uplink control channel  If a UE is provided a set of sidelink resource pool bitmaps, where sidelink resource pool bitmaps are placed in the set according to an ascending order of a sidelink resource pool index, the UE generates a Type-1 HARQ-ACK codebook for sidelink resource pool bitmap in the set of sidelink resource pool bitmaps separately in the following pseudo-code. The UE concatenates the HARQ-ACK codebook generated for each sidelink resource pool bitmap in the set of sidelink resource pool bitmaps according to an ascending order of the sidelink resource pool index to obtain a total number of  HARQ-ACK information bits.  For a SL BWP on a serving cell and an active UL BWP on the primary cell, as described in Clause 12, a UE determines a set of occasions for candidate PSSCH transmissions with corresponding PSFCH reception occasions for which the UE can multiplex corresponding HARQ-ACK information in a PUCCH transmission in slot . The determination is based on:  a) a set of slot timing values associated with the SL BWP where is provided by *sl-PSFCH-ToPUCCH* for DCI format 3\_0 or by *sl-PSFCH-ToPUCCH-CG-Type1*  b) the ratio between the sidelink SCS configuration and the uplink SCS configuration provided by *subcarrierSpacing* in *BWP-Sidelink* and *BWP-Uplink* for the SL BWP and the active UL BWP, respectively  c) a set of sidelink resource pool bitmaps  d) a value of a period of PSFCH transmission occasion resources for a sidelink resource pool provided by a respective *sl-PSFCH-Period*  For the set of slot timing values, the UE determines a set of occasions for candidate PSSCH transmissions with corresponding PSFCH reception occasions according to the following pseudo-code.  Set - index of occasion for candidate PSSCH transmissions with corresponding PSFCH reception occasions  Set  Set C to the cardinality of set  Set – index of slot timing values , in descending order of the slot timing values, in set  Set to the value of the period of PSFCH transmission occasion resources for the sidelink resource pool  while C  if  Set – index of a SL slot within an UL slot  while  if slot starts at a same time as or after a slot for an active UL BWP change on the PCell and slot is before the slot for the active UL BWP change on the PCell  ;  else  if slot belongs to the sidelink resource pool and includes PSFCH resources as indicated by a sidelink resource pool bitmap and *sl-PSFCH-Period*, where is the *k*-th slot timing value in set  Set – index of a SL slot within an PSFCH period  while  ;  ;  ;  end while  end if  ;  end if  end while  end if  ;  end while |