**3GPP TSG RAN WG1 #109-e** **R1-220xxxx**

e-Meeting, May 9th – 20th, 2022

**Agenda item:** 7.1

**Source:** Moderator (Samsung)

**Title:** Summary of [109-e-NR-CRs-03] Collision of more than two overlapped PUCCHs with repetition

**Document for:** Discussion and Decision

# Introduction

This contribution provides the summary for the following email discussion in RAN1#109-e:

[109-e-NR-CRs-03] Collision of more than two overlapped PUCCHs with repetition by May 13 – Sa (Samsung)

* Relevant tdocs: R1-2203130, R1-2204907, R1-2204974 and also consider R1-2203185, R1-2203279, R1-2203418, R1-2203851, R1-2204001 under agenda item 7.2.5.

Section 3 provides the background information. Section 4 captures the detailed email discussions. Section 5 summarizes the outcome of the email discussion.

# Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

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| --- | --- | --- |
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# Background

The PUCCH repetition related procedure is described in TS 38.213 9.2.6. If there are two overlapping PUCCHs of the same priority and at least one of them is with repetitions, prioritization is performed. The issue of more than 2 overlapping PUCCHs of the same priority was brought up during the email discussion of Rel-17 URLLC intra-UE multiplexing/prioritization A [1]. Samsung pointed out UE behaviour is not clear for the following case as shown in Figure 1.



**Figure 1**

There can be two UE behaviours

Behaviour 1: UE first resolves HARQ-ACK and SR and the UE drops the SR, then the UE resolves HARQ-ACK and CSI and the CSI is multiplexed with the HARQ-ACK.

Behaviour 2: UE first resolves SR and CSI and the UE drops the CSI, then the UE resolves HARQ-ACK and SR and the UE drops the SR, the UE only transmits HARQ-ACK.

According to the feedback of the Question 7.3 of Rel-17 URLLC intra-UE multiplexing/prioritization A [1], all the companies agreed to discuss the potential ambiguity of PUCCH collision handling with PUCCH repetition of a same priority in Rel-15/16 maintenance session since the issue exists in Rel-15 and Rel-16. In addition, Samsung and Qualcomm pointed out that it is almost impossible to change Rel-15 spec at this late stage and the discussion should focus on Rel-16. The issue was further discussed in 7 contributions submitted to RAN1#109-e [2]-[8] for Rel-16 maintenance.

In addition, Samsung [5] discussed the issue of more than 2 overlapping PUCCHs/PUSCHs of the same priority. Samsung pointed out UE behaviour is not clear for the following case as shown in Figure 2.

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**Figure 2**

There can be two UE behaviours

Behaviour 1: UE first resolves the collision of SR and PUSCH and the UE drops the PUSCH. The UE will transmit the HARQ-ACK and SR.

Behaviour 2: UE first resolves the collision of HARQ-ACK and PUSCH, the HARQ-ACK will be multiplexed in the PUSCH and then the UE resolves the collision of SR and PUSCH. In this case, the PUSCH with HARQ-ACK will be dropped. The UE will transmit the SR PUCCH.

# Email Discussion

The discussion focuses on the overlapping PUCCHs/PUSCHs of same priority and only for Rel-16 maintenance. The 1st round discussion aims to align companies understanding on this issue and collect companies’ preference. The discussion for the first issue will first focus on the case where all the PUCCHs are configured with repetitions for simplicity and then extend to the case where some PUCCHs are with repetitions and some PUCCHs are not with repetitions.

## First round

All the six companies [2] ~ [8] pointed out the UE behaviour is not clear for the case of more than two overlapping PUCCHs with repetitions. Five companies [2] ~ [7] provided their solutions to address the first issue. The candidate options are summarized below,

**Option 1)**

For a group of at least three PUCCHs which would overlap with each other, the UE performs the pairwise dropping rules of PUCCH repetition in the current clause 9.2.6 in 38.213, by selecting two PUCCHs including at least one PUCCH with repetition among the group of PUCCHs in descending order of the priority of UCI type, and for UCI type with the same priority, in the order of PUCCH starting time, until there is no overlapping including PUCCH repetition any more.

* Proponents: Huawei [2], [3], CATT [6]

**Option 2)**

In the group of overlapping channels, the UE shall only transmit the channel with highest priority (where the priority is determined based on the same approach as in Clause 9.2.6 based on the UCI type and starting slot of the PUCCH), and drop all the lower priority PUCCH channels in the group. Furthermore, the overlapping groups are identified using the same approach as in Clause 9.2.5 for UCI multiplexing for PUCCH channels without repetition.

* Proponents: Qualcomm [4]

**Option 3)**

For resolving more than two overlapping PUCCHs of the same priority, reuse the pseudo-code in TS 38.213 9.2.5 with the restriction of selecting up to 2 PUCCH resources and apply the rules defined in clause 9.2.6 if there is repetition or clause 9.2.5, otherwise.

* Proponents: Samsung [5]

**Option 4)**

For overlapping PUCCHs, a UE would transmit a first PUCCH with repetitions and at least a second PUCCH with or without repetitions, and the first PUCCH and any of the second PUCCHs do not include a UCI type with same priority, if any of the second PUCCHs includes a UCI type with higher priority than the UCI type of the first PUCCH, the UE transmits the second PUCCHs and does not transmit the first PUCCH that includes a UCI type with lower priority, otherwise, the UE transmits the first PUCCH and does not transmit the second PUCCHs

* Proponents: Nokia [7]

### **Clarification of “first PUCCH” and “second PUCCH” in clause 9.2.6**

Oppo [7] discussed the definition of “first PUCCH” or “second PUCCH” and pointed out the definition is not clear at least for the case where there is more than one PUCCH with repetitions within “a set of overlapping PUCCHs”.

From moderator’s understanding, it is necessary to first align companies understanding regarding “first PUCCH” and “second PUCCH” before agreeing on a CR. The related spec is copied below.

|  |
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| A UE does not multiplex different UCI types in a PUCCH transmission with repetitions over $N\_{PUCCH}^{repeat}>1$ slots. If a UE would transmit a first PUCCH over more than one slot and at least a second PUCCH over one or more slots, and the transmissions of the first PUCCH and the second PUCCH would overlap in a number of slots then, for each slot of the number of slots and with UCI type priority of HARQ-ACK > SR > CSI with higher priority > CSI with lower priority- the UE does not expect the first PUCCH and any of the second PUCCHs to start at a same slot and include a UCI type with same priority - if the first PUCCH and any of the second PUCCHs include a UCI type with same priority, the UE transmits the PUCCH starting at an earlier slot and does not transmit the PUCCH starting at a later slot- if the first PUCCH and any of the second PUCCHs do not include a UCI type with same priority, the UE transmits the PUCCH that includes the UCI type with higher priority and does not transmit the PUCCH that include the UCI type with lower priority  |

According to the spec, “first PUCCH” only include a PUCCH with repetitions while “second PUCCH” includes PUCCH(s) with or without repetitions. For a PUCCH without repetitions, it should be included in “second PUCCH”, however, for a PUCCH with repetitions, it seems not clear whether it should be included in “first PUCCH” or “second PUCCH” at least for the case where there are more than two overlapping PUCCHs and at least two PUCCHs are with repetitions.

If there are two overlapping PUCCHs with repetitions within “a set of overlapping PUCCHs”, it seems not necessary to clarify the definition of “first PUCCH” and “second PUCCH” as long as there is one to one mapping between the two PUCCHs and the “first PUCCH” and “second PUCCH”. For example, “first PUCCH” can be PUCCH#1 and “second PUCCH” can be PUCCH#2, or “first PUCCH” can be PUCCH#2 and “second PUCCH” can be PUCCH#1, the result would be the same. UE behaviour is clear for this case according to the current spec.

However, if there are more than two overlapping PUCCHs with repetitions within “a set of overlapping PUCCHs”, it seems necessary to clarify the definition of “first PUCCH” and “second PUCCH”. For example, consider Case 1 as shown in Figure 3 assuming all the PUCCHs are with repetitions, it is not clear to the moderator which PUCCH belongs to “first PUCCH” or “second PUCCH”.



**Figure 3: Case 1 (all the PUCCHs are with repetitions)**

#### **Q1:**

**Do you agree that the definition of “first PUCCH” or “second PUCCH” is clear for the case where there are two PUCCHs within “a set of overlapping PUCCHs”? If the answer is NO, please clarify the reason.**

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| --- | --- |
| Company | View |
| HW/HiSi | Yes |
| NTT DOCOMO | Yes |
| OPPO | Yes |
| CATT | Yes |
| Nokia, NSB | Yes |
| ZTE | Yes |
| Intel  | Yes |
| vivo | Yes |
| Samsung | Yes |
| Ericsson | Yes |
| LG | Yes |
| QC | Yes |
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#### **Q2:**

**Do you agree that the definition of “first PUCCH” or “second PUCCH” is not clear at least for the case where there are more than two PUCCHs within “a set of overlapping PUCCHs” and there are at least two PUCCHs with repetitions? If the answer is NO, please clarify “first PUCCH” and “second PUCCH” for Case 1 in Figure 3.**

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| --- | --- |
| Company | View |
| HW/HiSi | Yes |
| NTT DOCOMO | Yes |
| OPPO | There is a missing case where there are more than two PUCCHs within “a set of overlapping PUCCHs” and there is only one PUCCH with repetition (as shown in the following figure) needs to be clarified. To our understanding, in the above case, the PUCCH with repetition (SR) is regarded as the “first PUCCH”, all the PUCCHs overlapping with the “first PUCCH” (CSI and A/N) can be regarded as the “at least a second PUCCH”. Then UE will transmit the PUCCH with highest priority among “a set of overlapping PUCCHs” (A/N), drop all the other PUCCHs (SR with rep and CSI).We think it would be better to first clarify this case before deciding which option is better to choose. |
| CATT | Yes |
| Nokia, NSB | Yes.Agree with OPPO that there is also an issue with one PUCCH with repetition and two PUCCHs without repetition. |
| ZTE | Yes |
| Intel  | Yes, we agree, the definition is unclear for the case in Figure 3. But we’re wondering whether we need to consider the case in Figure 3. In Rel-15/16, PUCCH repetition is only supported for long PUCCH format, and only for slot-based repetition. Typically, the case for PUCCH repetition is, one PUCCH with a large number of symbols in a slot still cannot achieve desirable performance that requires multiple repetitions in multiple slots. In other words, it is unlikely that a gNB configures a PUCCH with only few symbols, e.g., it does not make sense for gNB to configure only 4 symbols for a PUCCH with repetitions in 2 or 4 slots. Therefore we think Figure 3 would be a corner case. UCI multiplexing procedure is already very complicated, we should be cautious to optimize any corner case for Rel-16, after more than 2 years after Rel-16. Regarding the case proposed by OPPO, we share same understanding with OPPO that, according to the current spec, it is clear, SR with repletion is 1st PUCCH, HARQ-ACK and CSI are 2nd PUCCHs, and only the PUCCH with highest priority is transmitted.  |
| vivo | YES. Current spec only defines the case of two PUCCHs overlapping (PUCCH pair), when there are more than two PUCCHs where at least one PUCCH is with repetition, any two PUCCHs with at least one PUCCH with repetition can be the PUCCH pair. Then different order for handling the PUCCH pairs will result in different results, that is the issue we need to solve by this email per understanding. |
| Samsung | Yes |
| Ericsson | Yes.We think the spec covers the case OPPO mentions.….transmit a first PUCCH over more than one slot and at least a second PUCCH over one or more slots,…There is an issue when not all PUCCHs overlap with each other (as Moderator showed in the Figure). |
| LG | Yes |
| QC | Yes. We also agree with OPPO and Nokia that there is also an issue with one PUCCH with repetition and two PUCCHs without repetition. |
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### **Determination of “a set of overlapping PUCCHs”**

For resolving the overlapping PUCCHs with repetitions, before associating overlapping PUCCHs with “first PUCCH” or “second PUCCH”, a UE should first determine “a set of overlapping PUCCHs” similar as resolving the overlapping PUCCHs without repetitions. The resulting PUCCH(s) can largely depend on the determination of “a set of overlapping PUCCHs.

For resolving the overlapping PUCCHs without repetitions, a UE first select “a set of overlapping PUCCHs” according the pseudo-code defined in TS 38.213 9.2.5, and then determine a PUCCH for multiplexing UCI associated with “a set of overlapping PUCCHs” if there are two or more PUCCHs in a set copied below.

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| if determine a single resource for multiplexing UCI associated with resources  as described in clauses 9.2.5.0, 9.2.5.1 and 9.2.5.2  |

Among the four candidate options, Option 1, 2, and 3 provide three different solutions for determining “a set of overlapping PUCCHs”. It is not clear how to determine “a set of overlapping PUCCHs” for Option 4 at least for the case where all the PUCCHs are with repetitions.

Note: the text “a set of overlapping PUCCHs” is used here to avoid misunderstanding because the meaning of the text “a group of overlapping PUCCHs” are different in the candidate options.

**Method 1)**

For a group of at least three PUCCHs which would overlap with each other, selecting two PUCCHs including at least one PUCCH with repetition among the group of PUCCHs in descending order of the priority of UCI type, and for UCI type with the same priority, in the order of PUCCH starting time, until there is no overlapping including PUCCH repetition any more.

* Proponents: Huawei [2], [3]

Moderator’s comment: “overlap with each other” seems not include the case where a PUCCH does not overlap with all the other PUCCHs in a group. For example, PUCCH 1 overlaps with two non-overlapping PUCCH 2 and PUCCH 3.

**Method 2)**

The overlapping groups are identified using the same approach as in Clause 9.2.5 for UCI multiplexing for PUCCH channels without repetition of same priority.

* Proponents: Qualcomm [4]

**Method 3)**

The overlapping groups are identified using the same approach as in Clause 9.2.5 for UCI multiplexing for PUCCH channels without repetition of different priorities. (Selecting up to 2 PUCCH resources)

* Proponents: Samsung [5]

Among the 3 methods, Method 2) does not restrict the maximum number of the PUCCHs in “a set of overlapping PUCCHs” while Method 1) and 3) restrict the maximum number to be 2. From moderator’s understanding, the intention of restricting the maximum number to be 2 is to simply the specification work. As discussed in section 4.1.1, from moderator’s understanding, the spec is clear for two overlapping PUCCHs with repetitions. If the maximum number of the overlapping PUCCHs within “a set of overlapping PUCCHs” is restricted to be 2, UE behaviour is clear for resolving the overlapping PUCCHs within “a set of overlapping PUCCHs” by reusing existing rules. No additional spec impact is expected except the determination of “a set of overlapping PUCCHs”. On the contrary, without restricting the maximum number to be 2, there can be lots of cases of two or more overlapping PUCCHs that need to be discussed or specified.

Similar issue was discussed in Rel-17 URLLC intra-UE multiplexing of different priorities and it was agreed to adopt the restriction of selecting up to 2 overlapping PUCCHs when resolving overlapping PUCCHs with different priorities for simplicity.

#### **Q3:**

**Do you agree that if the determination of “a set of overlapping PUCCHs” is clarified and the maximum number of the overlapping PUCCHs within “a set of overlapping PUCCHs” is restricted to be two, the UE behaviour is clear for resolving the overlapping PUCCHs by reusing existing rules defined in TS 38.213 9.2.6 and no additional spec impact is expected? If the answer is NO, please clarify what is the additional spec impact.**

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| Company | View |
| HW/HiSi | Does the **“a set of overlapping PUCCHs”** means the pairwise PUCCHs to be handled? If so we agree that if this set is clarified, then the behavior is clear. In our understanding, the PUCCH dropping is resolved by selecting **“a set of overlapping PUCCHs”** among ‘a group of overlapping PUCCHs’ and performing pairwise dropping.[Moderator] Yes, the understanding is correct.In addition, it needs to be pointed out that the determination of ‘**a set of overlapping PUCCHs**’ and the PUCCH repetition handling should happen earlier than 9.2.5, instead of mixed with 9.2.5 procedure (pseudo code for the set of Q).E.g., as shown in below, ‘a group of overlapping PUCCHs’ denote HARQ-ACK, SR, and CSI with repetition, and ‘**a set of overlapping PUCCHs**’ should be HARQ-ACK and CSI repetition as per the interpretation of the current spec.[Samsung] As discussed in section 4.1.7, SR should not be considered, this is not a valid case for 9.2.6 |
| NTT DOCOMO | In our understanding, methods 1, 3 need a further rule on how to select two PUCCHs, after determining the set. Meanwhile, method 2 determines a set of overlapping PUCCHs, and just a single overlapping handling for the set is applied if we understand QC’s intention correctly. This seems aligned with handling rule in pseudo-code in 9.2.5 of 213.Therefore, all mechanisms will need spec impact in the same level and this question seems a bit unfair. |
| OPPO | The additional spec impact is how to select “a set of overlapping PUCCHs” in all the overlapping PUCCHs participate in the procedure in 9.2.6. |
| CATT | Yes, basically if there are only two overlapping PUCCHs within “a set of overlapping PUCCHs”, the UE behavior is clear. |
| Nokia, NSB | If there is no more than two PUCCHs then everything is clear. The question to address is what to do when there are more than two overlapping PUCCHs. |
| ZTE | Agree DOCOMO’s view |
| Intel  | Yes, we agree the maximum number of the overlapping PUCCHs within “a set of overlapping PUCCHs” is restricted to be two, the UE behavior is clear.   |
| vivo | Yes. |
| Samsung | Yes |
| Ericsson | Yes |
| LG | Yes, and similar view with DOCOMO. |
| QC | Similar view with DOCOMO. The question seems a bit unfair. All three method have spec impact. Among the three, we think method 2 is the simplest. A UE just follows same approach as in Clause 9.2.5 to determine “a set of overlapping PUCCHs”. Then within that set, the highest priority channel is transmitted.  |
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Next, we compare the difference of the methods with examples assuming all the PUCCHs are with repetitions. The indexes of PUCCHs are ordered according to the order function defined in TS 38.213 9.2.5 copied below.

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| Set  to the set of resources for transmission of corresponding PUCCHs in a single slot without repetitions where- a resource with earlier first symbol is placed before a resource with later first symbol- for two resources with same first symbol, the resource with longer duration is placed before the resource with shorter duration- for two resources with same first symbol and same duration, the placement is arbitrary- the above three steps for the set  are according to a subsequent pseudo-code for a function  |

The first set of “a set of overlapping PUCCHs” is given for each method.

**Case 1: As shown in Figure 3**

Method 1) PUCCH 3 and PUCCH 2

Method 2) PUCCH 1 and PUCCH 2 (PUCCH 1 is the reference resource, PUCCH 2 overlaps with PUCCH 1)

Method 3) PUCCH 1 and PUCCH 2 (PUCCH 1 is the reference resource, PUCCH 2 overlaps with PUCCH 1)

**Case 2: As shown in Figure 4**



**Figure 4: Case 2 (all the PUCCHs are with repetitions)**

Method 1) PUCCH 3 and [PUCCH2]

Method 2) PUCCH 1 and PUCCH 2 (PUCCH 1 is the reference resource, PUCCH 2 overlaps with PUCCH 1)

Method 3) PUCCH 1 and PUCCH 2 (PUCCH 1 is the reference resource, PUCCH 2 overlaps with PUCCH 1)

Moderator’s comment: does overlapping should be prioritized over UCI type?

**Case 3: As shown in Figure 5**



**Figure 5: Case 3 (all the PUCCHs are with repetitions)**

Method 1) PUCCH 2 and PUCCH 1

Method 2) PUCCH 1, PUCCH 2 and PUCCH 3(PUCCH 1 is the reference resource, PUCCH 2 and PUCCH 3 overlap with PUCCH 1)

Method 3) PUCCH 1 and PUCCH 2 (PUCCH 1 is the reference resource, PUCCH 2 overlaps with PUCCH 1)

#### **Q4:**

**Do you agree with the above analysis of each method? If the answer is NO, please clarify.**

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| Company | View |
| HW/HiSi | As a confirmation:For method 1) and case 1, Firstly PUCCH 4 overlaps with PUCCH 3 so PUCCH 3 is dropped. Then PUCCH 1 is dropped by PUCCH 2. So ‘**a set of overlapping PUCCHs**’ is PUCCH 4 and PUCCH 3 (and then PUCCH 2 and PUCCH 1).For method 1) and case 2, the ‘**a set of overlapping PUCCHs**’ should be PUCCH 1 and PUCCH 2. [Moderator] Could you clarify why it should be PUCCH 1 and PUCCH 2? Please clarify how to determine a group of PUCCHs first and the spec impact of the group determination. For example consider case 2 and 4.For method 1) and case 3, the interpretation is correct. |
| NTT DOCOMO | At least Yes for Method 2.For Method 3, we are not sure whether the above is intended behavior since we cannot find how to select two resources from the set.[Moderator] First a set only includes two resources for method 3. UE determines the set according to the pseudo-code in 9.2.5 same as Rel-17 intra UE multiplexing of different priorities. It is the quite similar as method 2, the only difference is the reference PUCCH and the first overlapping resource is selected for Method 3 and the reference PUCCH and all the overlapping resources are selected for Method 2. |
| OPPO | For Case 3, Method 3) seems to select all PUCCH 1/2/3 in the first set? Is that correct understanding? |
| CATT | Yes |
| ZTE | At least method 2) is clear, other methods need more clarification. |
| Intel  | Yes, we agree.  |
| vivo | Yes. |
| Samsung | Yes |
| LG | Similar view with DOCOMO and ZTE. |
| QC | Similar view with DCM and ZTE.  |
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### **Details of Method 1)**

The order of the PUCCHs is based on the following aspects for a group of overlapping PUCCHs:

* Whether the PUCCH is with repetitions
* Whether where is overlapping
* Priority of UCI types.
* PUCCH starting time

Method 1) requires all the PUCCHs are overlapping with each other. The case for a group of overlapping PUCCHs where there are non-overlapping PUCCHs in the group need clarification. In addition, Method 1 requires including at least one PUCCH with repetitions, if there are PUCCHs with or without repetitions in a group, how to ensure there is at least one PUCCH with repetitions in the selected pair needs further clarification. Hopefully the proponents could help clarify the details. For example, consider Case 4 in Figure 6.



**Figure 6: Case 4 （only PUCCH1 is with repetitions）**

#### **Q5:**

**Do you have any comments/suggestions for Method 1?**

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| Company | View |
| HW/HiSi | For Case 4, it is subject to the legacy pairwise overlapping case which can be resolved by the legacy 9.2.6.The UE search for all PUCCHs with repetition following the time order and finds the PUCCH 1, then as it is overlapped with PUCCH 2, the PUCCH 1 is dropped. As there is no PUCCH w/ repetitions, the 9.2.6 procedure is finished. Then 9.2.5 will follow. |
| CATT | Same understanding as Huawei. |
| QC | We think method 1 has some ambiguity. There are two understanding of method 1. We hope proponents of method 1 can clarify which one is the correct understanding. Understanding 1: in a group of overlapping channels, UE keep forming a pair (denote the two entry of the pairs are entry A and entry B) based on the following while loop**While there are still overlapping channels*** **UE first select the channel with highest priority and put it in entry A.**
* **In the remaining channels, UE then select the channel with highest priority and put it in entry B.**
* **UE do pairwise dropping between entry A and entry B**

**End while loop**Understanding 2: in a group of overlapping channels, when UE form a pair, for both entries of the pair, say entry A and entry B, UE does the following two for loops.**For A sweep all channels in the group from highest to lowest priority****For B sweep all channels in the group from highest to lowest priority****Pairwise prioritization between A and B****End for loop for B****End for loop for A**Although both can work, the single while loop and double for loop could end up with different outcome. Which understanding is the correct understanding of method 1?Another question is how does method 1 form a group of overlapping channels?  |
| HW/HiSi2 | @QC We fail to see the difference between these two understandings. In understanding 1, when UE do pairwise dropping between entry A and entry B, B will be dropped due to its lower priority. Then if there are still overlapping channels, then the UE selects A and another PUCCH e.g. C, and so on… In understanding 2, pairwise prioritization between A and B is performed first, then A and C, and so on…, so isn’t the same as understanding 1? In addition, the inner loop seems redundant: if the intention is to select B as the highest priority, why there is a need to keep sweeping (to a lower priority than B) this loop?**For B sweep all channels in the group from highest to lowest priority****Pairwise prioritization between A and B****End for loop for B** |
| QC2  | @HW. Let me give an example and hopefully it can show the difference of the two understanding. There are five channels A, B, C, D, E in a formed overlapping group. Let’s say A is with priority 5, B is priority 4, C is priority 3, D is priority 2, E is priority 1, where 5 is the highest priority and 1 is lowest. Let’s assume the following overlapping scenario. With understanding 2, it is clear that the first channel being dropped in E. With understanding 1, may I know which channel is the first being dropped? In other words, how to “selecting two PUCCHs including at least one PUCCH with repetition among the group of PUCCHs in descending order”? After checking pairs A+B, A+C, should UE check A+D or should UE check B+C? Is the descending order based on the sum of priorities of the two channels in a pair? |
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UCI type-based ordering was discussed for Rel-17 URLLC intra-UE, for example, Option 3 and Option 4 in the agreement below require UCI type-based ordering, in RAN1#108e the majority companies agreed not to further consider Option 3 and Option 4 because of the significant modifications of current spec, the detailed discussion can be found in Section 3 Down-selection of PUCCH collision resolution options of the email discussion of Rel-17 URLLC intra-UE multiplexing/prioritization A [1].

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| **Agreement (RAN1#107b)**For resolving collision of PUCCHs of different priorities without repetition within a time unit, down-select from the following options:* + Option 1:
		- The reference PUCCH resource is determined as in Rel-15, i.e. based on the starting symbol and duration
		- In step 2.1-2, select up to one PUCCH resource overlapping with the reference PUCCH resource according to Rel-15 pseudo code
	+ Option 2:
		- The reference PUCCH resource is determined as in Rel-15, i.e. based on the starting symbol and duration
		- In step 2.1-2, select all the PUCCH resources overlapping with the reference PUCCH resource according to Rel-15 pseudo code
	+ Option 3:
		- The reference PUCCH resource is determined by prioritizing HP PUCCH over LP PUCCH on top of Rel-15 rules
		- In step 2.1-2, select all the PUCCH resources overlapping with the reference PUCCH resource according to Rel-15 pseudo code
	+ Option 4:
		- The reference PUCCH resource is determined by prioritizing LP PUCCH carrying HARQ-ACK on top of Rel-15 rules
		- In step 2.1-2, If a LP PUCCH carrying HARQ-ACK overlaps with multiple HP PUCCHs and one of the HP PUCCH includes HARQ-ACK, only select the HP PUCCH including HARQ-ACK in step 2.1-2; otherwise, select all the PUCCH resources overlapping with the reference PUCCH resource according to Rel-15 pseudo code

FFS: Details on time units for all options |

From moderator’s understanding, the spec impact and implementation complexity are similar as UCI type-based ordering rules as discussed in Rel-17 intra-UE multiplexing of different priorities. Considering the late stage of Rel-16, moderator’s suggestion is not to further consider UCI type-based ordering rules.

#### **Q6:**

**Do you agree that Method 1) has the largest spec impact and implementation complexity among the three methods? If the answer is NO, please clarify.**

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| Company | View |
| HW/HiSi | **Implementation perspective:**For Method 1), the implementation will loop all potential UCI types with descending priority, and for each UCI type, the overlapping/dropping behavior is performed.For Method 2)/3), the implementation will loop the reference PUCCH and its overlapping PUCCHs as per the 9.2.5 pseudo code.Both Methods introduce loop operation.**Spec perspective:**Some clarification may be needed for method 2) /3)**1,** In method 2), the set Q and order (Q) in clause 9.2.5 is reused. For the case shown below, ‘**a set of overlapping PUCCHs**’ is HARQ-ACK, SR and CSI repetition, and both SR and CSI repetition would be dropped. However, as per the interpretation of the current spec, ‘**a set of overlapping PUCCHs**’ should be HARQ-ACK and CSI repetition, and only CSI repetition would be dropped, then HARQ-ACK is multiplexed with SR. Method 2) seems not aligned with the current spec for this case.[Samsung] As discussed in section 4.1.7, SR should not be considered, this is not a valid case for 9.2.6**2,** For the case shown below for Method 2)/3), according to the pseudo-code in clause 9.2.5, the overlapped group is SR and HARQ-ACK (SR is the reference), and the UE would multiplex HARQ-ACK and SR, which is 9.2.5 procedure. But when the resultant HARQ-ACK+SR PUCCH overlaps with CSI rep PUCCH, it goes to 9.2.6. In this sense, 9.2.5 happens earlier than 9.2.6.C:\Users\l00285311\AppData\Roaming\eSpace_Desktop\UserData\l00285311\imagefiles\EE39C749-7EFA-4759-9C68-93A924B607A0.png[Samsung] As discussed in section 4.1.7, SR should not be considered, this is not a valid case for 9.2.6 |
| NTT DOCOMO | Now we are discussing clarification on Rel-16 UE behavior. We should discuss from Rel-16 perspective and there is no need to care Rel-17 topic. Once Rel-16 behavior is fixed, then Rel-17 WI can discuss on top of the behavior. So we think this question is meaningless.[Moderator] The whole discussion is for Rel-16 and the question is for Rel-16 spec impact. |
| CATT | No. The other alternatives change the fundamental processing order which has much larger specification impact in our view.[Moderator] Could you clarify the details of the processing order in your understanding? |
| Nokia, NSB | It is of course good to understand the spec impact of the candidate solutions, but we are not sure if this line of questioning is helping in the selection process. |
| vivo | Similar as NTT DOCOMO, now we are trying to clarify UE behavior in Rel-16, any method aligns or mostly align with current spec can be discussed. |
| Samsung | Yes |
| Ericsson | @HW/HiSi, Samsung:To Samsung: Why the case is not valid? In our understanding it is valid and based on the current spec, PUCCH with HARQ-ACK survives.[Samsung] The discussion is for resolving PUCCH with repetitions, i.e. for the procedure in 9.2.6. According to the comments for Q12, all the companies think SR in the above example should not be involved in 9.2.6 because it doesn’t overlap with a PUCCH with repetitions, my intention of “not a valid case” if for 9.2.6. |
| LG | Similar view with DOCOMO and vivo. |
| QC | YES |
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#### **Q7:**

**Do you agree NOT to further consider UCI type-based ordering rule for determining “a set of overlapping PUCCHs”? If the answer is NO, please clarify.**

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| Company | View |
| HW/HiSi | We DO NOT agree. For the case below, method 1) is aligned with the current spec.[Samsung] As discussed in section 4.1.7, SR should not be considered, this is not a valid case for 9.2.6

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| --- |
| A UE does not multiplex different UCI types in a PUCCH transmission with repetitions over $N\_{PUCCH}^{repeat}>1$ slots. If a UE would transmit a first PUCCH over more than one slot and at least a second PUCCH over one or more slots, and the transmissions of the first PUCCH and the second PUCCH would overlap in a number of slots then, for each slot of the number of slots and with UCI type priority of HARQ-ACK > SR > CSI with higher priority > CSI with lower priority…- if the first PUCCH and any of the second PUCCHs do not include a UCI type with same priority, the UE transmits the PUCCH that includes the UCI type with higher priority and does not transmit the PUCCH that include the UCI type with lower priority … |

 |
| NTT DOCOMO | From Rel-16 perspective, this way would be a possible option. Although it is not our preference, why dropped here is unclear. |
| CATT | We do not agree. |
| Nokia, NSB | At this stage, no. As with DOCOMO we don’t quite see the reason for forcing a downselection this way. |
| ZTE | UCI type-based ordering rule should be considered |
| vivo | Agree with DOCOMO and Nokia. |
| Samsung | Yes |
| Ericsson | No. The current spec supports the example shown by HW.  |
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### **Details of Method 2)**

From moderator’s understanding, Method 2) is clear for determining “a set of overlapping PUCCHs” and the spec impact is minimum among the three methods.

#### **Q8:**

 **Do you agree that Method 2) is clear for determining “a set of overlapping PUCCHs” and the spec impact is minimum among the three methods? If the answer is NO, please clarify.**

|  |  |
| --- | --- |
| Company | View |
| HW/HiSi | We agree that method 2) is clear for determining **“a set of overlapping PUCCHs”**. But the issue is it does not align with the legacy spec principle where 9.2.6 happens earlier than 9.2.5.Same clarification question from Q6 is pasted in below:For the case shown below for Method 2), according to the pseudo-code in clause 9.2.5, the overlapped group is SR and HARQ-ACK (SR is the reference), and the UE would multiplex HARQ-ACK and SR, which is 9.2.5 procedure. But when the resultant HARQ-ACK+SR PUCCH overlaps with CSI rep PUCCH, it goes to 9.2.6. In this sense, 9.2.5 happens earlier than 9.2.6.C:\Users\l00285311\AppData\Roaming\eSpace_Desktop\UserData\l00285311\imagefiles\EE39C749-7EFA-4759-9C68-93A924B607A0.png[Samsung] As discussed in section 4.1.7, SR should not be considered, this is not a valid case for 9.2.6 |
| NTT DOCOMO | Yes |
| CATT | We agree with Huawei that method 2 changes the legacy processing order at least in some cases. |
| ZTE | Yes |
| Intel  | Yes.  |
| vivo | Yes |
| Samsung | Yes |
| Ericsson | We thought we use the methods based on 9.2.5 to determine which two PUCCH resources to consider together. Then we do dropping rules for those two. And continue until there is no overlapping. |
| LG | Yes |
| QC | YES. To HW/CATT: The legacy spec principle where 9.2.6 happens earlier than 9.2.5 is for channels in a **same** set of overlapping PUCCHs. In this example, there are actually two different sets of overlapping channels. Method 2 form a first set of overlapping PUCCHs including SR and HARQ-ACK and there is no repetition in that group. So UE would mux these two channels and the resultant channel might overlap with CSI repetition. But this is another set of overlapping PUCCHs. Not sure the legacy applies to two different sets of PUCCHs.Maybe I know in method 1, how to determine **“a set of overlapping PUCCHs”**. I’d like to see how method 1 handle this example that HW provided.  |
| Huawei/Hisi | @QC: The following paragraph is copied from 213. HARQ-ACK and CSI rep are overlapping PUCCHs, so they should be proceeded in prior than any other 9.2.5 PUCCHs (without repetition). It is straightforward that HARQ-ACK and CSI rep belong to ‘**a set of overlapping PUCCHs**’If a UE has overlapping resources for PUCCH transmissions in a slot and at least one of the PUCCH transmissions is with repetitions over multiple slots, the UE first follows the procedures described in clause 9.2.6 for resolving the overlapping among the resources for the PUCCH transmissions.C:\Users\l00285311\AppData\Roaming\eSpace_Desktop\UserData\l00285311\imagefiles\EE39C749-7EFA-4759-9C68-93A924B607A0.pngIn method 1 for this case, according to the priority, the PUCCH order should be HARQ-ACK, SR, and CSI repetition. Then there would be following 4 steps: Step 1: UE sweeps PUCCHs subject to repetitions, then CSI rep is selected.Step 2: UE finds all PUCCHs overlapping with CSI rep, i.e. HARQ-ACK.Step 3: Prioritization is performed, i.e. CSI rep is dropped.Step 4: As there is no more PUCCH w/ rep., HARQ-ACK and SR perform 9.2.5 |
| QC2 | @Huawei, I disagree with this statement “It is straightforward that HARQ-ACK and CSI rep belong to ‘**a set of overlapping PUCCHs**’. please notice that, yes, it is obvious to a human that the above three channels in your example are in a set of overlapping PUCCHs. But UE does not have a human’s intelligence to figure that out. A UE has to run an algorithm to decide what is a set of overlapping PUCCHs. In my understanding, ‘**a set of overlapping PUCCHs**’ is defined based on the Pseudo code in section 9.2.5. Before you run method 1 to prioritize, can you please describe how a UE form a group of overlapping PUCCH in your example? |
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### **Details of Method 3)**

From moderator’s understanding, Method 3) is clear for determining “a set of overlapping PUCCHs” and the spec impact is acceptable.

#### **Q9:**

 **Do you agree that Method 3) is clear for determining “a set of overlapping PUCCHs”? If the answer is NO, please clarify.**

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| --- | --- |
| Company | View |
| HW/HiSi | Method 3) is not clear for determining “a set of overlapping PUCCHs” at least for the following cases. **Case A**: for PUCCH resources with same first symbol and same duration shown below, it is not clear whether **“a set of overlapping PUCCHs”** includes HARQ-ACK and SR repetition, or includes SR repetition and CSI, since the order among these PUCCHs is **arbitrary** according to clause 9.2.5 (marked yellow below).

|  |
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| **Copied from 38.213**Set $Q$ to the set of resources for transmission of corresponding PUCCHs in a single slot without repetitions where- a resource with earlier first symbol is placed before a resource with later first symbol- for two resources with same first symbol, the resource withlonger duration is placed before the resource with shorter duration- for two resources with same first symbol and same duration, the placement is **arbitrary**- the above three steps for the set $Q$ are according to a subsequent pseudo-code for a function $order(Q)$ |

[Samsung] In 9.2.6 only prioritization is considered, regardless of the order, the result is the same for Option 3, transmit HARQ-ACK.**Case B**: **“a set of overlapping PUCCHs”** includes HARQ-ACK and SR. The UE would perform multiplexing between HARQ-ACK and SR. Then if the resultant HARQ-ACK+SR overlap with CSI rep, then CSI repetition would be dropped? If so, the same situation with Q6 that 9.2.5 earlier than 9.2.6 for a group of overlapping PUCCHs.Note: As per our understanding of the current spec, **“a set of overlapping PUCCHs”** should be HARQ-ACK and CSI repetition, so CSI repetition would be dropped. Then the UE would perform multiplexing between HARQ-ACK and SR.[Samsung] As discussed in section 4.1.7, SR should not be considered, this is not a valid case for 9.2.6 |
| NTT DOCOMO | Yes |
| CATT | We agree with Huawei that method 3 cannot resolve the issue as shown in Case A. In addition, it changes the processing order as method 2. |
| ZTE | Yes |
| Intel  | We agree with Huawei that UE behavior by method 3 can not identify a pair of two PUCCHs in case A without ambiguity.  |
| vivo | Yes |
| Samsung | Yes |
| LG | Yes |
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#### **Q10:**

 **Do you agree that the spec impact is acceptable for Method 3? If the answer is NO, please clarify.**

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| Company | View |
| HW/HiSi | For method 3), it may need to clarify **“a set of overlapping PUCCHs”** at least for below cases as raised in Q9. [Samsung] No need to clarify for the first one, the order doesn’t impact the result, the second one is not a valid case for 9.2.6. |
| NTT DOCOMO | As commented above, how to select two resources from the set is unclear for us; thus spec impact is unclear.[Moderator] First a set only includes two resources for method 3. UE determines the set according to the pseudo-code in 9.2.5 same as Rel-17 intra UE multiplexing of different priorities. It is the quite similar as method 2, the only difference is the reference PUCCH and the first overlapping resource is selected for Method 3 and the reference PUCCH and all the overlapping resources are selected for Method 2. |
| CATT | Method 3 does not solve the issue. |
| ZTE | Agree with DOCOMO |
| Intel  | We agree with CATT and HW, it seems method 3 still can’t work for some cases.  |
| vivo | Method 3 does not solve the issue in the case in HW’s comment. |
| Samsung | Yes |
| Ericsson | For these two figures, spec is clear. |
| LG | Same view with DOCOMO and other companies. |
| QC | Same view as DCM and LG. |
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### **Preference of the candidate methods**

#### **Q11:**

**What is your preference of the above methods? Please provide your preference in the first table below. If you have strong concern on a method, please clarify the reason in the second table below.**

|  |  |  |
| --- | --- | --- |
| Method 1) | Support/ can live with | HW/HiSi, CATT |
| Cannot accept |  |
| Method 2) | Support/ can live with | NTT DOCOMO, ZTE,vivo, Samsung, Intel, LG, QC  |
| Cannot accept |  |
| Method 3) | Support/ can live with | Samsung |
| Cannot accept |  |
| Others |  |  |

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| --- | --- |
| Company | View |
| HW/HiSi | We need to first clarify all methods before making a preference. |
| OPPO | As our comment to Q3, before making preference and concern, it would be better to first clarify the definition of “first PUCCH” and “at least a second PUCCH” in the missing case where there are more than two PUCCHs within “a set of overlapping PUCCHs” and there is only one PUCCH with repetition (as shown in the following figure). To our understanding, in the above case, the PUCCH with repetition (SR) is regarded as the “first PUCCH”, all the PUCCHs overlapping with the “first PUCCH” (CSI and A/N) can be regarded as the “at least a second PUCCH”. Then UE will transmit the PUCCH with highest priority among “a set of overlapping PUCCHs” (A/N), drop all the other PUCCHs (SR with rep and CSI). |
| Nokia, NSB | Agree with Oppo. |
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### **Clarification of PUCCHs involved for resolving PUCCHs without repetitions**

The order of resolving PUCCHs with or without repetitions was discussed in Rel-17 URLLC intra-UE and a clear majority companies agreed that a UE first resolves PUCCHs with repetitions and then resolves PUCCHs without repetitions. The detailed discussion can be found in [1].

For resolving PUCCHs with repetitions, it should first identify which PUCCHs are involved, from moderator’s understanding, only PUCCHs with repetitions and PUCCHs overlapping with a PUCCH with repetitions should be considered. PUCCHs without repetitions that do not overlap with a PUCCH with repetitions should not be considered in 9.2.6.

#### **Q12:**

**Do you agree that in 9.2.6 only PUCCHs with repetitions and PUCCHs overlapping with a PUCCH with repetitions are considered?**

**Note: PUCCHs without repetitions that do not overlap with a PUCCH with repetitions are not considered in 9.2.6.**

|  |  |
| --- | --- |
| Company | View |
| HW/HiSi | Yes |
| NTT DOCOMO | Yes |
| OPPO | Yes |
| CATT | Yes |
| Nokia, NSB | Yes |
| ZTE | Yes |
| Intel  | Yes |
| vivo | Yes |
| Samsung | Yes |
| Intel  | We’d like to clarify. If method 3 or method 2 is used, does it mean, we first find which PUCCHs should be put into set Q, i.e., all PUCCHs with repetition, and also find PUCCHs without repetition which overlap with at least one PUCCH with repetition. After that, we can use pseudo-code in TS 38.213 9.2.5? For example, the figure provided by HW. We first put HARQ-ACK and CSI Rep in set Q, resolve the collision between HARQ-ACK and CSI Rep, drop CSI Rep. After that, we resolve colliions without repetition. We put HARQ-ACK and SR into set Q, and multiplex SR and HARQ-ACK. Is it correct understanding ? If method 1 is used, do we still need to find the set for PUCCHs to be handled in 9.2.6 first, which is similar to find all PUCCHs for set Q? Then, we’ll handle PUCCH collisions within the set according to UCI type? [Samsung] We share the same understanding as Intel. This is a general issue for all the options, for resolving the overlapping PUCCHs in 9.2.6, UE first needs to identify which PUCCHs are related, the other PUCCHs should not be considered in 9.2.6 as clarified by the note, for example SR in the figure above should be excluded when performing 9.2.6. |
| LG | Yes |
| QC | Yes. To Intel: to clarify method 2. Here is how it works. Step 1: UE use the pseudo code in 9.2.5 to form a set Q. Step 2: resolve overlapping in set QStep 2a: If the set has at least one PUCCH with repetition, UE goes to 9.2.6 and in 9.2.6, we proposed a CR to only keep the highest priority channel in set Q while drop the others (for simplicity).Step 2b If the set has no PUCCH with repetitions, UE goes to 9.2.5 to do mux. Step 3: go back to step 1 until UE cannot form any set Q with >1 channels.  |
| Intel2 | @QC, thanks for the explanation. In step1, according to 9.2.5, ‘Set  to the set of resources for transmission of corresponding PUCCHs in a single slot without repetitions’, it is not workable for repetition case. I’m wondering, maybe your intention is to put all PUCCHs regardless of repetition or not, and, your step 1, 2, 3. In other words, when using pseudo code in 9.2.5 to find a set of overlapping PUCCHs (i.e., a reference PUCCH and PUCCHs overlapped with the reference PUCCH), we don’t differentiate a PUCCH with or without repetition. Then, when we resolve the collision within the set, if there is at least one PUCCH with repetition, we go with 9.2.6. Is it my understanding correct?  |
| QC2 | @Yes, your understanding is correct. By the way, in the current spec, there are many places mentioned a group of overlapping PUCCH channels, where the definition of a group of overlapping channels is not clear. Like way explained to Huawei, yes, it is obvious to a human that a set of channels are overlapping. But UE does not have a human’s intelligence to figure that out. A UE has to run an algorithm to decide what is a set of overlapping PUCCHs. In my understanding, ‘**a set of overlapping PUCCHs**’ is defined based on the Pseudo code in section 9.2.5. |
|  |  |

### **Comparison of candidate options for resolving “a set of overlapping PUCCHs”**

For Case 1, UE transmits HARQ-ACK and CSI for Option 1. UE only transmits HARQ-ACK for Option 2 and 3.

For and Case 2, UE behaviour is the same for Option 1,2 and 3.

For Case 3, UE transmits HARQ-ACK and CSI for Option 1 and 3. UE only transmits HARQ-ACK for Option 2.

Option 4 is not clear for “first PUCCH”.

From moderator’s understanding, Option 1 has the best performance with respect to UCI transmission. However, the determination of “a set of overlapping PUCCHs” is not clear and complicated as discussed above. Option 1 has the largest spec impact as well as implementation complexity among the candidate options.

Option 2 is the simplest with respective to spec impact but with the worst performance with respect to UCI transmission.

Option 3 is in the middle ground between Option 1 and 2.

Option 4 needs further clarification.

#### **Q13:**

**Do you agree with the above analysis of each option? If the answer is NO, please clarify.**

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| --- | --- |
| Company | View |
| HW/HiSi | Yes |
| NTT DOCOMO | Why ‘method’ ‘option’ are discussed separately is unclear for us. [Moderator] The method is for determining “a set of overlapping PUCCHs”, this issue should be clarified first, some option doesn’t provide how to determine “a set of overlapping PUCCHs”, therefore, the discussion is decoupled. |
| CATT | We agree with the outcome but not the analysis on spec impact and implementation complexity for Option 1. |
| Samsung | Yes |
| QC | Option 4 is an interesting proposal. A quick question to option 4: How does option 4 deal with more than one PUCCHs with repetitions in an overlapping group of channels? |
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#### **Q14:**

**What is your preference of the above Options? Please provide your preference in the first table below. If you have any concern/comments on an Option, please provide the details in the second table below.**

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| --- | --- | --- |
| Option 1) | Support/ can live with | HW/HiSi, CATT |
| Cannot accept |  |
| Option 2) | Support/ can live with | Samsung, QC |
| Cannot accept |  |
| Option 3) | Support/ can live with | Samsung |
| Cannot accept |  |
| Option 4) | Support/ can live with |  |
| Cannot accept |  |
| Others |  | HW/HiSi OPPO |

|  |  |
| --- | --- |
| Company | View |
| HW/HiSi | Similar with Q11, we need to first clarify all methods before making a preference. |
| OPPO | Option 5):For cases where there are more than two PUCCHs within “a set of overlapping PUCCHs” and there is only one PUCCH with repetition: * Regard the PUCCH with rep as the “first PUCCH”, regard all the PUCCHs overlapping with the “first PUCCH” as “at least a second PUCCH”, UE transmit the PUCCH with the highest UCI priority among the “first PUCCH” and “at least a second PUCCH” -----No spec impact.

For cases where there are more than two PUCCHs within “a set of overlapping PUCCHs” and there is more than one PUCCH with repetition, select the PUCCH with rep as the “first PUCCH” according to the UCI priority or starting symbol/duration.----spec impact.[Moderator] Could you clarify how to determine “a set of overlapping PUCCHs” for your proposal? It is not clear for “according to the UCI priority or starting symbol/duration”, could you clarify the details?[OPPO2]:Agree the proposed conclusion P2.For cases where there are more than two PUCCHs within “a set of overlapping PUCCHs” and there is only one PUCCH with repetition: * UE behavior 1: Regard the PUCCH with rep as the “first PUCCH”, regard all the PUCCHs overlapping with the “first PUCCH” as “at least a second PUCCH”, UE transmit the PUCCH with the highest UCI priority among the “first PUCCH” and “at least a second PUCCH” ----That is, “a set of overlapping PUCCH” includes the “first PUCCH” and “at least a second PUCCH” overlapping with the first PUCCH.

For cases where there are more than two PUCCHs within “a set of overlapping PUCCHs” and there is more than one PUCCH with repetition:* First, UE select the PUCCH with rep as the “first PUCCH” according to the UCI priority (defined in 9.2.6) or starting symbol/duration (similar rule as in 9.2.5)
* then UE can perform behavior 1 (which is the current UE behavior), that is, UE find “at least a second PUCCH” based on the selected “first PUCCH”, and transmit the PUCCH with highest priority among “a set of overlapping PUCCH”;
* loop the above two procedure until there is no PUCCH overlapping with repetition PUCCH or there is no overlapping.

Hope that clarifies. |
| Intel  | We share similar view with HW that we need to first clarify/align our understanding for each methods. If the only unclear case is “there are more than two PUCCHs within “a set of overlapping PUCCHs” and there is more than one PUCCH with repetition,” we’re fine to exclude such case, e.g., UE does not expect such case to happen, to avoid additional complicated design for Rel-16 UE.  |
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#### **Q15:**

**Do you have any additional comments/suggestions for resolving PUCCHs with repetitions?**

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| --- | --- |
| Company | View |
| HW/HiSi | As the solutions on the table are quite diverse, maybe we may consider ‘UE does not expect…’ as a potential candidate. |
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### **More than two overlapping PUCCHs with repetitions and PUSCH(s)**

Samsung [5] discussed the issue of more than 2 overlapping PUCCHs with repetitions and PUSCH(s) of the same priority. The issue of more than 2 overlapping PUCCHs with repetitions and PUSCH(s) of the different priorities was discussed in Rel-17 URLLC intra-UE and it is agreed to drop the LP PUSCH before multiplexing with HP HARQ-ACK if the LP PUSCH overlaps with a HP PUCCH with repetitions.

|  |
| --- |
| TS 38.213 h10- third, the UE resolves the overlapping for PUCCH and PUSCH transmissions of different priority indexes- the UE drops PUSCH transmissions of smaller priority index that overlap with a PUCCH transmission with positive SR of larger priority index prior to multiplexing UCI in a PUSCH transmission of smaller priority index, if any- the UE drops PUSCH transmissions of smaller priority index that overlap with a PUCCH transmission with $N\_{PUCCH}^{repeat}>1$ repetitions of larger priority index prior to multiplexing UCI in a PUSCH transmission of smaller priority index, if any |

The intention of the above spec is to avoid unnecessary UCI dropping. For example, as shown in Figure 7, a HP HARQ-ACK overlaps with a LP PUSCH and the LP PUSCH overlaps with a HP SR with repetitions. If HP HARQ-ACK is multiplexed in the LP PUSCH before resolving the collision of LP PUSCH and HP SR, the HP HARQ-ACK will be dropped together with the LP PUSCH.



**Figure 7**

Samsung [5] pointed out that similar issue exists for the same priority as shown in Figure 2 copied below.

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**Copied Figure 2**

The issue was not discussed before and UE behaviour is not clear. There can be the following two behaviours.

Behaviour 1) UE first resolves overlapping PUSCHs and PUCCHs with repetitions and then resolves overlapping PUSCHs and PUCCHs without repetitions.

Behaviour 2) UE first resolves overlapping PUSCHs and PUCCHs without repetitions and then resolves overlapping PUSCHs and PUCCHs with repetitions.

From moderator’s understanding, the spec impact and implementation complexity is similar for the two behaviours, Behaviour 1 can provide better performance because it can avoid UCI dropping.

#### **Q16:**

**Do you agree that UE behaviour is not clear if a PUSCH overlaps with both a PUCCH with repetitions and a PUCCH without repetitions? If the answer is NO, please clarify your understanding and the related spec.**

|  |  |
| --- | --- |
| Company | View |
| HW/HiSi | Yes |
| NTT DOCOMO | Although we are not sure this situation is in scope of this thread, our view for this question is Yes.  |
| CATT | Yes |
| Nokia, NSB | Yes |
| ZTE | Yes |
| Intel  | Yes, we agree.  |
| vivo | Yes |
| Samsung | Yes |
| Ericsson | The scenario for the same priority is strange. But in general, the answer is Yes. |
| LG | Yes |
| QC | Yes |
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#### **Q17:**

**If the answer to Q16 is YES, which behaviour do you prefer?**

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| --- | --- |
| Company | View |
| HW/HiSi | We prefer behaviour 1, i.e. drop PUSCH and transmit HARQ-ACK. |
| NTT DOCOMO | Behavior 1. PUCCHs overlapping with repetitions are handled firstly according to 9 of 213. Similarly, PUCCH with repetition vs PUSCH should be solved firstly. |
| OPPO | Behavior 1 |
| CATT | We prefer behavior 1. |
| ZTE | Behavior 1 |
| Intel  | We prefer Behavior 1, which is aligned with existing principle, i.e. first resolve collision for PUCCH with repetition, and then, resolve PUCCH without repetition.  |
| vivo | We prefer behaviour 1, i.e. drop PUSCH and transmit HARQ-ACK. This is similar as SR PUCCH and HARQ-ACK PUCCH with no repetition overlapped with PUSCH, where PUSCH is dropped and HARQ-ACK is transmitted. |
| Samsung | Behavior 1 |
| Ericsson | Behaviour 1 for the same reason as DCM.  |
| LG | Behavior 1 |
| QC | Behavior 1 |
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## Second round

For the first issue, it seems there are quite a few misalignments based on the input of companies. Please find some of Moderator’s comment/questions inline above. The 2nd round will first try to align the basic understanding of the procedure of 9.2.6 instead of discussing the candidate options.

### **Order between 9.2.5 and 9.2.6**

As pointed out in the first round, the order of resolving PUCCHs with or without repetitions was discussed in Rel-17 URLLC intra-UE and a clear majority companies agreed that a UE first resolves PUCCHs with repetitions and then resolves PUCCHs without repetitions. The detailed discussion can be found in [1]. Related discussion is copied below.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| So processing order of collision handling of PUCCHs with repetition and without repetition needs to be determined. As per moderator’s understanding, collision handling of PUCCHs with repetition is performed first in Rel-15/16 as defined in TS38.213 Clause 9.

|  |
| --- |
| If a UE has overlapping resources for PUCCH transmissions in a slot and at least one of the PUCCH transmissions is with repetitions over multiple slots, the UE first follows the procedures described in clause 9.2.6 for resolving the overlapping among the resources for the PUCCH transmissions. |

Then collision handling of PUCCHs without repetition is performed as defined in Clause 9.2.5 and the following is defined to avoid a resultant PUCCH to be overlapped with a PUCCH with repetition.

|  |
| --- |
| For each PUCCH resource in the set  that satisfies the aforementioned timing conditions, when applicable,- the UE transmits a PUCCH using the PUCCH resource if the PUCCH resource does not overlap in time with a PUSCH transmission after multiplexing UCI following the procedures described in clauses 9.2.5.1 and 9.2.5.2- the UE multiplexes HARQ-ACK information and/or CSI reports in a PUSCH if the PUCCH resource overlaps in time with a PUSCH transmission, as described in clause 9.3, and does not transmit SR. In case the PUCCH resource overlaps in time with multiple PUSCH transmissions, the PUSCH for multiplexing HARQ-ACK information and/or CSI is selected as described in clause 9. If the PUSCH transmission by the UE is not in response to a DCI format detection and the UE multiplexes only CSI reports, the timing conditions are not applicable- the UE does not expect the resource to overlap with a second resource of a PUCCH transmission over multiple slots if the resource is obtained from a group of resources that do not overlap with the second resource.  |

**Question 7.1:**Do you agree that in Rel-15/16, collision handling of PUCCHs with repetition is performed before collision handling of PUCCHs without repetition?

|  |  |
| --- | --- |
|  | **Company** |
| Yes | Huawei/Hisi, Samsung, CATT, Intel, LG, ZTE, Nokia/NSB, Panasonic,OPPO,vivo, DOCOMO, Sony, NEC, InterDigital, Sharp, Ericsson, Apple |
| No | QC |

 |

However, based on QC’s explanation for option 2, it seems QC still has different understanding. If this basic understanding is not aligned, it is not possible for us to come to a consensus. Let’s try whether we can come to a conclusion regarding the processing order between 9.2.5 and 9.2.6.

#### **P1**

**Proposed conclusion:**

**For resolving overlapping PUCCHs with and/or without repetitions in a slot in Rel-16, a UE first performs 9.2.6 to resolve overlapping PUCCHs where at least one PUCCH is with repetitions, and then UE performs 9.2.5 to resolve overlapping PUCCHs without repetitions.**

**Note: The above is performed per slot.**

|  |  |
| --- | --- |
| Company | View |
| Apple | Support. It should be good to clarify also if two PUCCHs with repetition are present in the same slot(s), then 9.2.6 is run for each of them if they don’t overlap. If such a case is found not useful, we can also clarify the UE does not expect two PUCCHs with repetition are present in the same slot(s) yet they don’t overlap. [Moderator] The intention of the conclusion is performing the procedure per slot, add a Note for further clarification. |
| DCM | Support. According to section 9 of 213. |
| vivo | Support. it is aligned with the current spec. |
| Intel  | Support. We share same understanding with FL that UE resolves collision for PUCCHs with repetitions in a slot first, and then, resolve collisions for PUCCH without repetitions in a slot. In 9.2.5, before pseudo-code “Set $Q$ to the set of resources for transmission of corresponding PUCCHs in a single slot without repetitions”, then, we run pseudo-code until we resolve collisions for all PUCCHs within a slot. In other words, we don’t add any new PUCCH in set Q during the loop pseudo-code, i.e., we don’t add PUCCH with repetition in set Q during the loop pseudo-code. Therefore, it is clear the intention of the spec is to resolve all PUCCH with repetitions in a slot by 9.2.6, after finish the processing for all PUCCHs with repetitions in the slot, go to 9.2.5 for all remaining PUCCHs without repetition in the slot.  |
| OPPO | Support. |
| Huawei/Hisi | Support. |
| ZTE | Support |
| CATT | Agree. The spec is clear and the understanding is agreed by companies in Rel-17 intra-UE multiplexing discussion. |
| Moderator | Thanks to Intel for the explanation, based on spec quoted by Intel, the spec is clear that in 9.2.5 set Q includes all the PUCCHs without repetitions in a slot, the collision of PUCCH repetitions in a slot should be resolved before performing 9.2.5. |
| QC | We are fine with the proposal. We actually agree with everyone that UE resolve collision with repetition first, as it was settled already. We’d like to ask: in 9.2.6, when UE resolve overlapping PUCCHs where at least one PUCCH is with repetitions, UE has to form **the set of overlapping PUCCHs**, right? How does UE form the set? What we are proposing is that UE simply reuses the pseudo code in section 9.2.5 to form that set, as listed in method 2. **Method 2)** The overlapping groups are identified using the same approach as in Clause 9.2.5 for UCI multiplexing for PUCCH channels without repetition of same priority.I guess FL’s confusion on our position came from the following answer to Q12. Let’s call this approach 1. I admit approach 1 mixed 9.2.5 and 9.2.5. To strictly comply with rule of “9.2.6 first and 9.2.5 later”. We can consider reformulate it as approach 2. Approach 1: Step 1: UE use the pseudo code in 9.2.5 to form a set Q. Step 2: resolve overlapping in set QStep 2a: If the set has at least one PUCCH with repetition, UE goes to 9.2.6 and in 9.2.6, we proposed a CR to only keep the highest priority channel in set Q while drop the others (for simplicity).Step 2b If the set has no PUCCH with repetitions, UE goes to 9.2.5 to do mux. Step 3: go back to step 1 until UE cannot form any set Q with >1 channels.Approach 2: Stage 1: UE execute 9.2.6Step 1: UE reuse/borrow the pseudo code in 9.2.5 to form a set Q. Step 2: resolve overlapping in set QStep 2a: If the set has at least one PUCCH with repetition, UE goes to 9.2.6 to do prioritization ~~and in 9.2.6~~. For the prioritization, we proposed a CR to only keep the highest priority channel in set Q while drop the others (for simplicity).Step 2b: If the set has no PUCCH with repetitions, do nothing. Step 3: go back to step 1 until UE cannot form any set Q with >1 channels.Stage 2: UE execute 9.2.5Step 1: UE use the pseudo code in 9.2.5 to form a set Q. Step 2: resolve overlapping in set Q, by multiplexing themStep 3: go back to step 1 until UE cannot form any set Q with >1 channels.In our view, Approach 2 is really a little inefficient. A UE need run the Pseudo code in 9.2.5 twice in stage 1 and 2. While in stage 1, for the set of overlapping PUCCHs which have no repetition, it intentionally skips the multiplexing operation and push it to later stage 2. But if everyone wants to strictly follow the “repetition first, non-repetition later” as a golden rule, we are totally fine to go with approach 2. Again, our key point is that in 9.2.6, UE should reuse pseudo code in 9.2.5 to form the set of Q for overlapping PUCCHs, including PUCCHs with repetitions. Hope that clarifies our position. |
|  |  |

### **Clarification of 9.2.6 procedure**

In the first round, it seems there is still some misalignment regarding the understanding of the procedure in 9.2.6. Also, as mentioned by Huawei “it needs to be pointed out that the determination of ‘**a set of overlapping PUCCHs**’ and the PUCCH repetition handling should happen earlier than 9.2.5, instead of mixed with 9.2.5 procedure (pseudo code for the set of Q).” It seems necessary to further align our understanding on the procedure of 9.2.6.

In the first round, all the companies agree with Q12, with this understanding the case below given by Huawei is not valid for 9.2.6 because SR does not overlap with a PUCCH with repetitions.



**Figure 8**

It seems necessary to make a conclusion regarding the PUCCHs involved in 9.2.6 to avoid misalignment in further discussion.

The following proposed conclusion is to capture the understanding of Q12, all the companies replied YES in the first round.

#### **P2**

**Proposed conclusion**

**For resolving overlapping PUCCHs with repetitions in 9.2.6 in Rel-16, PUCCHs with repetitions and PUCCHs overlapping with a PUCCH with repetitions are considered. PUCCHs without repetitions that do not overlap with a PUCCH with repetitions are not considered.**

|  |  |
| --- | --- |
| Company | View |
| DCM | It would depend on definition of ‘a set of overlapping PUCCHs’ and how many PUCCHs in the set is PUCCH repetition.[Moderator] Could you please clarify why it depends on definition of ‘a set of overlapping PUCCHs’? All the companies including Docomo replied YES to Q12 in the first round, the conclusion is to capture the understanding of Q12.At least in Rel-15, where only two PUCCHs overlap with at least one PUCCH repetition is considered, the answer is YES. |
|  vivo | Agree with DCM that it would depend on definition of ‘a set of overlapping PUCCHs’.For Rel-15, YES.[Moderator] Could you please clarify why it depends on definition of ‘a set of overlapping PUCCHs’? All the companies including vivo replied YES to Q12 in the first round, the conclusion is to capture the understanding of Q12. |
|  Intel  | Support. In our understanding, when we determine ‘a set of overlapping PUCCHs’ , we only find the set of overlapping PUCCHs’ within a set **Z** (to differentiate from set Q for PUCCHs without repetition in 9.2.5). Set **Z** includes all PUCCHs with repetition, and PUCCHs without repetition which overlaps with at least one PUCCH with repetition. Within the set Z, there can be multiple sets of overlapping PUCCHs. It is similar to the concept of set Q and multiple sets of overlapping PUCCHs for PUCCH without repetition in 9.2.5. Therefore, we think the proposed conclusion is always true, no matter how to define ‘a set of overlapping PUCCHs’.  |
| OPPO | Agree. |
| Huawei/Hisi | For this case we agree that SR is not included in the ‘a set of overlapping PUCCHs’. But still we are wondering what is the processing procedure for Method 2) and Method 3).As per our understanding: Method 1): In 9.2.6: the PUCCHs w/ rep. are found out, i.e. CSI rep, then its overlapping PUCCHs are found out, i.e., HARQ-ACK. Then prioritization is performed. After that is 9.2.5.Method 2): In 9.2.5&9.2.6: Q set is constructed as HARQ-ACK (reference PUCCH), SR, and CSI rep; then 9.2.6 rule is performed, i.e., HARQ-ACK survives while SR and CSI rep are droppedMethod 3): In 9.2.6: the PUCCHs w/ rep. are found out, i.e. CSI rep. Then its overlapping PUCCHs are found out, i.e. HARQ-ACK. CSI rep and HARQ-ACK constructs Q set, and CSI rep. is then prioritized. After that is 9.2.5.Please proponents of Method 2) and Method 3) clarify if our understanding is incorrect.[Moderator] The proposed conclusion applies to all methods, this is to capture the understanding of Q12. As clarified above, the 2nd round is aiming for align our understanding of current spec first, and then we will further discuss the candidate solutions with the same assumption.  |
| ZTE | Support |
| CATT | Agree |
| Moderator | @DCM, vivo, please check whether Intel’s comments address your concern? |
| QC | Sorry for the confusion if caused our reply in previous round. We are actually fine with this proposal. See our response to P1. |
| Apple | Intel’s explanation provides an operational procedure to determine overlapping PUCCHs, it seems it works.  |

The issue was first raised for the ambiguity of Figure 1, copied below. Oppo also asked for clarification for a similar case in the first round. Based on the input in the first round, oppo, E/// and Intel think the case is clear and covered by the current spec while Nokia, vivo and QC think there is ambiguity.

The avoid the ambiguity, two related questions can be clarified first. 1) whether multiplexing is allowed in 9.2.6 as mentioned by Huawei~~.~~? 2) Whether the resulting PUCCHs after performing 9.2.6 can overlap~~.~~? If the answer is NO to both questions, the case in Figure 1 becomes clear. UE can only transmit HARQ-ACK and the result is aligned with the understanding of Intel, E/// as commented in Q2.



**Copied Figure 1**

Please note the following question is to ask for your understanding of current spec.

#### **Q18:**

**Do you agree the procedure of 9.2.6 only consider prioritization, multiplexing is not considered in 9.2.6? If the answer is NO, please clarify the reason.**

|  |  |
| --- | --- |
| Company | View |
| DCM | Yes |
|  vivo | YES |
| Intel  | Yes |
| OPPO | We agree that the procedure of 9.2.6 only consider prioritization, but we think there exists different understanding on how many PUCCHs in ‘a set of overlapping PUCCHs’ would participate in the prioritization procedure in 9.2.6 at a time.[Moderator] the details can be further discussed later, the intention is to first align basic understanding.  |
| Huawei/Hisi | YES@Moderator: ‘1) whether multiplexing is allowed in 9.2.6 as mentioned by Huawei.’— it is not our understanding (not sure anywhere of previous discussions causes any misunderstanding). PUCCHs w/ rep. will not perform multiplexing in 9.2.6. In 9.2.6 only prioritization is performed. The multiplexing of the remaining PUCCHs (w/o repetition) happen in 9.2.5 afterwards.[Moderator] Sorry for the confusion, my intention is you would like to ask for clarification whether multiplexing is allowed in 9.2.6.  |
| ZTE | Yes |
| CATT | Agree |
| QC | Sorry for the confusion if caused our reply in previous round. We are actually fine with an answer of Yes to this question. See our response to P1. |
| Apple | It is fair to state when Rel-15 design was put together, 9.2.6 probably didn’t not have this case (figure 1 case ) covered. Yes, multiplexing is not supported in 9.2.6. |

Please note the following question is to ask for your understanding of current spec.

#### **Q19:**

**Do you agree the resulting PUCCHs after performing 9.2.6 cannot overlap with each other? If the answer is NO, please clarify the reason.**

**Note: “the resulting PUCCHs” do not include the PUCCHs not involved in 9.2.6, for example SR in Figure 8.**

|  |  |
| --- | --- |
| Company | View |
| NTT DOCOMO | If intention of this question is ‘after performing 9.2.6 to solve any PUCCH overlap with repetition’, the answer is YES.[Moderator] Yes, add a note for clarification. |
|  vivo | It would depend on how to handle the overlapping. If option 1 is used, as shown in figure 1, SR id dropped, the resulting HARQ-ACK and CSI are overlapped.[Moderator] This question is to ask for your understanding of current spec. |
| Intel  | Yes.  |
| OPPO | Similar with vivo and as our comments to Q1, it depends on how to perform the prioritization procedure in 9.2.6. * If UE selects SR with rep as the “first PUCCH”, both HARQ-ACK and CSI as “at least a second PUCCH”, the PUCCH with highest priority in all the “first PUCCH” and “at least a second PUCCH” is transmitted and UE drop the remaining PUCCHs, then the resulting PUCCH after 9.2.6 cannot overlap with each other, the answer is YES;
* If the handling is something as vivo mentioned, then there would be HARQ-ACK and CSI overlapping, and in such a case, the HARQ-ACK and CSI would multiplex according to 9.2.5, the answer is NO.

[Moderator] This question is to ask for your understanding, please indicate which is your understanding. |
| Huawei/Hisi | If ‘**the resulting PUCCHs**’ means a group of overlapped PUCCHs, then it is possible that the remaining PUCCHs after 9.2.6 can overlap (e.g., HARQ-ACK and CSI in the figure 1, or HARQ-ACK and SR in the following figure). They will perform 9.2.5 afterwards.[Moderator] Please see the note for the clarification of ‘**the resulting PUCCHs**’, could you please clarify your understanding of the question based on the clarification of ‘**the resulting PUCCHs**’. Please note, SR is not involved in 9.2.6. |
| CATT | Our current understanding is that after performing 9.2.6, there would be no PUCCH overlapping with a PUCCH with repetition. But it is possible that there are overlapping PUCCHs without repetition as commented by other companies.[Moderator] Please see the note for the clarification of ‘**the resulting PUCCHs**’ |
| QC | Agree.  |

#### **Q20:**

**Do you think there is ambiguity issue for the case in Figure 1 based on current spec? Please clarify your understanding.**

|  |  |
| --- | --- |
| Company | View |
| NTT DOCOMO | Yes |
|  vivo | Yes |
| Intel  | We think there is no ambiguity. As explained in 1st round by OPPO, 1st and 2nd PUCCH is clear (1st PUCCH is SR with rep, 2nd PUCCH is HARQ-ACK and CSI), if we can understand ‘higher’ priority in the spec means ‘highest’, then, it is clear only HARQ-ACK is transmitted, SR and CSI is dropped. @Docomo, @vivo, could you explain why there is ambiguity in figure 1? If the spec says ‘highest’, do you think Figure 1 is clear ?

|  |
| --- |
| A UE does not multiplex different UCI types in a PUCCH transmission with repetitions over $N\_{PUCCH}^{repeat}>1$ slots. If a UE would transmit a first PUCCH over more than one slot and at least a second PUCCH over one or more slots, and the transmissions of the first PUCCH and the second PUCCH would overlap in a number of slots then, for each slot of the number of slots and with UCI type priority of HARQ-ACK > SR > CSI with higher priority > CSI with lower priority- the UE does not expect the first PUCCH and any of the second PUCCHs to start at a same slot and include a UCI type with same priority - if the first PUCCH and any of the second PUCCHs include a UCI type with same priority, the UE transmits the PUCCH starting at an earlier slot and does not transmit the PUCCH starting at a later slot- if the first PUCCH and any of the second PUCCHs do not include a UCI type with same priority, the UE transmits the PUCCH that includes the UCI type with higher priority and does not transmit the PUCCH that include the UCI type with lower priority  |

 |
| OPPO | Although our initial thinking is spec can cover the case in Figure 1 as explained by Nokia, we are open for further clarification to achieve common understanding among companies. |
| Huawei/Hisi | Yes.Method 1): In 9.2.6: SR w/ Rep. is found out. Then all its overlapping PUCCHs are found out, i.e., HARQ-ACK and CSI. Then the 3 PUCCHs are selected in pairwise with priority order, i.e. HARQ-ACK + SR. Then SR is dropped. Then it goes to 9.2.5 to handle the HARQ-Ack and CSI.Method 2): In 9.2.6: HARQ-ACK, SR w/ rep., and CSI are found out to construct Q. Then HARQ-ACK survives, and SR rep and CSI are droppedMethod 3): In 9.2.6: SR w/ Rep. is found out. Then all its overlapping PUCCHs are found out, i.e., HARQ-ACK and CSI. Then the 3 PUCCHs are selected in pairwise with 9.2.5 rule, i.e. CSI and HARQ-ACK. Not clear whether 9.2.5 is interrupted here?[Moderator] The question is to ask for your understanding of current spec, all the methods are new, not the current behavior, could you clarify your understanding of current behavior? |
| CATT | Yes. This case was identified that there would be ambiguity which triggers the discussion.[Moderator] Intel clarified the understanding of current spec, based on Intel’s understanding, this case is clear, Moderator tends to agree with Intel. If you don’t agree with Intel’s understanding, , could you please clarify the details. |
| Moderator | Intel’s understanding seems reasonable, if you have different understanding from Intel, could you please clarify the details? |
| QC | @Intel, @moderator, the issue is that higher can not interpret as highest 😊.  |

### **More than two overlapping PUCCHs with repetitions and PUSCH(s)**

For the 2nd issue, all the companies share the same understanding in the first round. The following proposal is made to adopt Behaviour 1.

#### **P3**

**Proposal**

**For resolving overlapping PUCCHs and PUSCHs of the same priority in Rel-16, a UE first resolves overlapping PUSCHs and PUCCHs with repetitions, if any, and then resolves overlapping PUSCHs and PUCCHs without repetitions, if any.**

|  |  |
| --- | --- |
| Company | View |
| NTT DOCOMO | OK |
|  vivo | OK |
| OPPO | OK |
| Huawei/Hisi | OK |
| ZTE | OK |

# Summary and conclusions

# Reference

1. R1-2202770, Summary #3 of email thread [108-e-R17-IIoT-URLLC-03], Moderator (CATT)
2. R1-2203130, Discussion on the collision of more than two overlapped PUCCHs with repetition, Huawei, HiSilicon
3. R1-2204907, Correction on the collision of more than two overlapped PUCCHs with repetition, Huawei, HiSilicon
4. R1-2204974, Issue on PUCCH overlapping with PUCCH with repetitions, Qualcomm Incorporated
5. R1-2203851, Remaining issues on intra-UE multiplexing/prioritization, Samsung
6. R1-2203418, PUCCH collision handling in case of PUCCH repetition, CATT
7. R1-2203279, [Draft CR] Intra-UE prioritization/multiplexing considering PUCCH repetition, Nokia, Nokia Shanghai Bell
8. R1-2204001, Clarification on collision handling for overlapping PUCCHs with repetitions, OPPO