3GPP TSG RAN WG1 #104-e R1-21xxxxx

e-Meeting, January 25th – February 5th, 2021

**Source: Moderator (Sharp)**

**Title: FL Summary#2 on Enhancements on PUSCH repetition type A**

**Agenda Item: 8.8.1.1**

**Document for: Discussion** **and Decision**

# Introduction

This document is intended to facilitate view exchange and discussions for the following assigned email discussion.

[104-e-NR-CovEnh-01] Email discussion on enhancements on PUSCH repetition type A – Toshi (Sharp)

* 1st check point: Jan 28
* 2nd check point: Feb 2
* 3rd check point: Feb 4

# Increasing the maximum number of repetitions

The discussions in this section are based on the following objective in the Coverage Enhancement WID.

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| The detailed objectives of the work item are as follows:   * Specification of PUSCH enhancements [RAN1, RAN4]   + Specify the following mechanisms for enhancements on PUSCH repetition type A [RAN1]     - **Increasing the maximum number of repetitions up to a number to be determined during the course of the work.**     - The number of repetitions counted on the basis of available UL slots. |

# The maximum number of repetitions

In Rel-15/16, RRC parameter *pusch-AggregationFactor* configures the number of repetitions for PUSCH, where the candidate value set of *pusch-AggregationFactor* = {2, 4, 8}. TRDA based dynamic repetition number indication introduced in Rel-16 is applied when configured, where the candidate value set of *numberOfRepetitions-r16* = {1, 2, 3, 4, 7, 8, 12, 16}.

13 companies (ZTE, OPPO, CATT, vivo, Intel, China Telecom, NEC, Panasonic, Xiaomi, Sierra Wireless, Apple, Qualcomm, NTT DOCOMO) provided their views that the maximum number of repetitions should be increased to 32. One ~~major reason is~~ company expressed that it enables 8 actual repetitions in DDDDDDDSUU slot structure. Two companies (CMCC, Samsung) also accepted increasing it to 32.

2 companies (Huawei, HiSilicon) mentioned that the currently supported maximum number of repetition being 16 is sufficient to meet the coverage requirement.

1 company (Sharp) proposed considering the maximum number of repetitions of 36 which enables 8 actual repetitions in DDDSU slot structure.

1 company (IITH) preferred increasing of the maximum number of repetitions to 128.

1 company (Ericsson) proposed that assuming FDD for determination of the maximum number of repetitions without postponement justifies an increase to 20. Values greater than 20 needs confirmation that the corresponding data rates support vocoder operation with sufficient quality and low enough higher layer overhead.

2 companies (Nokia, Nokia Shanghai Bell) provided their views that specification changes on TDRA should be avoided for the Rel-17 enhancements on PUSCH repetition type A.

1st round discussion

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| **FL observation 1-1:**  Clear majority supports 32 as the maximum number of repetitions.  **Question 1-1:**  Companies are invited to provide technical reasoning / technical concern to the majority’s view. | |
| **Company** | **Comment** |
| Samsung | If a number larger than 16 is agreed, the maximum size of the TDRA table remains unchanged (64 rows, 6 bits in DCI for the indication) as a UE’s coverage condition is slowly varying and the TDRA table can be adjusted by RRC. |
| Qualcomm | Support increasing maximum number of repetitions to 32 for both RRC configured PUSCH and dynamic TDRA-based PUSCH grants. This aids VoIP traffic where one aggregated packet is generated every 40 ms and the resulting packet can be repeated a large number of times. Allowing large number of repetitions is also useful from an NTN perspective where retransmissions may not be feasible due to large time delays. |
| Apple | We supports 32 as the maximum repetition number, other values and indication can discuss later. |
| Intel | We are fine with the proposal to support 32 as maximum number of repetitions. |
| China Telecom | Support the proposal to increase the maximum number of repetitions to 32. The feature is independent of the number of repetitions counted on the basis of available UL slots. Even the maximum number of repetitions is increased to 32, the actual number of repetitions is still very limited for TDD. |
| NTT DOCOMO | We supports 32 as the maximum number for the repetition. |
| ZTE | Agree to support a maximum of 32 repetitions.  Considering TDD configuration, increasing the number of repetitions is desirable to make sure the actual number of repetitions transmitted. In addition, from UE capability point of view, increasing the number of repetitions with may be easier for coverage enhancement compared to the number of slots counted by available slots. |
| Panasonic | We support 32 as the maximum repetition number, since for Rel.15/16 PUSCH repetition Type A mechanism, supporting 32 as the maximum number of repetitions seems reasonable considering the actual number of repetitions and slot structure. |
| CATT | We support 32 as the maximum repetition number. Besides, the gNB does not always have to configure/indicate 32, if it thinks 32 is rather too large. |
| Sharp | We also think 32 repetitions should be supported. In addition, we suggest considering 36 as well, which enable 8 actual repetitions in DDDSU slot structre. |
| NEC | We support 32 as the maximum number for the repetition. |
| CMCC | From our view, 16 repetitions are sufficient for the coverage enhancement.  Our understanding is that, after the discussion of available slot, the 16 or 32 repetition should work under the definition of available slots. In this condition, the actual repetition should be more close to the ‘nominal’ repetition, not the poor 8 repetitions mentioned before.  For the RRC configured *AggregationFactor*, we do not see much motivation to extend the repetition number, since TDRA based repetition indication have provided sufficient flexibility. Please clarify the motivation and using scenarios. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | We understand the motivation for 32 for VOIP scenarios. But for eMBB, the coverage gap is around 7dB. In our simulations we showed that without 128 actual repetitions, the coverage gap cannot be overcome. So, we would like to understand the motivation behind 32 for all scenarios. |
| OPPO | Agree to support 32 as the maximum repetition number and this is also FDD 20 slot aggregation.  We think there should be clarification on how to introduce the 32 slots, Via numberOfRepetitions-r16 or Aggregation factor. If we add the 32 into numberOfRepetitions-r16 it will also applicable to Repetition type B. Thus, we consider to add 16 and 32 to aggregation factor. |
| vivo | Maximum number of repetitions can be extended to 32. |
| Sierra Wireless | Support but when making the agreement, we need to clarify that 32 repetitions is only supported when TBoMS (TB over multi-slots) is NOT used and how repetitions with TBoMS is FFS. The concern is that if TBoMS support coding over e.g. 4 slots, then the transmission time could be as long as 4\*32 =128 slots. Alternatively, we could specify as maximum slots of transmission. |
| Ericsson | There’re 2 options to enhance Type A PUSCH repetition according to the WID. And there seem to be two possible ways of specifying Options 1 and 2, which will affect how to determine the maximum number of repetitions for option 1 and option 2:  1) There are two UE capabilities for the two options  2) There is one UE capability.    If there are two capabilities, then they should be able to be configured differently, and there should be two different maximum numbers of repetitions for 2 options (option 1 has the increased maximum number of repetitions, while option 2 has legacy repetition factors).  If there is one UE capability, then the operation would likely be unified, and the maximum number of repetitions should be determined according to Option 2, which may not need as large a number of repetitions, i.e. same as legacy and there’s no need to increase number of repetitions.  Another point is that Options 1 and 2 are not equally useful for FDD and TDD. Increasing the maximum number of repetitions directly increases the repetitions for FDD, but less so for TDD. So we can consider different use cases when determining the maximum values for Options 1.  Assuming two UE capabilities is the least restrictive at this stage, and so we’re fine to further discuss a maximum number of repetitions for option 1 based on the use cases and data rates agreed for the study. However, we do not think it necessary to optimize the number of repetitions for option 2. |
| Nokia/NSB | Firstly, we would like to ask the FL (and the group) for clarification on the following question:   * Are we going to specify the two functionalities independently, i.e., a UE that supports “increasing the maximum number of repetitions” may or may not support “counting the number of repetitions based on the available UL slots”? or the two functionalities need to be both supported in a single new UE feature?   We understand that, at this stage, we are not discussing about UE feature yet. However, an answer for the above question would help clarifying our motivation for exact value of maximum number of repetitions. Indeed, from the FL’s summary, the rationale for using 32 repetitions is to enable 8 actual repetitions for some TDD pattern in case “counting the number of repetitions based on the available UL slots” is not considered. This implies that we are specifying the two functionalities independently. However, as pointed out by many companies during SI phase, the two functionalities are leading to the same goal. Therefore, specifying two independent features that solve the same issue does not seem to be a good approach.  On the other hand, in case the “counting the number of repetitions based on the available UL slots” is used together with “increasing the maximum number of repetitions”, using 32 repetitions is a bit too high especially when latency is taken into account. We think that more substantial elements should be considered before taking this decision.  In addition, we share Samsung’s view that the maximum size of TDRA table should remain unchanged.  Finally, we are not sure that using any specific slot structure to identify “a good number” is a wise course of action, when we have the possibility for slot structure to be dynamically changed using SFI. Note that we are considering SFI as an important “variable” in many other discussions occurring in the WI. Is it less important here, for some reasons? If yes, if may be good to clarify. |
| Lenovo, Motorola Mobility | We are fine to support 32 as the maximum number of repetitions. Although, we expect that more 16 repetitions should not be configured for the mode when this repetition number is the number of available UL slots. |
| Huawei, HiSilicon | The main motivation of two bullets in WID is to ensure enough actual repetitions (e.g. >8) to meet coverage requirement. To achieve the same goal, a unified UE capability rather than specifying the 2 bullets independently seems to be a better approach. Given the support of bullet 2, current supported 16 repetitions can achieve the goal of 8 actual repetitions and there is no necessity of further increasing the maximum repetition number, e.g. to 32.  Furthermore, by increasing the maximum repetition number along with counting on an available-slot basis, there might be potential risk of overlapping with LPWA which is not within the scope of CE SID/WID. |
| Xiaomi | Support 32 as the maximum number of repetitions. |

**Summary on Question 1-1 in the 1st round discussion is as follows:**

A large majority of companies expressed that the maximum number of repetitions should be extended to 32.

**FL observation 1-1 after the 1st round discussion:**

Need more discussions on increase of the maximum number of repetitions. The values which have been raised by Companies’ comments and tdocs are listed below:

* 16 (This implies no extension from Rel16.)
* 20
* 32
* 36
* 128

It seems companies have different assumptions on UE capability(ies) to support 1) increase of the maximum number of repetitions and 2) the number of repetitions counted on the basis of available slots. The FL would like to ask companies to provide their views on the UE capability(ies). It should be noted that this does not intend to make any decision on corresponding UE feature(s), but is only for the purpose to exchange views for designing of the maximum number of repetitions.

2nd round discussion

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| **FL observation 1-1a:**  It seems companies have different assumptions on Rel-17 PUSCH repetition mode(s) to support 1) increase of the maximum number of repetitions and/or 2) the number of repetitions counted on the basis of available slots. In order to facilitate better understanding of each company’s proposal on the maximum number of repetitions, it is good to exchange companies’ views on the following options.   * Option 1: A single mode supporting both 1) potential increase of the maximum number of repetitions and 2) the number of repetitions counted on the basis of available slots * Option 2: Two independent enhancements, one supporting 1) potential increase of the maximum number of repetitions and the other supporting 2) the number of repetitions counted on the basis of available slots.   + Note: Configuring both enhancements to a UE is not precluded.   It should be noted that this does not intend to discuss corresponding UE feature(s), but is only for the purpose to exchange views for designing of the maximum number of repetitions.  **Question 1-1a:**  Any views on the above options? | | |
| **Company** | **Comment** | |
| Lenovo, Motorola Mobility | If we understand your options correctly, is option 1 saying that when maximum number of repetitions are increased, then also the counting can be done on the basis of available slots? And is option2 saying that one mode operates with increased number of maximum transmissions, but in that case, the counting is done as currently supported and if the maximum number of repetitions are not increased, then counting is done on basis of available slots?  If the above understanding is correct, then we would support option2 as we don’t see the need to increase the maximum number of repetition and also perform counting on basis of available slots for UL. | |
| Intel | This seems closely related to UE features, which is a bit early to discuss this.  We slightly prefer Option 2. It is not necessary to increase the number of repetitions while supporting the repetition on the basis of available UL slots at the same time. | |
| Qualcomm | We prefer to keep them separate and prefer Option 2. It doesn’t seem to make sense to penalize a UE and restrict it to fewer repetitions just because it counts carefully. | |
| ZTE | We prefer Option 2. gNB can independently configure one or both of the two enhancements. We don’t see a need to have to bundle them together. | |
| Panasonic | We prefer Option 2. For the repetition on the basis of available UL slots, there would be no need to increase the number of repetitions from Rel.16. | |
| China Telecom | Prefer option 2. These two functionalities can be configured separately. | |
| OPPO | Option 1 supports a single mode while Option 2 supports two independent modes.  Maybe one of the two modes can meet the coverage of eMBB and VoIP. But considering the coverage enhancement of NTN VoIP, it may not be appropriate to consider only one mode. For NTN VoIP, if only increase of the maximum number of repetitions, the number of repetitions maybe much larger than 32. If the maximum number of repetitions are not increased, then counting is done on basis of available slots, the number of repetitions maybe much small.  We prefer Option 1, because of it can meet the coverage of NTN VoIP, or shall we add Option 3: Three modes, 1) increase of the maximum number of repetitions; 2) the number of repetitions counted on the basis of available slots; 3) both 1) and 2). | |
| Samsung | We prefer Option 2 – independent features. | |
| Nokia/NSB | First of all, let us clarify that we agree with the majority that it should be sufficient to specify only one of the two approaches because they lead to the same result. In this regard, Option 1 is not an optimal solution. Unfortunately, the WID includes both approaches and we need to specify both.  Now, our concern for Option 2 is that these two approaches cannot be considered as two operation modes. Because they are just different ways of counting the number of repetitions, but they are not different in terms of the operation of the repetition procedure. Therefore, there is no reason why the gNB would select between the two modes if the UE supports at least “counting the number of repetitions based on the available UL slots”. We think that the confusion comes from the wording “mode”. Because “two modes” would mean that the gNB could switch between the two and would also mean that the UE must support both approaches, but each mode operates differently. Therefore, for the sake of progress, we can support Option 2 with the following modifications (in red):  *Two independent ~~modes~~ enhancements, one supporting 1) increase of the maximum number of repetitions and the other supporting 2) the number of repetitions counted on the basis of available slots.*  With these modifications, we can now discuss these two enhancements independently and let the discussion about whether/how to use the two enhancements in the future UE feature discussion in other AI/session. There will be no discussion on how to switch between the two modes here. | |
| Ericsson | Option 2. We share the majority view that there’s no need to increase number of repetitions if the only actual repetitions are counted. | |
| NTT DOCOMO | We prefer Option 2. In our understanding, in order to apply e.g. 8 PUSCH repetitions for DDDSU TDD patterns, we have two ways, 1) increase of the maximum number of repetitions, or 2) the number of repetitions counted on the basis of available slots, so that both 1) and 2) may not be considered at the same time. | |
| Sharp | For the purpose of designing the maximum repetition number at this stage, assuming independent configurations of those functions, i.e. Option 2, would be a safer choice to ensure support of the sufficient number of repetitions. | |
| Apple | We slight prefer Option 1.  Based on the evaluation, the gap between the PUSCH and benchmark channel is large over 8dB. Simple solution could not compensate this gap. If repetition number is doubled, at most 2dB gain is achieved. From this point, it will provide the better performance if both option 1 and option 2 are supported. 2) of Option 2 will increase the transmission delay dramatically for unpaired spectrum mode, only supporting this one makes little sense. Option 1 provide better performance and scheduling flexibility with two combinations. | |
| vivo | Option 2. UE only uses one mode based on RRC configuration. | |
| CATT | We prefer Option 2 in principle. From gNB’s perspective, separate configuration provides flexibility for a gNB to enhance the UL coverage, based on its condition like bands, TDD configuration, etc.  But we would like to confirm that Option 2 does not preclude the case where the gNB can configure both modes to a UE to maximize the coverage as much as possible, if the UE support both modes. This seems similar to OPPO’s preference (denoted as Option 3 by OPPO). | |
| Huawei, HiSilicon | | Current description of Option 1 and 2 is not clear enough:   * Because the maximum number may be eventually 16, therefore, “increase of the maximum number” should be changed to “potential increase of the maximum number” for both Option 1 and 2, or add a note that 16 could be the maximum number of Rel-17 PUSCH repetition type A. | |
| InterDigital | | We prefer Option 2. We have the same understanding as NTT DOCOMO. For Option 2 (1), depending on the TDD configuration we need to increase the number of repetitions to achieve the target number of repetitions. | |
| CMCC | | We share a similar view with Nokia that, the mode is not a suitable wording, which implies the operation modes or working modes could not work together.  If the repetition numbers are counted on the basis of available slots, current configuration of repetition number is enough for 8 and 16 repetitions. And WID still provide a chance to reconsider the maximum number. And considering the definition of available slots, the actual repetition number is increased.  Counting on the basis of the available slots is more straightforward, like counting the uplink slots in a TDD system for the PUSCH transmissions directly. And also this aligns the behavior of PUSCH repetition with PUCCH repetitions. It seems redundant to count the downlink slots between uplinks as one or several PUSCH repetitions.  Although we naming those enhancements 1) and 2) as mode, they are also actually UE capabilities. From our understanding, though UE cannot support maximum 32 repetitions without enhancements, it may not big enough to be defined as a separated capability. | |
| Qualcomm | | We may not have had a proper understanding of the two options when we first responded. To follow up on our earlier comment, we prefer to support only 1 mode of counting in a R17 UE. Allowing both flavors adds another point of divergence that we prefer to avoid. Regardless of how we count, we think its useful to allow up to 32 repetitions. We therefore prefer to go with Option 1. | |
| Xiaomi | | We prefer option2. It is no need to bundle two scheme together. But it is do necessary to keep both the two enhancement schemes. It depends on gNB configuration and the two methods can be supported case by case for more flexibility. For example, when the actual number 16 is enough, it only need to support method 2, and the method 2 only needs to change the counting mechanism, without changing the TDRA table or the DCI overhead. But, in some extreme cases with very poor coverage, the maximum 16 actual repetition is still not enough, it needs to increase the maximum number of repetitions to solve the problem fundamentally.  Thus, we suggest that which method is supported or both depends on the CE target. | |
| Lenovo, Motorola Mobility | | We support option 2. In our view, both modes can be configured to UE, however, only one of the two modes is applied based on number of repetitions indicated. We don’t see the need to apply counting based on available slots when number of repetitions are more than 16. | |
| Apple | | I understand the added potential for option 1. But for opion2 as the independent enhancements, if potential added, it means no enhancement. And increasing the maximum number of repetition was already agreed in WID, the open issue just the exact number. | |

**FL observation 1-1a after the 2nd round discussion:**

Need more discussions on increase of the maximum number of repetitions. The values which have been proposed by Companies are listed below:

* 16 (This implies no extension from Rel16.)
* 20
* 32
* 36
* 128

For the purpose of designing of the maximum number of repetitions, the following views have been provided in terms of the relation between two enhancements, 1) increase of the maximum number of repetitions and 2) the number of repetitions counted on the basis of available slots:

* Option 1: Two enhancements are bundled. (Two enhancements are always configured at the same time.)
  + Qualcomm, Apple, Nokia, NSB (1st preference)
* Option 2-A: Either one of two enhancements is configured to a UE. (Two enhancements are not configured at the same time.)
  + Lenovo, Motorola Mobility, Intel, Panasonic, Ericsson, NTT DOCOMO, vivo, Lenovo, Motorola Mobility
* Option 2-B: Two enhancements are configured independently. (Two enhancements can be configured at the same time.)
  + ZTE, China Telecom, OPPO, Nokia, NSB (2nd preference), Sharp, CATT, CMCC

The above views would be taken into account in the next round of discussion

3rd round discussion

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| In the 2nd round discussion on FL observation 1-1a, a large number of companies expressed their views 1st enhancement (increase of the maximum number of repetitions) and the 2nd enhancement (the number of repetitions counted on the basis of available slots) are separately/independently configured (i.e. Option 2-A or Option 2-B of the above FL observation 1-1a after the 2nd round discussion). In other words, the majority assumes that the 1st enhancement is always configured without configuring of the 2nd enhancement or that the 1st enhancement can be configured without configuring of the 2nd enhancement. Based on this observation, it is suggested that the 1st enhancement is designed such that the 1st enhancement achieves sufficient coverage improvement by itself (i.e. without the 2nd enhancement).  **FL proposal 1-1b:**  Increase of the maximum number of repetitions is designed such that it achieves coverage improvement assuming that the number of repetitions is counted based on contiguous slots (i.e. not based on available slots).  **Question 1-1b:**  Any views on the above FL proposal 1-1b? Moreover, if there is any other assumption (e.g. TDD configuration, service type such as VoIP) to be considered as well, please also describe it. | |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | We tend to agree with FL proposal and share similar understanding that UE can be configured with enhanced PUSCH repetition type A. And when it is configured and if number of repetitions are greater than currently supported values, then mode 1 is applied (counting based on contiguous slots) and if number of repetitions are based on currently supported values, then mode 2 is applied (counting based on available slots). |
| Nokia/NSB | We are fine with the FL’s proposal for the sake of progress. Let us further share our view on this aspect as follows.  Looking at the outcome of the previous round of discussion, it seems that, by splitting Option 2 into 2 sub-options depending on whether the two enhancements can be configured together or not, we have been moving away from the main focus of this topic. What we need to agree on is whether defining the maximum number of repetitions by counting contiguous slots or available slots. From our reading of the WID, the latter should be applied. However, it seems that the middle ground is to have 2 independent enhancements. Therefore, we are fine with it for the sake of progress. Discussions on whether the two enhancements can be configured together or not can be can happen later, in UE feature discussion. |
| Intel | We are fine with the FL’s proposal in principle, but we are not sure whether we need to discuss this as this is closely related to UE feature discussion. In our view, we can further discuss it at a later stage.  In our view, increasing maximum number of repetitions and counting PUSCH based on available UL slots are two independent enhancements, which should not be configured for UE to operate at the same time. |
| Huawei, HiSilicon | Not OK yet. If independent configurability of two slot-counting methods is the only purpose as the summary claimed, then the maximum number should be determined based on available slots. Because such configurability can be achieved **only when** all UEs capable of Rel-17 PUSCH petition type A support a repetition counting based on available slots. Otherwise, any UEs incapable of such counting leaves no option for gNB to configure.  Since a UE has supported the counting based on available slots, the maximum number of repetition should be determined based on available slots, **otherwise, it is kind of over-design which can unnecessarily increase UE cost**, like potentially increased buffer and increased maximum occupation time of one HARQ process for one received DCI.  Additionally, with the following agreement we just achieved, it seems not much UE complexity for the counting on a basis of available slots than the counting on a basis of contiguous slots.  *Agreements:*  *For defining available slots: a slot is determined as unavailable if at least one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the symbol not intended for UL transmissions*   * *FFS details*   Therefore, we propose,  ***Proposal****: Increase of the maximum number of repetitions is designed such that it achieves coverage improvement assuming that the number of repetitions is counted based on available slots.*  If the proposal is not agreeable, then we suggest to postpone such discussion until we have more concrete design for how to count available slots. |
| CATT | We have concern on this proposal. For the maximum number of repetitions design, increased maximum number of repetitions seems more useful in FDD where new counting available slot rule does not help. However, it may be rarely used in TDD if new counting available slot rule applies, unless extreme coverage is pursued. In this regard, we think this proposal does not cover all cases, or trying to use increased maximum repetition number to cover TDD case, which is inefficient and may lead to over design for FDD. We hope a united design can be applied for both FDD and TDD, but not sure this proposal helps.  For whether the two enhancements can be configured together or not, we prefer to discuss this in a latter phase. But in our view, since gNB has more knowledge on the situation than UE, a more flexible way is UE support both increased repetition number and new counting rule, and left to gNB to decide which enhancement (or both) is configured. |
| TCL | We are fine with the FL’s proposal for the sake of progress, but we need to further discuss whether the two enhancements can be configured together or not. |
| Sharp | Agree with FL proposal. Whether to have a common/separate UE feature(s) should be discussed later in appropriate AI. However, we cannot defer a decision of the maximum number of repetitions until the end of the UE feature discussion. Assuming contiguous slots would be safer to ensure support of the sufficient number of repetitions for the purpose of designing the maximum repetition number at this stage, although such assumption might result in over-design depending on UE feature discussions in later stage.  For other assumptions, the maximum number of repetitions should be targeted at the following:   * Both FDD and TDD   Both VoIP and eMBB traffic. |
| OPPO | We are fine with the FL’s proposal.  The motivation for increasing the number of repetitions is to ensure the actual number of repetitions, which is an enhancement consideration for contiguous counting scenarios. If the number of repetitions is counted based on available slots, the maximum number of repetitions can be supported at present, which does not require a larger number of repetitions.  The maximum number of repetitions can be considered as a maximum value that meet the coverage requirements based on continuous slots. At the same time, it certainly can satisfy the coverage requirements based on available slots counting.  If increase of the maximum number of repetitions is designed such that it achieves coverage improvement assuming that the number of repetitions is counted based on available slots, does it mean the two enhancements are always configured at the same time? Because the maximum number of repetitions may not meet the coverage requirements based on continuous slots if it is designed for available slots.  Please note that we are not discussing about UE feature in this stage, but about maximum number of repetitions. |

# Other candidate values for configured number of repetitions

3 companies (CATT, vivo, China Telecom) discussed that, on top of adding 32, additional values for a value set of the number of repetitions (e.g. also adding {20, 24, 28}) with finer granularity improve performance. 1 company (ZTE) discussed increasing of the number of candidate repetition factors from 8 to 16.

1st round discussion

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| **FL proposal 1-2:**  Additional candidate values for configured number of repetitions are discussed after concluding the discussion on the maximum number of repetitions. This is also affected by outcomes from Question 1-4.  **Question 1-2:**  Any views on the above suggestion? | |
| **Company** | **Comment** |
| Qualcomm | Candidate repetition factors can include {20,24,28,32}. |
| Intel | We are fine with the suggestions |
| NTT DOCOMO | We support FL proposal. |
| ZTE | Fine with the proposal. |
| CATT | Fine with the proposal. We think additional candidate value can provide flexibility for gNB. {20, 24, 28} is linear between 16 and 32, and fine for us. |
| Sharp | We are fine with FL proposal. |
| NEC | Support FL proposal. |
| CMCC | Considering the transmission latency caused by large number repetitions, additional candidate value between 16 and 32 is acceptable to us, if the 32 is agreed. |
| OPPO | We can consider {16, 20}, assuming AggregationFactor, as elaborated in the question 1-2. |
| Vivo | Fine with the proposal. Candidate values like {20, 24, 28} can provide flexibility and finer granularity for gNB scheduling. |
| Sierra Wireless | For VoIP, repetition factors which are multiples of 10ms could be considered. |
| Ericsson | The exact values of each candidate repetition factor can be further discussed. Note that a separate TDRA list for R17 is needed for backward combability. At least we do not want to increase the number of rows of the TDRA table which may increase the number of bits of TDRA indication in DCI. |
| Nokia/NSB | We are fine with FL’s proposal. |
| Lenovo, Motorola Mobility | Agree with FL’s proposal |
| Xiaomi | Agree with FL’s proposal |

**FL observation 1-2 after the 1st round discussion:**

Additional candidate values for configured number of repetitions can be discussed after concluding the discussion on the maximum number of repetitions.

# Repetitions for configured grant

In Rel-15/16, RRC parameter *repK* applies to both Type 1 and Type 2 configured grant transmissions, where the candidate value set of *repK* = {1, 2, 4, 8}. TRDA based dynamic repetition number indication introduced in Rel-16 is applicable to Type 2 configured grant transmission, where the candidate value set of *numberofrepetitions-r16* = {1, 2, 3, 4, 7, 8, 12, 16}.

2 companies (ZTE, Apple) discussed that the maximum repetition number for PUSCH transmission with configured grant is currently 8, and it should be increased, too.

1st round discussion

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| **FL observation 1-3:**  Only few companies have explicitly shown their views on increase of the maximum number of repetitions for configured grant.  **Question 1-3:**  Any views on increasing the maximum number of repetitions for configured grant? | |
| **Company** | **Comment** |
| Samsung | Apply same conclusion as for DG-PUSCH. |
| Qualcomm | Apply same maximum for both DG and CG PUSCH. |
| Apple | Agree with Samsung and Qualcomm. In addition, to align the objective of this WI, the proposal should clarify for PUSCH repetition type A with a configured grant. |
| Intel | We think new maximum number of repetitions should also apply to CG-PUSCH. |
| NTT DOCOMO | We support to apply the same maximum number or repetitions for configured grand. |
| ZTE | We should aim for the same conclusion for DG and CG. |
| Panasonic | It is desirable to apply same maximum number of repetitions for both DG and CG PUSCH. |
| CATT | Fine to apply same maximum number for DG and CG PUSCH. |
| Sharp | Same number specified for PUSCH with dynamic grant should be supported for PUSCH with configured grant. |
| NEC | Apply same conclusion as for DG-PUSCH. |
| CMCC | Need more clarification for the use cases and scenarios to extend the repetition number of configured grant transmission, which is not covered during the study item. Configured grant transmission is targeted for the URLLC traffic which have a high requirement about the latency. The increase of repetition number would induce a larger latency |
| OPPO | Yes. Repetition in configured grant is more important than DG. Gains for the repetition is higher in VoIP services. |
| Vivo | Apply the same maximum number of repetitions for both CG-PUSCH and DG-PUSCH. |
| Ericsson | For the enhancement of Type A PUSCH repetitions in R17, we assume we’re only doing enhancement based on the enhanced R16 Type A PUSCH repetition.  For Type 2 CG PUSCH, the enhanced R17 TDRA list with increase number of repetitions can be used by CG PUSCH as well.  For Type 1 CG PUSCH repetition, we do not see the need to enhance the R15 *repK* value. |
| Nokia/NSB | We support the majority view that the same maximum value specified for DG can be applied for CG. |
| Lenovo, Motorola Mobility | Same number should be agreed for both DG and CG PUSCH |
| Huawei, HiSilicon | Discussion for this questions can be deprioritized because it is based on the clarification of question 1-1 whether two bullets are specified independently. If a unified UE feature is enabled where repetitions count on available UL slots, then there is no need of further increasing the maximum repetition number. Thus, considering the same design for DG-PUSCH, e,g. there is no need of further increasing the maximum repetition number |

**Summary on Question 1-3 in the 1st round discussion is as follows:**

Almost all the companies think the maximum number of repetitions for DG-PUSCH is also applied to CG-PUSCH.

* Apply a same maximum number of repetitions for both DG-PUSCH and CG-PUSCH.
  + Samsung, Qualcomm, Apple, Intel, NTT DOCOMO, ZTE, Panasonic, CATT, Sharp, NEC, OPPO, vivo, Ericsson (for Type-2 CG-PUSCH only), Nokia, NSB,
* Need more discussion
  + CMCC

**FL proposal 1-3 after the 1st round discussion:**

Apply a same maximum number of repetitions for both DG-PUSCH and CG-PUSCH.

* FFS: Apply to both Type-1 and Type-2 CG-PUSCH or to Type-2 CG-PUSCH only.

Comments to FL proposal 1-3 after the 1st round discussion

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | Fine |
| LG Electronics | We are fine with FL’s proposal 1-3. |
| CATT | We support FL’s proposal. |
| Ericsson | Here the “maximum number repetitions” should be for the Type A PUSCH enhancement mode 1 “increasing the maximum number of repetitions of Type A PUSCH repetition in R16” in our understanding, which should be clarified. Given the CG Type-1 is just the repK indication of up to 8 repetitions, we do not see a need to enhance R15 number of repetitions as the number of repetitions is already 16 in R16.  According to above, we suggest:  For the Type A PUSCH repetition enhancement mode 2 “increasing the maximum number of repetitions of Type A PUSCH repetition in R16”, ~~A~~apply a same maximum number of repetitions for both DG-PUSCH and Type-2 CG-PUSCH.   * FFS: Apply to both Type-1 and Type-2 CG-PUSCH or to Type-2 CG-PUSCH only. |
| Xiaomi | We agree with FL’s proposal. Apply same maximum for both DG and CG PUSCH. |
| Nokia/NSB | We support the FL’s proposal. We do not agree with the modifications from Ericsson because, in this proposal, we do not discuss about whether there are two modes or a single mode yet. In addition, it is sufficient to add in the FFS whether this is applied to Type 1 only, Type 2 only or both. Therefore, the additional “Type-1” in the main bullet is not needed. |

According to the companies’ comment during the GTW session on Jan 28, FL proposal 1-3 after the 1st round discussion was further updated.

2nd round discussion

|  |  |  |  |
| --- | --- | --- | --- |
| **FL proposal 1-3a:**  The maximum number of repetitions for DG-PUSCH is also applicable to CG-PUSCH.  **Question 1-3a:**  Any views on the above updated proposal? | | | |
| **Company** | | **Comment** | |
| Lenovo, Motorola Mobility | | We support the updated proposal | |
| Intel | | As we commented in GTW session, we suggest to remove “• ~~FFS: applicable to both Type-1 and Type-2 CG-PUSCH or to either of them.~~”. Both Type 1 and Type 2 CG-PUSCH are equally important for enhancement. | |
| Qualcomm | | Same comment as Intel. | |
| ZTE | | We prefer to delete the FFS while would be also ok with current FL proposal. | |
| FL | | Based on the above comments, I deleted the FFS bullet. | |
| Panasonic | | We are fine with FL updated proposal. | |
| LG Electronics | | We are fine with FL’s proposal 1-3a. | |
| China Telecom | | We are fine with FL updated proposal. | |
| OPPO | | Fine with the FL’s updated proposal, seem type1 and 2 CG is naturally configured with same number of maximum repetition. | |
| Samsung | | OK with the FL’s proposal | |
| Nokia/NSB | | Support the FL’s proposal. | |
| Ericsson | | To move forward, we’re fine with the intention of the proposal with the understanding that when the number of repetitions is increased, same increased number should be applied for DG and CG based PUSCH repetitions. | |
| NTT DOCOMO | | We are fine with FL proposal. | |
| Sharp | | Support the proposal. | |
| Apple | | Ok with this proposal. | |
| CATT | | We are fine with FL updated proposal. | |
| Huawei, HiSilicon | | Fine. Agree with Intel to remove the FFS bullet. | |
| CMCC | | Regarding to the FL proposal 1-3a, we are fine to remove the FFS bullet under the proposal. But the description of “maximum number of repetitions” should be further clarified. Since the maximum number of repetitions is still under the discussion in section 2.1, we do not have a conclusion of an exact value of maximum repetition number. If my understanding is right, the maximum number of repetitions here contains at least two situations below,  1) a beyond 16 value as the maximum repetition number  2) an actual maximum repetition number considering the definition of “available slot”  Then we may suggest to add a note for further clarification.  **FL proposal 1-3a:**  The maximum number of repetitions for DG-PUSCH is also applicable to CG-PUSCH.  **Note, The maximum number of repetitions here could refer to a value beyond 16 and/or an actual repetition number considering the definition of “available slot”.**  As also mentioned during the 1st round and online discussion, we are lack of study for the CG-PUSCH coverage enhancement during the SI phase. And if the traffic of URLLC cannot reach the requirement, it may not be solved only by increasing repetitions. We have concerns on this extension. If it is the majority view to extend the conclusion of DG-PUSCH to CG-PUSCH, we could accept for the sake of progress. More views are welcome. | |
| FL | | @CMCC,  The “maximum number of repetitions” here refers to the maximum value of the value range for the configuration. It can also be understood to as the value which the number of actual transmission never exceeds. The exact value of the “maximum number of repetition” is still under discussion. I believe this is commonly understood. The note suggested by CMCC, especially its latter part, would cause some confusion. | |
| Xiaomi | | We are fine with FL updated proposal. | |

During the 2nd round discussion, almost all companies supported FL proposal 1-3a saying that The maximum number of repetitions for DG-PUSCH is also applicable to CG-PUSCH.

**FL proposal 1-3a after the 2nd round discussion:**

The maximum number of repetitions for DG-PUSCH is also applicable to CG-PUSCH.

Comments to FL proposal 1-4a after the 2nd round discussion

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | ~~OK~~ |
|  |  |

# RRC parameters to be extended

In GTW session, there was a discussion on which RRC parameters should be extended to support more repetitions.

1st round discussion

|  |  |
| --- | --- |
| **FL observation 1-4:**  There are 3 RRC parameters which are possibly extended so as to increase the maximum number of repetitions.   * *pusch-AggregationFactor* * *umberofrepetitions* * *repK*   **Question 1-4:**  Companies are invited to provide their views on which RRC parameter(s) is extended to increase the maximum number of repetitions. | |
| **Company** | **Comment** |
| Samsung | If the maximum number of repetitions in the TDRA table is increased above 16, *pusch-AggregationFactor* and *repK* should also be increased. |
| Qualcomm | All three parameters can be extended to accommodate up to 32 repetitions. |
| Apple | Which parameter needs to extend the value is related to indication the repetition number semi-statically or dynamically. If we agree repetition number is 32 or more. Semi-statically indication is less the flexibility and resource utilization is not so efficient. From this point, parameter *numberofrepetitions* and *repK* can be increased. |
| Intel | We think all three parameters should be included. |
| China Telecom | All three parameters should be extended to support maximum number of 32. |
| NTT DOCOMO | Three parameters needs to be extended. |
| ZTE | It seems introducing only one new parameter for *numberofrepetitions* with Rel-17 suffix included in TDRA table is sufficient. If this new parameter is not configured, then the number of repetitions is determined by legacy rules. |
| Panasonic | All three parameters can be extended if the maximum number of repetitions to be supported is increased from that supported in current specification. |
| CATT | Fine to increase the maximum repetition number for all three parameters. |
| Sharp | At least *numberofrepetitions* should be extended. Extension of the other two parameters can be also considered. |
| NEC | *numberofrepetitions* could overwrite *pusch-AggregationFactor*, so no need to extend *pusch-AggregationFactor* as in Rel-16. |
| CMCC | Currently, increase the repetition number of *numberofrepetitions* is sufficient. As mentioned in the replies above, the other two parameters need justifications. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | At least one of these parameters should be extended. |
| OPPO | * pusch-AggregationFactor * repK   As evaluated in the Qestion 1-1, it seems numberofrepetitions should not be increase since it is also for Type B repetition. |
| Ericsson | First of all, we do not think it necessary to enhance R15 repetition factors (i.e. *repK, pusch-AggregationFactor*) and we should focus on the enhancement of R16 repetition factors (up to 16).  Furthermore, this increased *numberofrepetitions* in a R17 TDRA list is only needed for Option 1 and there’s no need of separate TDRA list for Option 2 since the repetition factors in the existing R16 TDRA list will be treated as actual repetitions if a Type A PUSCH option 2 is configured. |
| Nokia/NSB | We share the same view with Apple that at least the parameters *numberofrepetitions* and *repK* can be increased, since we may not use the new maximum number of repetitions as a fallback value. |
| Lenovo, Motorola Mobility | All three parameters can be extended. |
| Huawei, HiSilicon | Discussion of this can be deprioritized before the clarification of whether 2 bullets in WID are specified independently and views on this question is related to conclusions of question 1-3. |

**Summary on Question 1-4 in the 1st round discussion is as follows:**

When the increased maximum number of repetitions is decided, it applies to:

* *numberofrepetitions*
  + Support: Samsung, Qualcomm, Apple, Intel, China Telecom, NTT DOCOMO, ZTE, Panasonic, CATT, Sharp, NEC, CMCC, Ericsson, Nokia, NSB, Lenovo, Motorola Mobility
  + No need: OPPO
* *pusch-AggregationFactor*
  + Support: Samsung, Qualcomm, Intel, China Telecom, NTT DOCOMO, Panasonic, CATT, Sharp, OPPO, Lenovo, Motorola Mobility
  + No need: Apple, ZTE, NEC, CMCC, Ericsson, Nokia, NSB
* *repK*
  + Support: Samsung, Qualcomm, Apple, Intel, China Telecom, NTT DOCOMO, Panasonic, CATT, Nokia, NSB, Lenovo, Motorola Mobility
  + No need: ZTE, CMCC, Ericsson

**FL proposal 1-4 after the 1st round discussion:**

When the increased maximum number of repetitions is decided, it applies to at least the parameter *numberofrepetitions*.

* FFS: also apply to *pusch-AggregationFactor* and/or *repK*.

Comments to FL proposal 1-4 after the 1st round discussion

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Huawei, HiSilicon | OK |
| LG Electronics | We are fine with FL’s proposal 1-4. |
| CATT | We support FL’s proposal. |
| Ericsson | Since “*pusch-AggregationFactor* and/or *repK*” are already enhanced in R16 from up to 8 repetitions to be up to 16 repetitions, we do not see the need to enhance R15 repetition factors from 8 to more than 16 while increasing R16 factors from 16 to more than 16.  If we enhance all legacy repetition factors in every release, e.g. if there’s another WI in R18 to further increase number of repetitions, are we going to further increase R15 repetition factor (up to 8), R16 repetition factor (already up to 16), and R17 repetition factors (already up to X, Y, where X is enhancement of R15 in R17, Y is enhancement of R16 in R18)? Then we will have more additional maximum numbers of repetitions M, N, O, P, where M is the enhancement from R15 to R18, N is the enhancement from R16 to R18, O is the enhancement from the enhancement from R15 to R17 to R18, P is the enhancement from the enhancement from R16 to R17 to R18. How many numbers of maximum number of repetitions do we want for NR? Note that for each enhancement, we need separate either TDRA list or separate aggregation factor defined for backward compatible design.  In another aspect, similar to other related proposals, the “maximum number repetitions” in this proposal should be for the Type A PUSCH enhancement mode 1 “increasing the maximum number of repetitions of Type A PUSCH repetition in R16” in our understanding, which should be clarified.  Regarding the concern that “*numberofrepetitions*” maybe also be used by PUSCH repetition Type B in R16, as the Type B PUSCH repetition will still use the R16 TDRA list to do repetition and there will be additional R17 TDRA list defined for Type A PUSCH repetition enhancement mode 1 anyway for backward combability, there’s no issue that we can see. Note that in R16, the parameter name is *numberofrepetitions-r16* in *PUSCH-Allocation-r16* in *PUSCH-TimeDomainResourceAllocationList-r16,* meaning that *numberofrepetitions* for R17 will be independent from the R16 parameter except that the maximum value in R17 will be larger than R16.  According to above, we suggest:  For the Type A PUSCH enhancement mode 1 “increasing the maximum number of repetitions of Type A PUSCH repetition in R16”, when the increased maximum number of repetitions is decided, it applies to at least the parameter *numberofrepetitions* for R17.   * ~~FFS: also apply to~~ *~~pusch-AggregationFactor~~* ~~and/or~~ *~~repK~~*~~.~~ |
| Xiaomi | We support FL’s proposal and all three parameters should be extended to support maximum number of 32. |
| Nokia/NSB | We support the FL’s proposal. Again, we do not agree with the modifications from Ericsson because, in this proposal, we do not discuss about whether there are two modes or a single mode yet. |
|  |  |

Similar to FL proposal 1-3 after the 1st round discussion, FL proposal 1-4 after the 1st round discussion was also further updated.

2nd round discussion

|  |  |  |
| --- | --- | --- |
| **FL proposal 1-4a:**  The increased maximum number of repetitions applies to at least the Rel-17 RRC parameter *numberofrepetitions*.   * FFS: also apply to *pusch-AggregationFactor* and/or *repK*.   **Question 1-4a:**  Any views on the above updated proposal? | | |
| **Company** | **Comment** | |
| Lenovo, Motorola Mobility | We support the updated proposal | |
| Intel | Given the large support of all three parameters, it is not clear to us why we cannot support the increased maximum number of repetitions for all three parameters. | |
| Qualcomm | Support FL proposal. | |
| ZTE | Support the proposal. As commented before, also well explained by Ericsson, we don’t support to increase all parameters for now. | |
| Panasonic | We support the updated proposal. | |
| China Telecom | We support the updated proposal. And we also support to apply to *pusch-AggregationFactor* and *repK.* | |
| OPPO | No.  The “*numberofrepetitions*” was introduced for URLLC enhancement. It will give high bar for UE implementation. Thus, we don’t accept only enhance it.  It should be noted that “*numberofrepetitions*” using the TDRA entries to also support dynamic repetition of PUSCH, which we think is not needed in coverage enhancement of eMBB PUSCH. PUSCH has already enough frequency domain resource flexibility. For URLLC it may be useful for adjust suitable latency.  In addition, increasing numberofrepetitions-r16 also would enhance Type B repetition. This parameter was equally used in Rel-16 Type A and B repetition. Then, it will be out of WID scope. | |
| Samsung | We think the maximum number of repetitions should be increased for all three parameters. | |
| Nokia/NSB | Support the FL’s proposal. | |
| Ericsson | To move forward, we’re fine with the updated proposal. Although our preference is to remove the FFS part since “at least” is already there.  We do not think the argument from OPPO is valid, the enhanced up to 16 repetitions in Rel-16 is general feature and the baseline of R17. And as commented earlier, Rel-16 TDRA tables will still be R16 TDRA tables (for Type A or Type B), Rel-17 will have its own TDRA table (for the enhanced Type A) for backward compatibility, and this enhancement has nothing to do with Type B repetition. | |
| NTT DOCOMO | We are fine with FL proposal. | |
| Sharp | Support the proposal. | |
| Apple | At this moment, we are not sure which way is the better, i.e., re-using or extending the range of existing parameter, or define a new parameter. | |
| OPPO2 | Regarding the UE feature issue, there is clear evidence the Repetition factor is for URLLC enhancement. Please see the document “[R1-2008540](file:///C:\Users\wanshic\OneDrive%20-%20Qualcomm\Documents\Standards\3GPP%20Standards\Meeting%20Documents\TSGR1_103\Docs\R1-2008540.zip) Summary on UE features for URLLC/IioT”. It is also in the list of feature list R1-2009585 agreed last time.    The Ericsson’s comment is baseless. There is not so call general enhancement for repetition. The UE capability issue should be taken into account.  The further problem is extend the “*umberofrepetitions*” will also be used for 11-5 which is type B repetition. From UE implementation point of view, we would like to reduced the complexity and focus on eMBB case. | |
| CATT | We support FL’s proposal.  As the concern that increased repetition number may be applied to type B repetition, we think clear restriction in spec may help, like ‘For type B repetition, the configurable repetition number is not larger than 16’. | |
| CMCC | For the sake of progress, we could accept the modified version like below,  **FL proposal 1-4a:**  The increased maximum number of repetitions applies to ~~at least~~ the Rel-17 RRC parameter *numberofrepetitions*.   * FFS: also apply to *pusch-AggregationFactor* and/or *repK*.   Since we have FFS in the sub-bullet we do not need the “at least” in the main bullet.  We do not see any motivation to enhance the *pusch-AggregationFactor* since the *numberofrepetitions* would be enhanced and will follow the definition of available slot which will improve the repetition efficiency significantly. Enhancing the *pusch-AggregationFactor* means that the counting rule in Rel-15 is still effective for the maximum 32 repetition, in which most repetition transmission will not happen.  Since the *numberofrepetitions* could be enhanced to 32 repetitions, there is no need to increase *repK*.  From the design of URLLC or configured grant transmission, the repetition is for the enhancement of reliability. If the system could not realize the high requirement of the performance, only increase a few repetition number could not solve the issue. | |
| Huawei, HiSilicon | | OK | |
| Ericsson2 | | Agree to remove “at least” proposed by CMCC or remove “FFS”.  @OPPO2,   |  |  |  | | --- | --- | --- | | 5-16 | Type 2 configured PUSCH repetitions over multiple slots | K = 2, 4, 8 times repetitions with RV sequences | | 5-17 | PUSCH repetitions over multiple slots | K = 2, 4, 8 times repetitions |   Our earlier comments were based on the fact that feature 11-6 only depends on 5-16 or 5-17 (See 38.822), i.e. the slot bundling in Rel-15, there’s no dependency relationship between 11-6 and other URLLC features in R16.  On the other hand, our understanding is that a R17 Type A PUSCH repetition with increased number of repetitions, when using the TDRA table based manner, can be treated as an further enhancement of legacy Type A repetitions. UE capability of this R17 type A repetition can be discussed later, and it doesn’t have to depend on repetition Type B or any other features other than Type A PUSCH repetitions in Rel-16. | |
| OPPO | | @Erisson2, thanks for you further explanation and focusing on the technical issue. Please note we may have different understanding of UE complexity issues of 11-6. There may be different between 11-5 and 11-6. But in the specs, they were all URLLC. Note that we had may discussion on those complexity. We don’t have common understanding here. | |
| Xiaomi | | We support the updated proposal. | |

In the 2nd round discussion on the RRC parameters which should be extended to support more repetitions, although large majority supports extension of all the three parameters *pusch-AggregationFactor*, *numberofrepetitions*, and *repK*. Several companies expressed that extension of *numberofrepetitions* is sufficient, and one companies objected the extension of *numberofrepetitions*.

The increased maximum number of repetitions applies to:

* *numberofrepetitions*
  + Support: Samsung, Qualcomm, Apple, Intel, China Telecom, NTT DOCOMO, ZTE, Panasonic, CATT, Sharp, NEC, CMCC, Ericsson, Nokia, NSB, Lenovo, Motorola Mobility
  + No need: OPPO
* *pusch-AggregationFactor*
  + Support: Samsung, Qualcomm, Intel, China Telecom, NTT DOCOMO, Panasonic, CATT, Sharp, OPPO, Lenovo, Motorola Mobility
  + No need: Apple, ZTE, NEC, CMCC, Ericsson, Nokia, NSB
* *repK*
  + Support: Samsung, Qualcomm, Apple, Intel, China Telecom, NTT DOCOMO, Panasonic, CATT, Nokia, NSB, Lenovo, Motorola Mobility
  + No need: ZTE, CMCC, Ericsson

During the 2nd round discussion, one discussion point was whether the extension of *numberofrepetitions*, which also affects Type B repetition in Rel-16, is allowed for Rel-17 Coverage Enhancement feature.

**FL proposal 1-4a after the 2nd round discussion:**

The increased maximum number of repetitions applies to at least the Rel-17 RRC parameter *numberofrepetitions*.

* Note: Rel-17 RRC parameter *numberofrepetitions* is not applicable to PUSCH repetition Type B

Comments to FL proposal 1-4a after the 2nd round discussion

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| --- | --- |
| **Company** | **Comment** |
| Samsung | OK |
|  |  |

3rd round discussion

|  |  |
| --- | --- |
| In the 2nd round discussion, a large majority supported the main bullet of FL proposal 1-4a. Meanwhile, a concern was raised, that is, the extension of *numberofrepetitions* is not a good approach, because it affects Type B repetition, which is not in the scope of this agenda item.  Also, it was suggested collecting companies’ views on whether they have “a dynamic indication of the number of repetitions by TDRA field in a DCI” in mind for the enhancement of the maximum number of repetitions or not.  Therefore, the proposal is reformulated using TDRA field, instead of *numberofrepetitions*.  **FL proposal 1-4b:**  PUSCH repetition Type A of which the number of repetitions is indicated by TDRA field in a DCI supports the increase of maximum number of repetitions.   * FFS: PUSCH repetition Type A of which the number of repetitions is configured by *pusch-AggregationFactor* or *repK*.   **Question 1-4b:**  Any views on FL observation 1-4b? | |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | Yes, we agree with the proposal (and our understanding/preference is when number of repetitions are greater than currently supported maximum value, then counting is done based on contiguous slots) |
| Nokia/NSB | We are fine with the FL’s proposal. |
| Intel | We are fine with the FL’s proposal. |
| Huawei, HiSilicon | Please remove “at least”, or please clarify what is the potential candidate other than PUSCH repetition Type A. The current proposal seems to leave a door for PUSCH repetition Type B here? |
| FL | Regarding the FL proposal 1-4b, “At least” does not intend to cover PUSCH repetition Type B. So far, many companies have expressed that they prefer enhancing pusch-aggregation-factror/repK related procedure as well. To avoid the confusion, I’d like modify FL proposal 1-4b (deleting “At lease” from the main bullet and adding the FFS sub-bullet). Hope it improves clarity. |
| CATT | We are fine with the updated proposal. |
| TCL | We are fine with the FL’s proposal. |
| Sharp | We are fine with the updated FL proposal. |
| OPPO | Support the updated FL proposal.  We think it is not needed for coverage enhancement if the number of slots for repetition is dynamically indicated by TDRA. The reason is the dynamic repetition would not bring gain since it had already FDRA, which can help for dynamic repetition. Further dynamic TDRA in slots only bring some latency gain. But it is only meaningful for URLLC. |

# TDRA list

During the 1st round discussion, several companies expressed that the number of rows of the TDRA table should remain unchanged, even if the maximum number of repetitions is decided to be extended to more than 16.

2nd round discussion

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| --- | --- | --- |
| **FL proposal 1-5:**  The number of rows of the TDRA table should remain unchanged from Rel-16.  **Question 1-5:**  Any views on the above proposal? | | |
| **Company** | **Comment** | |
| Lenovo, Motorola Mobility | We suggest to hold the discussion on TDRA table size until the value for maximum number of repetitions is agreed | |
| Intel | Is this for maximum number of rows for TDRA? The intention is not to increase the bit-width of the TDRA field in the DCI. Is this correct understanding?  We share similar view as Lenovo that we can revisit this issue later. | |
| Qualcomm | In principle, we agree. But we prefer to postpone this discussion, just in case some some new issues come up. | |
| ZTE | Share with above companies. | |
| Panasonic | We agree with Lenovo/Motorola Mobility. | |
| OPPO | We also suggest to hold on the discussion. Seems we should not intend to discuss DCI indication enhancement, based on the SI conclusion. | |
| Samsung | Agree with FL’s proposal. | |
| Nokia/NSB | Support the FL’s proposal. We are also fine to revisit this issue later as suggested by the majority. | |
| Ericsson | We’re fine with the proposal.  And this is at least good for discussing the number of candidates of the increased repetition number.  If we select too many candidates, the TDRA bit field may be required to be updated which is not preferred in our view. | |
| Sharp | Fine with deferring this discussion until the value for maximum number of repetitions is agreed. | |
| Apple | Agree to postpone the discussion. | |
| Vivo | Agree with this proposal. | |
| CATT | Agree with FL’s proposal. | |
| Huawei, HiSilicon | | Fine with FL proposal | |
| CMCC | | As mentioned by companies, it may be too early to discuss this issue. But we also do not prefer to increase the payload of DCI. | |
| Xiaomi | | We suggest to hold the discussion on TDRA table size until the value for maximum number of repetitions is agreed. If the maximum number of repetitions is allowed to expand to 32 as in option 2 section 1. Then we support to maintain two TDRA table, one is for 0-16, another is for 16-32 so that the number of rows TDRA list and the payload of DCI will not to be increased. | |

During the 2nd round discussion, although several companies agreed that the number of rows of the TDRA table should remain unchanged from Rel-16. Many companies expressed that it is premature to discuss TDRA table size until the value for maximum number of repetitions is agreed.

**FL observation 1-5 after the 2nd round discussion:**

TDRA table size is discussed after the value for maximum number of repetitions is agreed.

# The number of repetitions counted on the basis of available slots for the PUSCH transmissions

The discussions in this section are based on the following objective in the Coverage Enhancement WID.

1st round discussion

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| --- |
| The detailed objectives of the work item are as follows:   * Specification of PUSCH enhancements [RAN1, RAN4]   + Specify the following mechanisms for enhancements on PUSCH repetition type A [RAN1]     - Increasing the maximum number of repetitions up to a number to be determined during the course of the work.     - **The number of repetitions counted on the basis of available UL slots.** |

# Basic postponement mechanism

In Rel-15/16 the number of repetitions for a PUSCH repetition type A is counted at every slot regardless of whether the slot has sufficient available resources for UL transmissions or not.

4 companies (CATT, Panasonic, Qualcomm, NTT DOCOMO) mentioned that the number of repetitions counted on the basis of available resources for UL transmissions is already supported by Rel-15/16 PUCCH repetition and it can be reused for Rel-17 PUSCH repetition.

2 companies (ZTE, Ericsson) mentioned that definition of “available UL resource” can follow Rel-15/16 rules (i.e. reuse of legacy PUSCH omitting rules).

2 companies (OPPO, vivo) discussed that UE should postpone the transmission in a slot if the slot cannot transmit the repetition of a TB, where the postponing applies until the configured number of the repetition is achieved.

1st round discussion

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| --- | --- |
| **FL observation 2-1:**  Most of the companies share the views on postponement mechanism as the following:   * If a slot is determined as available for a scheduled PUSCH, the slot is counted in the PUSCH repetition. Otherwise, the slot is not counted in the PUSCH repetition and the repetition is postponed to the next slot. * Adopt one of the following:   + Alt 1: The above step is repeated until the count reaches the configured/indicated number of repetitions.   + Alt 2: The above step is repeated until the count reaches the configured/indicated number of repetitions N, or until the duration of the PUSCH transmission is K slots and the count is not larger than N.   + Note: additional dropping on the actual repetitions is not precluded (See FL proposal 2-2a).   **Question 2-1:**  Any views on the above observation? | |
| **Company** | **Comment** |
| Samsung | Postponing has the drawback of increasing latency (and resources), and complicating the gNB scheduler as resources are reserved in advance. How much postponing can be done by a UE needs to be controlled by the gNB. We suggest the following change in red:   * The above step is repeated until the count reaches the configured/indicated number of repetitions N, or until the duration of the PUSCH transmission is K slots and the count is not larger than N. |
| Qualcomm | Postponing and on-the-fly determination of slots available for repetition can lead to unpredictable latency and scheduling complications.  We prefer to reuse methodology used for PUCCH repetitions. No postponements are allowed. All slots for repetition are identified **right at the beginning** of the transmission and not revised later on.    This framework is also critical to enabling DMRS bundling, which is being studied in a separate sub-agenda. UE and gNB need to plan in advance for DMRS bundling/joint channel estimation.  Note further that typically PUSCH repetitions may be slightly over-provisioned to account for the fact that some repetitions may get dropped. It is therefore not necessary to specify a complicated mechanism of identifying slots for repetition.  Request FL to add an alternative to not allow postponing before discussing Alt 1 or Alt 2:  **Alt A:** If a slot is determined as available for a scheduled PUSCH prior to the beginning of the first transmission, the slot is counted in the PUSCH repetition. Otherwise, the slot is not counted in the PUSCH repetition. Once slots for repetition are identified they are not revised.  **Alt B:** If a slot is determined as available for a scheduled PUSCH, the slot is counted in the PUSCH repetition. Otherwise, the slot is not counted in the PUSCH repetition and the repetition is postponed to the next slot.  Adopt one of the following:   * + Alt 1: The above step is repeated until the count reaches the configured/indicated number of repetitions.   + Alt 2: The above step is repeated until the count reaches the configured/indicated number of repetitions N, or until the duration of the PUSCH transmission is K slots and the count is not larger than N.   + Note: additional dropping on the actual repetitions is not precluded (See FL proposal 2-2a). |
| Apple | Alt. 1 seems straightforward, gNB could control the repetition and delay if the PUSCH is scheduling. |
| Intel | We think we may need to further discuss the meaning of postponement or deferral. In our view, PUCCH repetition mechanism as defined in Rel-15 for TDD can also be viewed as postponement/deferral, i.e., if UE cannot transmit PUCCH in the next slot due to collision with semi-static UL/DL configuration, UE will defer the PUCCH transmission to the next available UL slots.  Certainly, the determination of available UL slots is performed before the actual first transmission. Note that it is possible that the PUCCH transmission on the available UL slots can be further cancelled due to other factors, including dynamic SFI/UL CI, or different priorities, but it should not be part of procedure on the determination of available UL slots for PUSCH repetition. |
| ZTE | Support Alt 1. gNB could properly handle this, e.g. indicating a proper number of repetitions based on TDD configuration. In addition, we suggest to the note. We can first discuss the issues in 3.2, and then come back to see whether a note is needed. |
| Panasonic | We think part of Alt.2 behaviour “until the duration of the PUSCH transmission is K slots and the count is not larger than N” could be achieved by Rel.15/16 PUSCH repetition Type A. If PUSCH repetition mode configuration/indication can allow to select either Rel.15/16 PUSCH repetition Type A and Rel.17 PUSCH repetition Type A, Alt.1 seems sufficient. |
| CATT | We share the same view with Intel that PUCCH repetition mechanism is a kind of postponement (though described as slot determination). In this regard, we are open to any description as long as the inner meaning is the same.  We also agree with Qualcomm and Intel that the determination of available UL slots is performed before the actual first transmission, i.e., based on semi-static RRC configuration. Possible SFI/CI may still lead to dropping of slots but does not change the already determined slot set, and no more additional postpone, as illustrated in the following figure.    We are OK with both Alt.1 and Alt.2. |
| Sharp | We prefer Alt.1. These alternatives are somehow correlated to alternatives in FL proposal 2-2a. If SFI/CI are not used for determination of the counting, excessive delay does not occur. |
| NEC | We are OK with the principle of both Alt.1 and Alt.2. Meanwhile, PUCCH mechanism can be baseline but some difference between PUSCH and PUCCH should be noticed. For example, when a UE is configured with multiple serving cells and is provided half-duplex-behavior = ‘enable’, and is not capable of simultaneous transmission and reception on any cell from the multiple serving cells, and indicates support of capability for half-duplex operation in CA with unpaired spectrum, some extra omission rules are adopted based on TS38.213 which is not used for PUCCH. |
| CMCC | Alt 1 is preferred. For the alternative 2, the relation between scheduled PUSCH slots and the repetition number should be clarified. According to the definition of PUSCH repetition type A, the repetition number N should be aligned with scheduled slots K in preconditions that the K slots are the available slots.  We share the similar view that the determination of available UL slots should be performed before the actual first transmission. Any dynamic change of the counting number of available slots will induce misalignments between gNB and UE.  The naming of this section, the postponement, may induce misunderstandings, though we understand that the intention is to describe the counting procedure of available slots for PUSCH repetitions or transmissions. Of course the long delay due to the unexpected postponement of PUSCH is not preferred. |
| OPPO | Alt 1 seems would be simple and controllable. As the PUCCH also not have another limit of repetition, it should be feasible.  Note, the most relevant case is for semi-static UL/DL configuration and the number of available UL slot is predictable by gNB |
| vivo | Alt. 1 is preferred. Since the available slots to be counted is not expected to be changed even if considering the dynamic indication like SFI, CI. |
| Sierra Wireless | We prefer Alt 1 as it is simpler and gNB can still control the total length of transmission. |
| Ericsson | We prefer to discuss the definition of the available slots first. |
| Nokia/NSB | We prefer Alt. 1. As also pointed out by Apple, the gNB can fully control how many repetitions are needed. There is no reason why a gNB would configure a high number of repetitions in the first place and then configure another timer for trimming some of the repetitions.  In addition, we think that the proposal from Qualcomm, i.e., all slots for repetition are identified right at the beginning of the transmission and not revised later on, seems to be a better approach than postponing. With this approach, after identifying the available UL slots from the beginning of a transmission, the Rel-16 rule can then be applied, i.e., if a transmission occasion in one of the identified UL slots partly or fully overlaps with DL or invalid symbols due to dynamic SFI, then that repetition is not transmitted and we don’t revise the number of repetitions. This would also make Rel-17 PUSCH Type A repetition and PUCCH repetition follow the same counting logic. |
| InterDigital | This discussion can take place after we make a decision on FL proposal 2-2 and 2-2a. |
| Lenovo, Motorola Mobility | We agree with Samsung’s views and support Alt 2 and think that it is better that gNB provided limit on the postponement. |
| Huawei, HiSilicon | Alt.1 is preferred if postponing is accepted.  The main motivation of this bullet in WID for coverage enhancement is to ensure enough number of repetitions as configured by gNB, if a duration K is configured as a limitation for postpone slots, there would be less repetitions than the configured number. Furthermore, it’s hard to decide the value of K, which makes the mechanism of repetition too complex.  View for this question is also based on the ‘FL observation 2-2’. If a semi-static configuration is referred to determine the available UL slot, gNB can schedule a proper number of repetitions without introducing a duration limitation K. |
| Xiaomi | Both alt 1 and alt 2 are fine. Alt 1 is simple. Alt 2 can achieve early termination and gNB can still control the total length of transmission. |

**Summary on Question 1-4 in the 1st round discussion is as follows:**

Although Alt 1 has more support, it is observed that the necessity of an upper limit of postponement is highly affected by the discussion 2-2a that whether dynamic signaling, e.g. SFI, is referred to for the determination of available slots or not. Furthermore, several companies expressed their views that whether the determination of all the available slots is done prior to the first actual transmission of the repetitions or not is more important aspect.

**FL observation 2-1 after the 1st round discussion:**

An upper limit of postponement is discussed if necessary, after concluding FL proposal 2-2a discussion.

# Definition of available slots for PUSCH repetitions

Several companies (vivo, Apple) discussed that dynamic SFI, CI and higher priority transmissions can lead to repetition transmission resource to be unavailable and not to be counted for determination of relevant repetitions, so that “available UL slots” should correspond to the slots where UL repetition is actually transmitted.

7 companies (Intel, Panasonic, Qualcomm, Ericsson, WILUS, Nokia, Nokia Shanghai Bell) discussed that a slot is determined for a PUSCH transmission if the allocated symbols for the PUSCH according to TDRA do not partly or fully overlap with DL symbols or invalid symbols (e.g. SS/PBCH block symbols). In other words, the same number of PUSCH symbols should be kept in every repetition.

7 companies (Intel, China Telecom, NEC, CMCC, Qualcomm, Sharp, WILUS) discussed that only semi-static configuration is referred to for determination of relevant repetitions, and dynamic signaling (e.g. dynamic SFI, CI) is not referred to.

2 companies (OPPO, Sharp) proposed that only symbols semi-statically configured as UL are used for determination of slots for PUSCH repetition.

1 company (CMCC) mentioned that confliction between PUSCH repetitions and other UL transmission (e.g. SRS) should be further clarified. One company (WILUS) mentioned that PUSCH repetition should be postponed when conflicting with a PUCCH repetition.

In current specification, UE does not expect to detect a DCI, indicating a PUCCH resource for HARQ-ACK in a later slot, if UE detects a DCI scheduling a PUSCH transmission in a previous slot and the HARQ-ACK information be multiplexed on the PUSCH transmission. 1 company (vivo) discussed that this timeline restriction should be removed by allowing puncturing of some PUSCH symbols.

1 company (Qualcomm) proposed that all slots for a PUSCH repetition shall be identified prior to the start of the first PUSCH transmission.

1 company (Intel) discussed that a time window can/limitation of postponing can be configured so that an excessive postponement is avoided. For the same purpose, several companies (Lenovo, Motorola Mobility) discussed that a repetition span can be configured in TDRA table so that an excessive postponement is avoided. One company (Samsung) also discussed that limitation on the number of postponing can be configured separately from TDRA.

1 company (LG) discussed adopting early stop of PUSCH repetition mechanism such as indication in DCI (e.g. New Data Indication and HARQ process ID), introduction of maximum time duration for PUSCH repetition, and dynamic indication of number of PUSCH repetition in addition to semi-static configuration.

2 companies (Panasonic, Xiaomi) discussed that early termination of the repetition should be considered, and DFI mechanism as in Rel-16 NR-U can be a starting point.

1 company (InterDigital) proposed supporting enhancement to enable fixed number of repetitions for a TB over one or more bundles.

1st round discussion

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| **FL observation 2-2:**  There seems to be several views on how to determine a given slot as available for PUSCH repetitions. E.g.,   * Only semi-static configurations are referred to for determination of whether or not a given slot as available for PUSCH repetitions for a postpone mechanism, * Dynamic signaling is also referred to for determination of whether or not a given slot as available for PUSCH repetitions for a postpone mechanism.   **FL proposal 2-2:**  For further discussions on definition of available slots for PUSCH repetitions for the postpone mechanism, the following terminology is used   * *Counted repetitions for a PUSCH repetition*: A set of the slots which are considered as available and counted according to the postpone mechanism. The number of counted repetitions is configured/indicated by gNB. * *Actual repetitions for a PUSCH repetition*: Transmission occasions with actual transmissions the UE performs for the PUSCH repetition.   + If there are transmission occasions without actual transmissions, the number of actual repetitions is smaller than the number of the transmission occasions.   **Question 2-2:**  Any views on the above proposal 2-2? | |
| **Company** | **Comment** |
| Samsung | The proposed definitions seem not to be needed. “Counted” or “Actual” is independent on how a slot is determined to be available.  We only need to decide whether a slot is considered available for UL transmission based on the tdd\_ul\_dl configuration or can be also adapted by SFI.  We support adaptation by SFI. It is a Rel-15 feature. Rel-16 already supports a similar functionality through the UL CI and even Rel-17 URLLC considers operation in conjunction with SFI despite the much higher reliability requirements. |
| Qualcomm | It may further help to identify at what point a slot is deemed to be available and when a repetition counter is incremented. |
| Apple | Try to understand the proposal, *counted repetitions for a PUSCH repe*tition just precludes the DL slots for unpaired spectrum case, and *actual repetitions* precludes some of UL slots which could not be used for transmission. |
| Intel | We are not sure whether we need to define actual repetition as in PUSCH repetition type B. In our view, for enhancement on PUSCH repetition type A, the available UL slots are only determined based on semi-static RRC configuration as dynamic indication may introduce misalignment between UE and gNB, which should be avoided. The introduction of actual repetition is unnecessary. |
| ZTE | In our view, if a slot is available, a repetition will be transmitted and counted, as long as it doesn’t exceed the number of configured/indicated number of repetitions. If one repetition would collide with some invalid symbols in a slot, the slot would be not an available slot. Thus, our understanding is Alt 2 below. |
| Panasonic | We support to use the terminology of “counted repetitions for a PUSCH repetition” and “actual repetitions for a PUSCH repetition”. The actual repetitions for a PUSCH repetition can be different from counted repetitions for a PUSCH repetition according to dynamic signalling such as SFI, CI, etc. |
| CATT | Seems like the 2nd and 4th line in our figure in Question 3.1.  At this stage, we are fine with the terminology of ‘Actual repetition’ since it helps understanding during the discussion. But it may not need to define ‘actual repetition’ at the end. Simple description should be enough, like (1) determine the UL available slots by semi-static RRC configuration. (2) Within these UL available slots, drop any slot if conflicted with dynamic indication. |
| OPPO | It is general problem of counting; we see it count only for the real transmission. |
| Vivo | Agree FL that the counted repetition and the actual repetition number may be different. And even if some slots are not used for PUSCH repetition, e.g. due to SFI, CI, there are still counted in the repetition numbers. |
| Ericsson | In our view, we do not think it necessary to discuss the detail omission/cancellation rules in R16 for Type A PUSCH repetition.  As a start point, the available slot can be defined based on the rules to determine the subset of slots that is not omitted for actual PUSCH type A repetition transmission in R16, i.e. the following omission rules:  For PUSCH repetition Type A, a PUSCH transmission in a slot of a multi-slot PUSCH transmission is omitted according to the conditions in Clause 9, Clause 11.1 and Clause 11.2A of [6, TS38.213].  If addition rules are needed, we are open to further discuss. |
| Nokia/NSB | We understand that the intention of the FL’s proposal is to facilitate our discussion by clarifying terminologies. However, we share the same view with the majority that it would be better to agree on how to define an available UL slot and how to count the number of available UL slots first. In this context:   * We observe a possible misalignment among companies on the concept of “postponement”. We are not sure this term helps in any way to have a clearer understanding and suggest not using it, unless we allow for dynamic slot identification for PUSCH repetitions (which we haven’t agreed on yet).   We think we should start by first deciding if dynamic changes to slot structure via SFI/CI can or cannot change the initial slot identification performed by the UE upon reception of the PUSCH repetition configuration from gNB. This is crucial to understand which counting logic make sense and which don’t. |
| Lenovo, Motorola Mobility | We are not sure if the definitions in the proposal are needed. |
| Xiaomi | We are fine with the terminology definition. Beside the impact of TDD\_ul\_dl configuration, the actual repetitions for a PUSCH repetition can be different from counted repetitions for a PUSCH repetition because of the dynamic signalling such as SFI,CI etc. |

**FL observation 2-2 after the 1st round discussion:**

It is commonly understood that “available slots” are outcomes from the counting process (a.k.a. determination of the available slots). No need to define other terms for further discussions.

With the above terminology, companies’ preferences can be classified as follows:

Alt 1: Counted repetitions for a PUSCH repetition are determined by semi-static configuration (e.g. TDD configuration). Actual repetitions for a PUSCH repetition are determined as remaining counted repetitions after dropping according to dynamic signaling (e.g. SFI, CI, etc).

Alt 2: Counted repetitions for a PUSCH repetition are determined by semi-static configuration (e.g. TDD configuration) and dynamic signaling (e.g. SFI, CI, etc). Actual repetitions are the same as the counted repetitions.

1st round discussion

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| **FL proposal 2-2a:**  Adopt one of the following:   * Alt1: Whether or not a slot is considered as available for UL transmissions depends on tdd\_ul\_dl configuration and does not depend on SFI. * Alt2: Whether or not a slot is considered as available for UL transmissions depends on tdd\_ul\_dl configuration and also depends on SFI.   **Question 2-2a:**  Any views on the above proposal 2-2a? | |
| **Company** | **Comment** |
| Samsung | We support adaptation by SFI. It is a Rel-15 feature. Rel-16 already supports a similar functionality through the UL CI and even Rel-17 URLLC considers operation in conjunction with SFI despite the much higher reliability requirements. |
| Qualcomm | Support Alt 1. Please see response to Question 2-1 for justification. This is for eMBB/Voice traffic, and the latency considerations for URLLC are not required here. Its best to keep this specification straightforward. |
| Apple | Some cases are not considered by the proposal, such as UE specific UL/DL configuration, CI, PUSCH priority for URLLC.  From our side, the available slot simply means the slot with actual transmission. This is compliant what we agreed up to Rel.16. |
| Intel | We support Alt. 1. The issue of using dynamic SFI or CI to determine the available UL slot is that if UE mis-detects the DCI carrying dynamic indication, UE may have different understanding from gNB on which slots to be used for PUSCH repetitions. If we further consider postponement mechanism, this would introduce undesirable interference or even cross-link interference in the network.  We would also like to include “invalid UL symbols” as defined in Rel-16, which is also semi-statically configured, to determine the available UL slots. |
| China Telecom | Support Alt.1. In our view, the available UL slots semi-statically configured based on TDD frame structure is more robust. |
| NTT DOCOMO | We support Alt.1, since we have the same concern with Intel that if UE can’t detect DCI for SFI, UE and gNB may have different understanding for the PUSCH slots for repetition. |
| ZTE | Support Alt 2.  In our view, even dynamic SFI is configured, there would be no ambiguity on the number of repetitions among gNB and UE. Because, for DG PUSCH, no conflict between dynamic grant and SFI is expected in Rel-15. For CG PUSCH, the UE will not transmit on flexible symbols. So, there is no conflicts with SFI.  The Rel-15 collision handling rule is well summarized in R1-1913519, “Summary #4 of PUSCH enhancements for NR eURLLC (AI 7.2.6.3). Companies can further check whether dynamic SFI could cause problem based on the summary. |
| Panasonic | We support Alt.1. It is similar functionality to available slot determination in Rel.15/16 PUCCH repetition. |
| CATT | We support Alt.1 in principle.  However, tdd\_ul\_dl configuration may not be the only RRC parameter that should be considered when determining the UL available slot. Other semi-static RRC parameter should also be included. |
| Sharp | Support Alt. 1.  The other dynamic signaling/scheduling based factors, such as CI and PUSCH priority, should be treated in the same way as SFI. |
| NEC | Support Alt. 1. |
| WILUS | Support Alt. 1. Ambiguity between UE and gNB can occur when UE mis-detects DCI format 2\_0 with CRC scrambled by SFI-RNTI. |
| CMCC | Alt 1 is preferred.  As mentioned in our contribution, the available uplink slots should be determined based on semi-static RRC configurations, i.e. tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated. The SFI indication may induce different understanding of the available uplink slots between gNB and UE and increase the complexity of the specification.  We are open to further consideration of the limitations induced by other semi-static RRC parameter. |
| OPPO | Alt 1. The SFI and other dynamic one should be carefully used, since it have implication of flexibility. |
| Vivo | Support Alt. 1.  Since gNB is not aware of whether UE has correctly detected dynamic SFI, UE and NW may have different understandings on PUSCH transmission occasions and RV index of each PUSCH repetitions. |
| Ericsson | In our view, we do not think it necessary to discuss the detail omission/cancellation rules in R16 for Type A PUSCH repetition.  As a start point, the available slot can be defined based on the rules to determine the subset of slots that is not omitted for actual PUSCH type A repetition transmission in R16, i.e. the following omission rules:  For PUSCH repetition Type A, a PUSCH transmission in a slot of a multi-slot PUSCH transmission is omitted according to the conditions in Clause 9, Clause 11.1 and Clause 11.2A of [6, TS38.213].  If addition rules are needed, we are open to further discuss. |
| Nokia/NSB | Can consider both alternatives, but preference for Alt 1. |
| Lenovo, Motorola Mobility | Support Alt. 1 and agree with Qualcomm’s views |
| Huawei, HiSilicon | Slightly prefer Alt.1 where semi-static configuration of available UL slots is more stable. |

**FL proposal 2-2a after the 1st round discussion:**

Select one of the following alternatives, considering the aspect whether or not the determination of all the available slots should be done prior to the first actual transmission of the repetitions:

* Alt1: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and does not depend on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).
  + Qualcomm, Intel, China Telecom, NTT DOCOMO, Panasonic, CATT, Sharp, NEC, WILUS, CMCC, OPPO, vivo, Nokia/NSB (1st preference), Lenovo, Motorola Mobility, Huawei, HiSilicon, Xiaomi
* Alt2: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and also depends on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).
  + Samsung, Apple, ZTE, Ericsson, InterDigital, Nokia/NSB (2nd preference)

Comments to FL proposal 2-2a after the 1st round discussion

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| **Company** | **Comment** |
| Huawei, HiSilicon | Prefer Alt.1 where semi-static configuration of available UL slots is more stable. |
| LG Electronics | We are fine with FL’s proposal. |
| CATT | We support FL’s proposal. |
| Ericsson | Seems fine.  As we commented earlier, we’re also open to discuss whether there’re any other rules with which UE cancels a transmission but gNB doesn’t know. However, according to discussions so far, there seems no such issue.  At least there’s no need to count the slots cancelled based on the rules known by both gNB and UE in our view. If we worry about the latency due to the cancelled slots are not counted, network can configure a smaller number of actual repetitions.  More discussions may be needed on checking with URLLC topic on whether “UE may have different understanding from gNB on which slots to be used for PUSCH repetitions” as Intel and ZTE pointed out. |
| Xiaomi | We prefer alt1 and we think the main factor affects the available UL slots is the configuration of TDD frame structure configured by RRC. |
| InterDigital | We support Alt. 2 for flexibility in configuration of transmission of repetition and to increase opportunities to increase coverage. In addition, for mis-detection of SFI, as explained in our contribution, if repetition can be completed over multiple bundles, it will guarantee completion of the fixed number of repetitions for a TB, even the dynamic SFI is missed by the UE. |
| Nokia/NSB | We are fine with the FL’s proposal. As discussed in the first round, both alternatives can be considered. Therefore, please also add our name in Alt. 2 as a second preference. Thank you! |
| WILUS | We are fine with the FL proposal and our preference is Alt 1. To avoid on-the-fly change of available UL slots, TDD configuration and semi-static configurations should be used. Also, we don’t see big differences between PUCCH repetition and PUSCH repetition when defining available UL slots, so that the counting rule for PUCCH repetition can be reused as baseline. |
| Samsung | OK in principle with the proposal. We don’t agree with the FFS regarding the UL CI or the UL grant for URLLC as that is Rel-16 operation. |

There are several FFS points in the agreement based on FL proposal 2-2a.

2nd round discussion

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| **FL observation 2-2b:**  For discussions on further details of Alt 1 of the following agreement, what kind of RRC configurations that companies have in mind should be identified.  Agreements:  Select one of the following alternatives, considering the aspect whether or not the determination of all the available slots should be done prior to the first actual transmission of the repetitions (other alternatives are not precluded)  -        Alt1: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and does not depend on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).  -        Alt2: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and also depends on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).  **Question 2-2b:**  Companies (especially the ones supporting Alt1) are encouraged to provide views on what kind of RRC configurations (in addition to tdd\_ul\_dl configuration) are referred to for the determination of available slots.   * Alt1: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and does not depend on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC). | |
| **Company** | **Comment** |
| Intel | In our view, invalid UL symbols “numberInvalidSymbolsForDL-UL-Switching” also need to be considered to determine available UL slots. |
| Qualcomm | We consider flex symbols as being available for PUSCH transmission.  We can repurpose PUCCH repetition framework and also exclude flexible symbols that have SS/PBCH block. |
| Panasonic | We think reuse PUCCH repetition framework could be starting point, but the handling of flexible symbols is FFS. |
| WILUS | We share the same view with QC and Panasonic that PUCCH repetition framework can be used as a starting point. That is, semi-statically configured UL symbol or flexible symbol that is not SS/PBCH block symbol can be determined as available UL symbol. Also, in order to provide transmission occasions for PUCCH or SRS, the concept of invalid UL symbols as introduced in Type-B repetition may further considered. |
| Sharp | *ssb-PositionsInBurst* is referred to, in addition to *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated.*  Rel-16 *numberOfInvalidSymbolsForDL-UL-Switching* is used for PUSCH repetition type B but are not used for PUSCH repetition type A. Not sure that should be changed for Rel-17 PUSCH repetition type A. |
| vivo | PUCCH repetition framework can be considered as starting point. Slots not available due to other RRC configuration and procedure can be further discussed. |
| CATT | Besides common and UE dedicated TDD configuration, we think at least RRC that configuring SSB, Type0CSS and CORESET#0, shall be included. |
| Xiaomi | The same view as vivo. And at least RRC that configuring SSB shall be considered. |

During the 2nd round discussion, in addition to the TDD configuration, it was proposed that RRC that configuring SSB should be used for the determination of available slots, as in PUCCH repetition frame work in Rel-15/16. Several companies also proposed using numberInvalidSymbolsForDL-UL-Switching to PUSCH Type A repetition in Rel-17, though it was applicable only to PUSCH Type B repetition in Rel-16. Moreover, one company proposed using RRC configuration for Type0CSS and CORESET#0, too.

**FL proposal 2-2b after the 2nd round discussion:**

In addition to *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* (agreed already), *ssb-PositionsInBurst* for SS/PBCH block is used for the determination of available slots.

* FFS: whether to use *pdcch-ConfigSIB1* for a CORESET for Type0-PDCCH CSS.
* FFS: whether to use *numberInvalidSymbolsForDL-UL-Switching.*

Comments to FL proposal 2-2b after the 2nd round discussion

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| **Company** | **Comment** |
| Samsung | OK – the FFS were also considered in Rel-16 (for URLLC) and were not agreed |
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2nd round discussion

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| **FL observation 2-2c:**  For discussions on further details of Alt 2 of the following agreement, what kind of RRC configurations and dynamic signaling that companies have in mind should be identified.  Agreements:  Select one of the following alternatives, considering the aspect whether or not the determination of all the available slots should be done prior to the first actual transmission of the repetitions (other alternatives are not precluded)  -        Alt1: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and does not depend on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).  -        Alt2: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and also depends on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).  **Question 2-2c:**  Companies (especially the ones supporting Alt2) are encouraged to provide views on what kind of RRC configurations (in addition to tdd\_ul\_dl configuration) and dynamic signaling (in addition to SFI) are referred to for the determination of available slots.   * Alt2: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and also depends on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC). | |
| **Company** | **Comment** |
| Ericsson | According to our understandings, with this alternative, it’s enough to say in 38.214 that the omitted slots mentioned in the text below (copied from 38.214 for legacy Type A) are not counted as a slot for Type A PUSCH repetition (mode 2) transmissions.  For PUSCH repetition Type A, a PUSCH transmission in a slot of a multi-slot PUSCH transmission is omitted according to the conditions in Clause 9, Clause 11.1 and Clause 11.2A of [6, TS38.213].  What else do we need? |
| Samsung | All DCI-based signaling indicating whether or not a UE can transmit should be included together (SFI, UL CI, UL grant). For example, there is no reason and it makes no sense why a NW can cancel a transmission (including repetitions) by UL CI, can also cancel a configured transmission by SFI, but cannot cancel a repetition of a transmission by SFI. The NW/UE requirements on the use of UL CI, such as both on how often it needs to be transmitted/received and on a target BLER, are actually much more demanding than for SFI while the DCI payloads are comparable. Note that a previous comment by Qualcomm regarding the UL CI is incorrect, the UL CI is not applicable for URLLC traffic, it is applicable for (lower priority) eMBB traffic (same holds for cancellation by UL grant).  The Rel-17 CovEnh WI has the opportunity to fix a useless restriction of the Rel-15 specs that only constraints deployments and has no impact on UE implementation. Otherwise, RAN1 is simply forbidding a network to operate SFI and CovEnh simultaneously. There is no technical reason for that.  To answer the question from E/// above, reference to 11.1.1 of 38.213 is what is needed. Also, the validity of our previous comment “no need for FFS for the UL CI and the UL grant” is evident by the reference of the cited text to Clauses 11.2 and 9, respectively. |
| ZTE | Basically, we share with the the view of Ericsson. For now, we didn’t identify any issues by reusing Rel-15/16 rules. Note that, if there is an ambiguity on the number of repetitions for counting by available slots in Rel-17 (which we don’t think so per our understanding), there would be ambiguity in Rel-15/16, in which slot a repetition would be omitted. |

During the 2nd round discussion on Alt 2. Although only a few companies provided their views, there seems to be common understanding that the current PUSCH omission rules (i.e. according to the conditions in Clause 9, Clause 11.1 and Clause 11.2A of TS38.213) can be reused for the determination of available slots, given that “Clause 11.1” is understood to include Clause 11.1.1 as well.

**FL proposal 2-2c after the 2nd round discussion:**

For the determination of available slots in Alt 2, the Rel-16 PUSCH repetition omission rules (i.e. according to the conditions in Clause 9, Clause 11.1 (including Clause 11.1.1) and Clause 11.2A of TS38.213) are reused.

Comments to FL proposal 2-2c after the 2nd round discussion

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| **Company** | **Comment** |
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The next-level details of the determination of available slots are discussed below. According to companies’ contributions, there are different views on whether to allow different time domain resource allocation among slots for repetitions.

2nd round discussion

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| **FL observation 2-2d:**  If SFI is not configured,   * Option 1: A slot is determined as unavailable if at least one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with DL symbol or Flexible symbol with SSB according to TDD UL/DL configuration or the symbol which is RRC-configured not to be used for UL transmissions (TBD by Questions 2-2b and 2-2c). * Option 2: A slot may be determined as available even if any of the symbols indicated by TDRA for a PUSCH in the slot overlaps with DL symbol or Flexible symbol with SSB according to TDD UL/DL configuration or the symbol which is RRC-configured not to be used for UL transmissions (TBD by Questions 2-2b and 2-2c). When the slot is determined as available, time domain resource allocation in the slot is different from the one indicated by the TDRA.   **Question 2-2d:**  Any views on the above options? | |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | We prefer option 1. In our view, the motivation to increase maximum repetition or perform counting on basis available slots. Based on this, we don’t see the need to enhance how the slot is determined available even when some symbols overlap with DL symbol, etc. |
| Intel | It is not clear to why this is related to SFI. As agreed for Alt.1, dynamic SFI is not part of procedure for determination of available UL slots.  For both options, as commented above, we suggest to add “invalid UL symbols”, i.e.,   * Option 1: A slot is determined as unavailable if at least one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with DL symbol, invalid UL symbols or Flexible symbol with SSB according to TDD UL/DL configuration. * Option 2: A slot may be determined as available even if any of the symbols indicated by TDRA for a PUSCH in the slot overlaps with DL symbol, invalid UL symbols or Flexible symbol with SSB according to TDD UL/DL configuration. When the slot is determined as available, time domain resource allocation in the slot is different from the one indicated by the TDRA.   We prefer Option 1, as option 2 would change the basic TDRA for PUSCH repetition type A, i.e., same time domain resource allocation in each slot. We are not sure whether it is reasonable to change this. |
| Qualcomm | Prefer Option 1. Retain same TDRA across all repetitions. |
| ZTE | We prefer Option 1. We can further discuss for the case with dynamic SFI configured. |
| FL | The reason to put ”If SFI is not configured” is to decouple this discussion from down-selection from Alt1/Alt2 of the agreement. The case with dynamic SFI configured can be discussed after the down-selection is done, if necessary.  I also made some updates based on Intel’s comment. |
| Panasonic | We prefer Option 1. |
| LG Electronics | We prefer option1 in FL’s observation 2-2d. |
| China Telecom | We would like to ask one question for clarification:  Does any of the options have relation with special slot for TDD?  Basically we think the available slots should follow tdd\_ul\_dl configuration except for special slots.  Maybe we can add one sub-bullet for each option to consider special slots. |
| OPPO | We prefer Option 2.  In our view, the motivation to meet coverage while maintaining delay requirements. Though the symbols indicated by TDRA for a PUSCH in the slot overlaps with DL symbol or Flexible symbol with SSB according to TDD UL/DL configuration or the symbol which is RRC-configured not to be used for UL transmissions, it still has UL symbols. We should make full use of uplink resources.  If we drop the UL symbols in special slot, repetition may need to postpone more slots. Such as “DDDSUDDSUU”, if we only transmission at U slot, we need “DDDSUDDSUU DDDSU” for 4 actual repetition. If we can transmission at UL symbols in S slot, we may achieve performance by “DDDSUDDSUU” similar to only transmission at U slot by “DDDSUDDSUU DDDSU”. |
| Samsung | Whether SFI is configured or not is unrelated to the 2 options – we don’t agree with the FL formulation of the proposal and explanation.  Regarding the two options, option 2 would be better for resource allocation. We prefer Option 2. |
| WILUS | We prefer Option 1. The same SLIV in each slot. |
| Nokia/NSB | We prefer Option 1. The focus here should be on how to count the number of repetitions but time-domain allocation for each repetition should be kept as in Rel-16. |
| Ericsson | According to our understandings, with Alt 2 in 2-2c, it’s enough to say in 38.214 that the omitted slots mentioned in the text below (copied from 38.214 for legacy Type A) are not counted as a slot for Type A PUSCH repetition (mode 2) transmissions.  For PUSCH repetition Type A, a PUSCH transmission in a slot of a multi-slot PUSCH transmission is omitted according to the conditions in Clause 9, Clause 11.1 and Clause 11.2A of [6, TS38.213].  What else do we need? |
| NTT DOCOMO | We prefer Option 1. |
| Sharp | Prefer Option 1. |
| Vivo | Option 1 is preferred. |
| CATT | Not sure whether the rules from Option 1 and 2 will be applied to all slots.  For shots other than special slots, we prefer Option 1. For special slots, we would like to have further study. |
| CMCC | Option 1 is preferred. Similar reason as the RRC configuration is preferred for the determination of available slot for repetition, borrowing some dynamic changed resources for the repetition may induce more conflictions and uncertainty of the available resources. This could induce a misalignment between gNB and UE.  As the flexible symbols in the special slot are used for the guard period or the round trip time, there seems to be no further room for the uplink transmissions. If there are further considerations for the special slot, we are open to it. |
| FL | After thinking of the comments from Intel and Samsung again, I understand that the current Options are indeed unrelated to whether SFI is configured or not, because these Options are just saying the conditions for unavailable slots but not talking about the conditions for available slots. Therefore, I suggest removing “If SFI is not configured”, if people are OK.   * Option 1: A slot is determined as unavailable if at least one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with DL symbol or Flexible symbol with SSB according to TDD UL/DL configuration or the symbol which is RRC-configured not to be used for UL transmissions (TBD by Questions 2-2b and 2-2c). * Option 2: A slot may be determined as available even if any of the symbols indicated by TDRA for a PUSCH in the slot overlaps with DL symbol or Flexible symbol with SSB according to TDD UL/DL configuration or the symbol which is RRC-configured not to be used for UL transmissions (TBD by Questions 2-2b and 2-2c). When the slot is determined as available, time domain resource allocation in the slot is different from the one indicated by the TDRA.   At the same time, it should be also discussed the conditions for available slots. Now I’m thinking of the following for further discussions.   * If neither SFI nor certain dynamic signaling (TBD by Question 2-2c) is configured, a slot is determined as available if any of the symbols indicated by TDRA for a PUSCH in the slot does not overlap with DL symbol or Flexible symbol with SSB according to TDD UL/DL configuration or the symbol which is RRC-configured not to be used for UL transmissions (TBD by Questions 2-2b and 2-2c). |
| Qualcomm | Regarding the phrase “RRC-configured not to be used for UL transmissions” is this referring to the invalid symbol pattern defined for Type B repetitions? If so, it may not be a good idea to create dependencies on Type A repetitions that are based on certain parameters for Type B repetitions. |
| ZTE | We think the definition of available slots is related to whether SFI is configured or not. For instance, in Rel-15, if dynamic SFI is not configured, and if a repetition of CG PUSCH conflicts with a semi-static DL symbol, the repetition is not transmitted in the slot, i.e., unavailable slot. However, if dynamic SFI is configured and received, and if a repetition of CG PUSCH conflicts with a semi-static DL symbol or a dynamic DL/flexible symbol, the repetition is not transmitted in the slot, i.e., unavailable slot. If dynamic SFI is configured and not received, and if a repetition of CG PUSCH conflicts with a semi-static DL/flexible symbol, the repetition is not transmitted in the slot, i.e., unavailable slot. Thus, the definition of available slots may depend on whether SFI is configured or now.  Maybe, a better way out is to first summarize what’s the Rel-15/16 behavior on repetition type A about the definition of available slots for transmission of a DG/CG repetition, and then decide whether we can simply reuse the definition or some enhancements are needed. |
| Xiaomi | We prefer option 1. Option 2 would change the basic TDRA for PUSCH repetition type A, i.e., same time domain resource allocation in each slot. We are not sure whether it is reasonable. |
| Lenovo, Motorola Mobility | We still prefer option 1 |
| Apple | If our understanding on the proposal is right. We prefer option 1.  May FL clarify the meaning of “one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with **DL symbol or Flexible symbol** with SSB according to TDD UL/DL configuration”? does it mean that the symbol overlap DL symbols of SSB, or symbol overlaps with flexible symbol?  For SSB part, is it the intention to define valid UL slot for repetition, which is similar as 8.1A in 38.213  if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PUSCH occasion is valid if the PUSCH occasion  - does not precede a SS/PBCH block in the PUSCH slot, and  - starts at least *N*gap symbols after a last SS/PBCH block symbol, where *N*gap is provided in Table 8.1-2 |
| FL | @ Qualcomm,  “RRC-configured not to be used for UL transmissions” does not mean only invalid symbol pattern defined for Type B repetitions. My intention is “RRC-configured not to be used for UL transmissions” is more general, which includes SSB configuration and CORESET#0 configuration. But, what is included is discussed under 2-2b and 2-2c.  @ZTE,  I agree that, with Alt2, the determination of unavailable slots depends on whether dynamic SFI is configured or not. However, even if the SFI is configured, the unavailable slots which are determined based on RRC configuration will never change to be available by dynamic SFI later on. In this sense, Options 1 and 2 in the FL proposal 2-2d are applicable regardless of the presence of the dynamic SFI configuration.  @Apple,  My intention is the symbol overlapping “DL symbols” or the symbols overlapping “Flexible symbol that is also a part of SS/PBCH block symbols”. |

In the 2nd round discussion on Alt 2, it was discussed whether or not a slot is still possibly determined as available even if any of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the symbol which is RRC-configured not to be used for UL transmissions. Although slight majority preferred that such slot is not determined as available, it is better to have more discussions on this point for down-selection.

**FL proposal 2-2d after the 2nd round discussion:**

For defining available slots, select one from the following options.

* Option 1: A slot is determined as unavailable if at least one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the symbol which is RRC-configured not to be used for UL transmissions (TBD by Questions 2-2b and 2-2c).
  + Supported by Lenovo, Motorola Mobility, intel, Qualcomm, ZTE, Panasonic, LG Electronics, WILUS, Nokia, NSB, NTT DOCOMO, Sharp, vivo, CATT (for other than special slots), CMCC, Xiaomi, Lenovo, Motorola Mobility
* Option 2: A slot may be determined as available even if any of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the symbol which is RRC-configured not to be used for UL transmissions (TBD by Questions 2-2b and 2-2c). When the slot is determined as available, time domain resource allocation in the slot is different from the one indicated by the TDRA.
  + Supported by China Telecom (for special slots), OPPO, Samsung, CATT (for special slots)

Comments to FL proposal 2-2d after the 2nd round discussion

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| **Company** | **Comment** |
| Samsung | We suggest to add an FFS to both options   * + FFS whether the symbol is RRC-configured or DCI-indicated to not be used for UL transmissions |
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3rd round discussion

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| In the 1st GTW session, the following agreement was made.  Agreements:  Select one of the following alternatives, considering the aspect whether or not the determination of all the available slots should be done prior to the first actual transmission of the repetitions (other alternatives are not precluded)  -        Alt1: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and does not depend on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).  -        Alt2: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and also depends on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).  One aspect mentioned in the agreement is whether or not the determination of all the available slots should be done prior to the first actual transmission of the repetitions. To exchange companies’ views on this aspect would help further down-selection from Alt 1 and Alt 2.  **Question 2-2e:**  Any views on the following alternatives:   * Alt a: The determination of all the available slots has to be done prior to the first actual transmission of the repetitions. * Alt b: The determination of all the available slots does not have to be done prior to the first actual transmission of the repetitions. | |
| **Company** | **Comment** |
| Lenovo, Motorola Mobility | We support Alt a. |
| Nokia/NSB | We slightly prefer Alt. a but we are Ok with Alt. b as well if it helps making progress. |
| Intel | We support Alt. a.  Alt. b may have certain impact on UE implementation. |
| Huawei, HiSilicon | As the summary, the proposal is related to the following agreement,  *Agreements:*  *Select one of the following alternatives, considering the aspect whether or not the determination of all the available slots should be done prior to the first actual transmission of the repetitions (other alternatives are not precluded)*  *-        Alt1: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and does not depend on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).*  *-        Alt2: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and also depends on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).*  Alt a here can be paired with Alt 1 above, but not with Alt 2. Similarly, Alt b can be paired with Alt 2 only.  It seems better to put Alt a as a sub-bullet of Alt 1, Alt b as a sub-bullet of Alt 2. Or maybe propose something like if Alt 1 is selected, then Alt a is supported. |
| FL | Regarding the FL proposal 2-2e, I agree that Alt a/b are highly related to Alt 1/2 in the agreement. But, they are not just like one-to-one mapping. For example, if a UE uses RRC configuration and the SFI which was received before the first actual transmission of the repetitions for the determination of available slots, Alt a can be achieved. (Not sure if anyone prefers it, but it is still possible.) In 2-2b and 2-2c of the 2nd round, we had good discussions on further details of Alt1/2, but we haven’t touched the aspect of Alt a/b yet. Therefore, I’m trying to collect companies’ views on this aspect in this round. |
| CATT | We support Alt a.  We think Alt a can be applied to both ‘RRC only’ and ‘RRC + dynamic’ case, while Alt b can only reflect the case of ‘RRC + dynamic’. Not sure in what case the UE cannot determine the available slots before the first actual transmission in ‘RRC only’ case. |
| TCL | We prefer Alt. a. |
| Sharp | Either is fine. |
| Qualcomm | Strongly support Alt a. Alt b. has significant impact on UE implementation. |
| OPPO | We support Alt a. |

# Special slot handling

4 companies (OPPO, Huawei, HiSilicon, Samsung) discussed that a slot can be identified as an available UL slot if it consists of sufficient number of consecutive uplink symbols, e.g. number of consecutive uplink symbols is larger than a predefined or configurable threshold. 1 company (China Telecom) discussed symbol allocation in a special slot can be different from the one for UL slots.

2 companies (OPPO, China Telecom) discussed that utilizing of special slot(s) improves performance especially in low SNR case.

2 companies (Huawei, HiSilicon) discussed that new rate matching is performed if the number of UL symbols in a special slot is smaller than the scheduled number of symbols for the PUSCH.

1st round discussion

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| **FL observation 2-3:**  There seems to be several views on how to handle special slots. In general, some companies discussed some special handling on the special slots while some other companies discussed it together with definition of available slots for PUSCH repetitions.  **FL proposal 2-3:**  Discuss further how to handle special slots:  Alt 1: Discuss special slots together with section 3.2. Definition of available slots for PUSCH repetitions.  Alt 2: Discuss special slots separately from section 3.2. Definition of available slots for PUSCH repetitions.  **Question 2-3:**  Any views on the above proposal 2-3? | |
| **Company** | **Comment** |
| Samsung | Alt. 1 |
| Qualcomm | Alt. 1 |
| Apple | We are fine with both alternatives. |
| Intel | Alt. 1 |
| China Telecom | Either way is OK. In our view, for coverage enhancement, one of the principles is to maximize the amount of time a UE can transmit continuously at maximum power. In this sense, it is necessary to include any UL resource in time domain for PUSCH transmission, especially for TDD. |
| ZTE | Alt. 1  Whether special slot can be decided as available slot belong to the definition of available slot. |
| Panasonic | Alt.1. |
| CATT | Fine with both alternatives. |
| Sharp | Alt. 1 |
| NEC | Alt. 1. |
| CMCC | Share similar view with China telecom that fully use of the uplink resource is more important and encouraged for the TDD system.  From the view of unified design, Alt 1 is slightly preferred. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Alt 1 |
| OPPO | Alt.1. Separation will bring more complexity. |
| vivo | Support Alt 1. And the same S and L within a slot is expected for enhanced type-A PUSCH repetition. Otherwise, type-B PUSCH repetition can be used. |
| Ericsson | Alt2.  More evaluations are needed on the benefit of using special slot. |
| Nokia/NSB | Alt. 1 |
| InterDigital | We are ok with both alternatives. |
| Lenovo, Motorola Mobility | Fine with both alternatives |
| Huawei, HiSilicon | Either is fine. |
| Xiaomi | Either is fine. |

**Summary on Question 2-3 in the 1st round discussion is as follows:**

Most of the companies think handling of special slots can be discussed together with definition of available slots for PUSCH repetitions. Several companies provided their views that maximizing use of uplink resources is important.

**FL observation 2-3 after the 1st round discussion:**

Handling of special slots can be discussed together with definition of available slots for PUSCH repetitions.

# PUSCH repetition mode configuration/indication

2 companies (China Telecom, Ericsson) discussed that Network should be able to configure one of two modes: Mode 1) the number of repetitions is counted on the basis of contiguous slots; and Mode 2) the number of repetitions is counted on the basis of available UL slots; by RRC. 3 companies (Panasonic, Lenovo, Motorola Mobility)) mentioned either RRC configuration or use of TDRA table can be considered for the mode indication.

1st round discussion

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| **FL observation 2-4:**  So far, only a few companies provided their views on configuration/indication of PUSCH repetition mode between:   * the number of repetitions counted on the basis of contiguous slots (i.e. legacy PUSCH repetition) * the number of repetitions counted on the basis of available slots for the PUSCH transmissions (i.e. enhanced PUSCH repetition)   There seems to be two options:   * Alt 1: Whether the counting is based on contiguous slots or available slots is configured by higher-layer configuration. * Alt 2: Whether the counting is based on contiguous slots or available slots is indicated by dynamic signaling.   **Question 2-4:**  Companies are invited to provide their views on PUSCH repetition mode configuration/indication. | |
| **Company** | **Comment** |
| Samsung | No need to discuss. In case of no postponing, the counting is based on contiguous slots. In case of postponing, the counting is based on available slots. |
| Qualcomm | Motivation to maintain two modes of counting is not clear. Needs sufficient justification. Else, prefer to go with the new mode that is being discussed currently.  @Samsung, a case of no postponing but based on available slots (using semi-static tdd ul-dl configurations) is also a possibility. |
| Apple | According to the WID, the counting is only based on available slot. So the proposal seems beyond the objective of this WI. |
| Intel | In our view, for FDD or TDD without semi-static UL/DL configuration, the number of repetitions is counted on the basis of contiguous slots. For TDD with semi-static UL/DL configuration, it can be either based on available UL slots or contiguous slots, which also depend on the UL/DL configurations. |
| China Telecom | For Rel-17, there are two kinds of UE behaviours: on the basis of contiguous slots (maximum number of repetitions increased to 32) and on the basis of available slots. Rel-17 UE may support only one of them or support both. If both of them is supported by Rel-17 UE, UE need to be indicated which one is configured. Otherwise, how can UE distinguish which should it follow? The signalling can be explicit or implicit. |
| ZTE | If a new RRC parameter is introduced for the enhancements, it could be automatically used for indication of using the enhancements. We don’t see a need to discuss this issue now. |
| Panasonic | Firstly, whether Rel.17 CE UEs support both modes (Rel.15/16 PUSCH repetition Type A and Rel.17 enhanced PUSCH repetition Type A) or not should be discussed and concluded. |
| CATT | We can discuss this later. |
| Sharp | According to WID, two modes are supported.   * Mode 1: Counting based on contiguous slots with increased maximum number of repetitions * Mode 2; Counting based on available slots with maximum number of repetitions = 16 |
| NEC | We support Alt.1. |
| CMCC | We do not see any motivation to maintain two modes and change the mode during the procedure. The new defined mode could work in both TDD and FDD system. If a UE is updated to Rel-17, it should support the new defined mode. |
| OPPO | No further configurability is needed. We can decide to how to define the available slots. |
| vivo | Alt. 1.  In our view, there is no need to support two modes on PUSCH repetition at the same time. |
| Ericsson | RRC signaling in *pusch-config* is needed to indicate whether a legacy, or an option 1 or an option2 PUSCH repetition Type A should be used when a Type A repetition is configured, in a similar way as the RRC configuration to indicate PUSCH repetition type in R16 (TypeA or Type B) in *pusch-config*. |
| Nokia/NSB | As discussed during GTW session and also in our comments for Section 2.1, we do not think that two features that solve the same issue should be independently specified in RAN1. This practice should be strongly avoided otherwise specification is just a place to accommodate all solutions proposed by companies to solve the same issue. Our understanding from the WID is that both functionalities are supported in the same mode. Therefore, there is no reason why a gNB would configure a UE that supports the enhanced PUSCH repetition type A to use the legacy PUSCH repetition type A.  Having said this, even if we assumed that the problem existed, we would like to note that, from our perspective, 3.4 seems to be related to UE capabilities and not to the feature as such. Issues related to UE capabilities should be discussed in other AIs/sessions. |
| Lenovo, Motorola Mobility | Agree with China Telecom’s and Sharp’s views that two modes will be supported.  In our view, RRC can configured whether Rel-17 enhanced PUSCH repetition type A is followed or Rel-15/16 PUSCH repetition type A is followed.  Then to distinguish/switch between two modes for Rel-17 enhanced PUSCH repetition type A, we think the number of repetitions (repetition factor) should be considered. In our thinking, when more than 16 repetitions are indicated, then mode 1 should be used since the actual number of repetitions more than 16 might not be needed. For 16 or less, mode 2 should be used. |
| Huawei, HiSilicon | This discussion can be deferred till more consensus on the definition of available slots. |
| Xiaomi | Motivation to maintain two modes of counting is not clear. But we are open to discuss it. If it is really necessary to support both modes, we prefer alt 1 for simplicity. |

**FL observation 2-4 after the 1st round discussion:**

Proposals on PUSCH repetition mode configuration/indication are related to UE capabitilies. Discuss this aspect later.

# Appendix

# List of agreements in RAN1#104-e

Agreements:

Select one of the following alternatives, considering the aspect whether or not the determination of all the available slots should be done prior to the first actual transmission of the repetitions (other alternatives are not precluded)

-        Alt1: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and does not depend on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).

-        Alt2: Whether or not a slot is determined as available for UL transmissions depends on RRC configurations (at least tdd\_ul\_dl configuration, FFS: other RRC configurations) and also depends on dynamic signaling (at least SFI, FFS: other dynamic signaling e.g. CI, PUSCH priority for URLLC).

Agreements:

The maximum number of repetitions for DG-PUSCH is also applicable to CG-PUSCH.

Agreements:

For defining available slots: a slot is determined as unavailable if at least one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the symbol not intended for UL transmissions

* FFS details

# References

1. R1-2100095 Discussion on enhanced PUSCH repetition type A ZTE
2. R1-2100172 Enhancements on PUSCH repetition type A OPPO
3. R1-2100196 Coverage enhancements for PUSCH repetition typeA Huawei, HiSilicon
4. R1-2100397 Discussion on enhancements on PUSCH repetition type A CATT
5. R1-2100457 Discussion on enhancement for PUSCH repetition type A vivo
6. R1-2100665 Enhancements on PUSCH repetition type A Intel Corporation
7. R1-2100712 Discussions on PUSCH repetition type A enhancements LG Electronics
8. R1-2100731 PUSCH repetition for coverage enhancements InterDigital, Inc.
9. R1-2100915 Enhancements on PUSCH repetition type A China Telecom
10. R1-2100942 Discussion on enhancements on PUSCH repetition type A NEC
11. R1-2101001 Enhancements on PUSCH repetition type A Lenovo, Motorola Mobility
12. R1-2101017 Discussion on enhancements on PUSCH repetition Type A Panasonic Corporation
13. R1-2101055 Discussion on enhancements on PUSCH repetition type A CMCC
14. R1-2101127 Enhancements on PUSCH repetiton type A Xiaomi
15. R1-2101221 Enhancements on PUSCH repetition type A Samsung
16. R1-2101327 Design Considerations for Enhancements on PUSCH repetition Sierra Wireless, S.A.
17. R1-2101395 Discussion on PUSCH repetition type A enhancement Apple
18. R1-2101407 PUSCH Repetitions for Coverage Enhancement Indian Institute of Tech (H)
19. R1-2101477 Enhancements on PUSCH repetition type A Qualcomm Incorporated
20. R1-2101520 PUSCH Repetition Type A Enhancement Ericsson
21. R1-2101545 Enhancements on PUSCH repetition type A Sharp
22. R1-2101641 Enhancements on PUSCH repetition type A NTT DOCOMO, INC.
23. R1-2101656 Enhancements on PUSCH repetiton type A Xiaomi
24. R1-2101679 Discussion on enhancements on PUSCH repetition type A WILUS Inc.
25. R1-2101710 Enhancements on PUSCH repetition type A Nokia, Nokia Shanghai Bell