**3GPP TSG-RAN WG1 #106-e R1-21xxxxx**

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

**Agenda item: 8.8.1.1**

**Source: Moderator (Sharp)**

**Title: FL Summary #3 on Enhancements on PUSCH repetition type A**

**Document for: Discussion and Decision**

# Introduction

For PUSCH enahancements the following objectives are described in the Coverage Enhancement WID.

* *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.*

This document is intended to facilitate view exchange and discussions on the enhancements on PUSCH repetition type A, for the following assigned email discussion.

[106-e-NR-R17-CovEnh-01] Email discussion regarding enhancements for PUSCH repetition type A – Toshi (Sharp)

* 1st check point: August 19
* 2nd check point: August 24
* Final check: August 27

# Open Issues summary

## Increasing the maximum number of repetitions

For increasing of the maximum number of repetitions, the following agreements have been made.

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| **In RAN1#104-e**  Agreements:  The maximum number of repetitions for DG-PUSCH is also applicable to CG-PUSCH.  Agreements:  Rel-17 PUSCH repetition Type A supports the increase of maximum number of repetitions with repetition factors configured in a TDRA list with a row index indicated either by the configured grant configuration or by TDRA field in a DCI.   * FFS: increasing the maximum number of repetitions with repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig*.   **In RAN1#105-e**  Agreement:   * Down-selection in RAN1#106-e: * Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method, * Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots.   Agreement:  In addition to {1, 2, 3, 4, 7, 8, 12, 16} and {32}, the following additional value set for repetition factor is supported in Rel-17.   * {20, 24, 28} |

At the same time, the following two remaining issues have been identified.

* Issue#1-1: Value of the maximum number of repetitions
* Issue#1-2: RRC parameters to be extended for supporting the increased maximum number
* Issue#1-3: DCI formats supporting the repetition factors indicated/configured via TDRA lists

### [Open] Issue#1-1: Value of 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}. TDRA 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}. For CG-PUSCH, RRC parameter *repK* configures the number of repetitions, where the candidate value set of *repK* = {2, 4, 8}. For Type 2 configured PUSCH repetition, TDRA based dynamic repetition number indication with *numberOfRepetitions-r16* using activation DCI is also applicable.

In RAN1#105-e, although the majority supported the maximum number of 32, some companies wanted to first see companies’ views on assumptions for designing of the maximum value, e.g. whether the number of repetitions is counted based on contiguous slots or available slots, whether to consider both FDD and TDD or either of them and whether to consider both VoIP and eMBB or either of them.

When discussing how much the maximum repetition factor should be increased, the following three cases were raised by companies.

* Case 1: FDD or SUL
* Case 2: TDD with contiguous-slot-based counting
* Case 3: TDD with available-slot-based counting

Most of the companies believed that, once the increased maximum repetition factor is decided, it should be applicable to all the three cases, but there were still different views on which cases should assumed when evaluating if proposed values achieve sufficient PUSCH coverage. Some company said the value should be decided based on Case 1 while other companies argued it should be Case 2 or Case 3. This divergence came from different views on the “bundle” of two enhancements, (a) increasing the maximum number of repetitions and (b) the number of repetitions counted on the basis of available slots. The majority thought that the two enhancements are not bundled (i.e. can be configured separately/independently) while a few companies said that the two enhancements are always bundled. The most of the majority companies were also thinking that the maximum value should be extended to 32 by the enhancement (a) so that sufficient coverage can be achieved without the enhancement (b). Furthermore, the some of the companies who preferred “always-bundle” were also saying that the maximum value should be extended to 32 even with the enhancement (a).

After several rounds of email discussions, the following agreement was made in the online session.

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| Agreement:   * Down-selection in RAN1#106-e: * Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method, * Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots. |

The companies’ views collected during the 2nd round discussion in RAN1#105-e are summarized as follows.

* Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method,
  + - Qualcomm, CATT, vivo, Xiaomi, ZTE, Sharp, OPPO, China Telecom (1st choice), Samsung, Apple, LG, Nokia/NSB, Sharp
* Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots.
  + - Intel, Panasonic, China Telecom (2nd choice), Lenovo/Motorola Mobility, CMCC, NTT DOCOMO, Huawei, HiSilicon, Ericsson

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method,
  + - (16 companies): vivo [2], Nokia/Nokia Shanghai Bell [3], ZTE [4], CATT [6], China Telecom [9], OPPO [12], Qualcomm [13], CMCC [14], LG Electronics [15], Sierra Wireless [18], InterDigital [19], Apple [20], Sharp [21], NTT DOCOMO [22], Xiaomi [23]
* Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots.
  + - (8 companies): Huawei/HiSilicon [1], Rakuten Mobile, [8] NEC [10], Lenovo/Motorola Mobility [11], Ericsson [16], Intel [17]

The arguments are almost the same as what has been raised in the prerivous meetings. The proponents of Alt 1 are saying that Alt 1 provides more flexibility and achieves better coverage. Also, they think Alt 1 is simpler in terms of configuration and the restriction by Alt 2 would cause even more specification impacts. The proponents of Alt 2 are saying that 32 repetitions with the counting based on available slots makes the overall duration for a set of repetitions too long, which leads to too much delay.

1st round (Issue#1-1)

Companies are encouraged to provide their views on whether to support 32 repetitions with the counting based on available slots.

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| **Company** | **Comments** |
| vivo | It is not necessary to limit the maximum 32 repetitions only to repetition counted based on physical slots. Even if these two features are enabled at the same time, NW could configure a suitable number of repetitions, not always the maximum 32.  Furthermore, due to PUSCH dropping rules, the actual number of repetitions could be less than the configured one, even if it is counted based on available slots. Thus, Alt 1 is preferable. |
| Apple | We support the maximum repetition 32 is applied to both counting methods. There is no repetition based on available slot in Rel.16, thus no baseline of 16 repetitions there. It’s up to gNB whether to configure 32 repetitions for available slot based counting. |
| Ericsson | Support alt2.  Alt1 indicates that the 2 features will be bundled together, while the 2 features should be treated independently in our view and this is not discussed yet.  Another reason is that 16 repeated available slots in DDDSU case already mean 80 repetitions counted based on physical slots which is already long enough.  Furthermore, repetition compared to retransmission does not give more coverage.  It would be good to first discuss issue on whether the 2 features will be bundled together or will be treated independently instead. |
| Nokia/NSB | Even if two counting approaches are adopted by RAN1 for Rel-17, Alt. 1 is still a better option. Indeed, one argument from the proponents for having two counting approaches is that counting on consecutive slots is friendlier for implementation, which indirectly states that counting on available slots requires a higher implementation complexity. Generally speaking, one should only opt for a higher complexity approach if it could offer a higher benefit, which is the number of actual repetitions in our case. In this regard, Alt. 2 cannot guarantee that counting on available slots can always offer a higher number of actual repetitions compared to the counterpart. |
| Intel | We support Alt. 2.  We do not think we need to couple these two features together. In our view, 32 repetitions based on available slots in TDD indicate that for some TDD frame structure, PUSCH repetition is quite long, which is not desirable due to unnecessary delay. |
| Lenovo, Motorola Mobility | We support Alt 2 for following reasons:   * CE can be fulfilled if the transmitted repetitions (counting based on available slots) is up to 16   We don’t agree that the specification impact is more with separate number of maximum repetitions for the two techniques. Rather, Alt 2 simplifies the specification in terms of configuring either of the two techniques. Basically, if more than 16 repetitions are indicated, then counting is done as in Rel-15/16, otherwise counting is done based on available slots |
| Sierra Wireless | We support Alt 1 for reasons mentioned above. Alt 1 does not imply that the two features MUST be bundled together – only that they CAN be enabled at the same time, but it is up to infra when to do this. The argument against that Alt 1 that it will result in transmissions which are “too long” is also flawed, because infra controls the number of repeats so the transmission is only “too long” if the infra makes it “too long”. It is better to provide a few more repeats now than is needed base on simulation/theory so that we don’t need another WI to increase repeats in future releases due to field issues. |
| Qualcomm | Support Alt 1. We see no benefit to Alt 2 especially when it is up to the gNB to schedule the desired number of repetitions. Let us not add unnecessary “if/else” clauses in the spec. |
| Samsung | Support Alt 1. There is no reason to restrict the use of 32 repetitions based on the counting method. That would only complicate specifications and gNB implementation. The network can always choose to configure an appropriate number of repetitions from the possible values with either one of the two counting methods. |
| InterDigital | We support Alt. 1. The number of repetitions can be configured according to the coverage requirement. |
| Panasonic | We think Issue#1-1 is related to Issue 2-12. If Alt.2 in Issue 2-12 is the conclusion, the conclusion of Issue 1-1 would be automatically Alt.1. If Alt.3 in Issue 2-12 is the conclusion, the conclusion of Issue 1-1 would be automatically Alt.2. For Alt.1 in Issue 2-12, whether to support 32 repetitions with the counting based on available slots should be discussed. |
| ZTE | Support Alt 1. |
| LG | We support Alt 1. It is not necessary to limit to support 32 repetitions for the counting based on available slots. |
| CATT | Support Alt.1, i.e. 32 repetitions with the counting based on available slots. It does not harm the network since 32 is just the ‘maximum’ value. The ‘actual’ configured/indicated value can still be smaller if the gNB desires. |
| NTT DOCOMO | We support Alt.1. We also understand that it may not be necessary to configure 32 repetitions for the basis of available UL slots. On the other hands, the configuration may be separated, so that it’s not necessary to define an additional rule for the restriction as in Alt 2. |
| Spreadtrum | We support Alt 1. |
| CMCC | Support Alt 1. An same maximum repetition number could be used for both counting methods. |
| OPPO | We support Alt1.  The motivation of the two enhancements is to ensure the actual number of repetitions. Though the maximum number is 32, the network may still configure a smaller value. It is not necessary to limit the maximum 32 repetitions only to repetition counted based on physical slots.  Regarding on the counting based on available slots, there is also the case that actual PUSCH repetition is dropped on the available slots. A larger maximum number can ensure the 16 actual repetitions and guarantee the coverage performance. |
| Xiaomi | We support alt1. On the one hand, they should be two independent methods for increasing the PUSCH coverage. On the other hand, we see no obvious benefit to Alt 2 other than increasing the complexity of specification. |
| Huawei/HiSilicon | We do not see any clear benefit to support 32 repetitions with the counting based on available slots. As analysized in our contributions, in the typical TDD mode, 16 for the counting based on available slots has better performance than 32 for the counting based on physical slots, so it is unreasonable to increase 16 to 32 for the counting based on available slots, but not increase 32 to a bigger value for the counting based on physical slots. Thus, Alt.2 is better than Alt.1. |
| NEC | We support alt2, but we are OK with alt1. We think 32 actual repetitions which may last for about 100 slots for typical TDD-UL-DL configuration are rare case configured by network and it may increase UE complexity to support 32 repetitions. On the other hand, maximum supported repetition is UE capability and network may not configure 32 repetitions. Just from signaling perspective, 32 can also be OK from our side. |
| Sharp | We support Alt 1. The restriction in Alt 2 would lead to more specification impacts. |
| China Telecom | We support Alt 1. It is useful to support the maximum number of repetition as 32 based on available slots for VoIP with relaxed time budget. |
| Rakuten Mobile | We support Alt 2. For the case of Alt 1, it might have too long period to receive the complete PUSCH transmission for unpaired spectrum. |
| Panasonic2 | Considering the situation, we are OK to conclude Issue 1-1 first and we support Alt.1 for Issue 1-1. |
| FL | @Panasonic:  Thank you for informing of your preference. I updated the summary accordingly. |

1st round summary (Issue#1-1)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method,
  + (20 companies): vivo, Apple, Nokia/NSB, Sierra Wireless, Qualcomm, Samsung, InterDigital, ZTE, LG, CATT, NTT DOCOMO, Spreadtrum, CMCC, OPPO, Xiaomi, NEC (2nd choice), Sharp, China Telecom, Panasonic
* Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots.
  + (8 companies): Ericsson, Intel, Lenovo/Motorola Mobility, Huawei/HiSilicon, NEC (1st choice), Rakuten Mobile
* ~~Discuss Issue#2-12 first~~
  + ~~(1 company): Panasonic~~

2nd round (Issue#1-1)

FL proposal on Issue#1-1

Select one of the following two alternatives in GTW session

* Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method,
  + (20 companies): vivo, Apple, Nokia/NSB, Sierra Wireless, Qualcomm, Samsung, InterDigital, ZTE, LG, CATT, NTT DOCOMO, Spreadtrum, CMCC, OPPO, Xiaomi, NEC (2nd choice), Sharp, China Telecom, Panasonic
  + Views from Alt 1 proponents:
    - NW can configure a suitable number of repetitions when counting based on the available slots.
    - Alt. 2 cannot guarantee that counting on available slots can always offer a higher number of actual repetitions, e.g., the 16 actual repetitions.
    - The limitation by Alt 2 leads to more spec impacts, e.g., “if/else” clauses in the spec.
    - It is better to provide a few more repeats now than is needed base on simulation/theory so that we don’t need another WI to increase repeats in future releases due to field issues.
    - It is useful to support the maximum number of repetitions as 32 based on available slots for VoIP with relaxed time budget.
* Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots.
  + (8 companies): Ericsson, Intel, Lenovo/Motorola Mobility, Huawei/HiSilicon, NEC (1st choice), Rakuten Mobile
  + Views from Alt 2 proponents:
    - Alt 1 makes PUSCH repetition too long, which causes unnecessary delay. (16 repeated available slots in DDDSU case already mean 80 repetitions counted based on physical slots)
    - Alt 2 simplifies the specification in terms of configuring either of the two techniques.

If companies would like to raise other aspects than the ones captured above, please provide.

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| **Company** | **Comments** |
| Ericsson2 | On top of what we commented in last round, more views are added to Alt2:   * Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots.   + (8 companies): Ericsson, Intel, Lenovo/Motorola Mobility, Huawei/HiSilicon, NEC (1st choice), Rakuten Mobile   + Views from Alt 2 proponents:     - The over optimization in Alt 1 makes PUSCH repetition too long, which causes unnecessary delay. (~~16~~32 repeated available slots in DDDSU case already mean ~~80~~ 160 repetitions counted based on physical slots)     - Alt 2 simplifies the specification in terms of configuring either of the two techniques. E.g. when the network only wants to schedule legacy repetitions based on available slot so that the network doesn’t have to configure a separate TDRA table for increased number of repetitions, counting the slots based on an indication of the R17 repetition type (legacy Type A, R17 Type A1, R17 Type A2) is enough. However, if the 2 features are combined, a separate TDRA table is always required for increased number of repetitions since legacy TDRA table can not be modified to include new repetition factors for the reason of backward compatible.     - If number of actual transmissions cannot be achieved to be maximum number, use HARQ retransmissions, there’s no evidence in theory and practice showing that repetition can provide more gains than HARQ retransmission.     - Based on NR Rel-16 Type A PUSCH repetitions, supporting repetitions counted based on available slot and increasing repetitions from up to 16 to up to 32 are listed in 2 separate objectives in the WID. Alt1 means a 3rd objective should be added in the WID, i.e. supporting increased number of repetitions counted based on available slot. This should be discussed in RAN plenary. |

### [Pending] Issue#1-2: RRC parameters to be extended for supporting the increased maximum number

In Rel-16, there are three RRC parameters which are used to configure repetition factors, *pusch-AggregationFactor*, *numberOfRepetitions*, and *repK* as shown below, where *numberOfRepetitions* supports up to 16 repetitions while the value ranges of *pusch-AggregationFactor* in *PUSCH-Config* and *repK* in *ConfiguredGrantConfig* are {2, 4, 8} and {1, 2, 4, 8}, respectively.

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| **TS38.214v16.6.0**  6.1.2.1 Resource allocation in time domain  *[Omitted]*  For PUSCH repetition Type A, when transmitting PUSCH scheduled by DCI format 0\_1 or 0\_2 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or CS-RNTI with NDI=1, the number of repetitions *K* is determined as  - if *numberOfRepetitions* is present in the resource allocation table, the number of repetitions K is equal to *numberOfRepetitions*;  - elseif the UE is configured with *pusch-AggregationFactor*, the number of repetitions *K* is equal to *pusch-AggregationFactor*;  - otherwise *K=1*.  *[Omitted]*  6.1.2.3 Resource allocation for uplink transmission with configured grant  *[Omitted]*  For PUSCH transmissions with a Type 1 or Type 2 configured grant, the number of (nominal) repetitions *K* to be applied to the transmitted transport block is provided by the indexed row in the time domain resource allocation table if *numberOfRepetitions* is present in the table; otherwise *K* is provided by the higher layer configured parameters *repK.* |

In RAN1#104-e, we discussed which parameter(s) should be extended to support the increased maximum repetition factor. Although the large majority originally supported extension of all the three parameters, several companies expressed that extension of *numberOfRepetitions* (i.e. the one associated with TDRA list) is sufficient. In RAN1#104-e, it was agreed that Rel-17 PUSCH repetition Type A supports the increase of maximum number of repetitions with repetition factors configured in a TDRA list with a row index indicated either by the configured grant configuration or by TDRA field in a DCI. There was still the sub-bullet saying that “FFS: increasing the maximum number of repetitions with repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig*”. In other words, it should be decided whether the repetition factors semi-statically configured without using the TDRA list (of which the value range was {1, 2, 4 or 8} in Rel-15/16) also support the increase of maximum number of repetitions in Rel-17 or not.

In RAN1#105-e, whether repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* supports the increased maximum number of repetitions or not was discussed again in the 1st and 2nd round discussions. Companies’ views provided are summarised as follows.

* Support (8 companies): Intel, China Telecom, Samsung, LG, OPPO, Xiaomi (IEs are up to RAN2), Nokia/NSB
* Not support (13 companies): Qualcomm, ZTE, Apple, Ericsson, NTT DOCOMO, Sharp, CATT, CMCC, Lenovo/Motorola Mobility, Sierra Wireless, vivo, Xiaomi

As shown above, in RAN1#105-e there was no consensus to support the increased maximum number of repetitions by the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig*. Proponents can try to convince the other party in this meeting.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* The repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* supports the increased maximum number of repetitions
  + (7 companies): Nokia/Nokia Shanghai Bell [3], Samsung [5], OPPO [12], LG Electronics [15], Intel [17], Xiaomi [23]
* The repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* does NOT support the increased maximum number of repetitions
  + (6 companies): vivo [2], ZTE [4], CATT [6], CMCC [14], Sharp [21], NTT DOCOMO [22]

The arguments are almost the same as what has been raised in the prerivous meetings. The proponents are saying that, Rel-16 TDRA list based repetition is an optional feature and Rel-17 CovEnh should support the increased maximum repetition factor without using the TDRA list based scheme. Meanwhile, the opponents think the enhancement of the TDRA list based scheme is sufficient to support the increased maximum number of repetitions and there is no need to enhance the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* on top of the TDRA list based scheme.

1st round (Issue#1-2)

Companies are encouraged to provide their views on the necessity/benefits to enhance the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig*.

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| **Company** | **Comments** |
| vivo | We do not see the clear benefit to enhance the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig*. Number of repetition can be applied to both DG and CG-PUSCH.  Although type-A repetition with repetition number in TDRA is an optional feature, but CE Ues must support some additional capabilities for achieve better coverage. Hence, it is not an issue if maximum 32 repetitions is only supported for parameter ‘*numberOfRepetitions*’. |
| Apple | It’s not necessary to configure the repetition factor in *PUSCH-Config* and/or *ConfiguredGrantConfig*, indication of repetition in TDRA list is enough. If it is allowed the PUSCH-config to support the 32 repetitions, additional effort is required to determine which repetition number is applied if both are configured, i.e. *pusch-AggregationFactor* vs., *numberOfRepetitions*. |
| Ericsson | Enhancement of Type A PUSCH repetition based on the repetition factors signalled in TDRA list is enough. |
| Nokia/NSB | Please refer to our comment on Issue 1-3, which is an example for why it may be beneficial for at least increasing the maximum number of repetitions for *pusch-AggregationFactor.* |
| Intel | We support to enhance the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig.*  As defined in the NR, when numberofrepetitions is not presented in the TDRA table and if pusch-AggregationFactor is configured in PUSCH-Config, the number of repetitions is determined based on pusch-AggregationFactor. In this case, it is more desirable to also support pusch-AggregationFactor with the increased maximum number of repetitions and also repK. |
| Lenovo, Motorola Mobility | We support the first alternative where the repetition factor configured in PUSCH-Config and/or *ConfiguredGrantConfig* supports the increased maximum number of repetitions |
| Sierra Wireless | Agree with Vivo, Apple and Ericsson |
| Qualcomm | We see no strong need to update the parameters in *PUSCH-Config* and/or *ConfiguredGrantConfig.* A UE that does not support TDRA lists is unlikely to take benefit of several other coverage enhancement features. Introducing specific enhancements targeted at such Ues may not be necessary. |
| Samsung | For the same reasons that the maximum *numberOfRepetitions* was agreed to be increased, when *numberOfRepetitions* is not present in the TDRA table, the maximum value of the parameter (*pusch-AggregationFactor* or *repK*) should be increased. |
| ZTE | We do not identify any benefits. Instead, it will introduce more specification impacts. |
| LG | We think increasing the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* is benefitial in some cases.  For instance, there will be a case where the UE is located for a long time in an environment that requires coverage enhancement. Then, it may be necessary to continuously apply a large repetition number to PUSCH transmission, and it seems helpful to support the increased maximum number of the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig*. |
| CATT | Not support increasing the repetition factor configured in *PUSCH-Config* or *ConfiguredGrantConfig*. No further coverage enhancement will be achieved. Prefer to keep the standard impact small. |
| NTT DOCOMO | We think extending number of repetition in TDRA list is enough. |
| Spreadtrum | The repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* does NOT support the increased maximum number of repetitions  Extension on *numberOfRepetitions* is sufficient, which can be applied to both dynamic grant and configured grant. |
| CMCC | Not support the enhancements to *PUSCH-config* or *ConfiguredGrantConfig*.  As the enhancements to *numberOfRepetitions* could solve all the use cases of DG and CG-PUSCH, we do not see the motivation to support *PUSCH-config* or *ConfiguredGrantConfig ,* which seems redundant for the enhancements. |
| OPPO | When UE is not configured with *numberOfRepetitions* in the TDRA table, UE needs to follow the pusch-AggregationFactor configured in PUSCH-Config. In this case, a larger repetition factor can help meet the coverage enhancement target. This also applies for repK in ConfiguredGrantConfig. |
| Huawei/HiSilicon | Agree with Intel. |
| Sharp | In our view, extending number of repetition in TDRA list is sufficient, as the repetition factors via TDRA list are applicable to all of the DG-PUSCH, Type-1 CG-PUSCH and Type-2 CG-PUSCH. |
| China Telecom | We support to enhance the repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig.* |
| Rakuten Mobile | We don’t think that the enhancement is needed in *PUSCH-config* or *ConfiguredGrantConfig*. *numberOfRepetitions* can cover both DG- and CG-PUSCH. |

1st round summary(Issue#1-2)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1: The repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* supports the increased maximum number of repetitions
  + (11 companies): Nokia/NSB, Intel, Lenovo/Motorola Mobility, Samsung, LG, OPPO, Huawei/HiSilicon, China Telecom
* Alt 2: The repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig* does NOT support the increased maximum number of repetitions
  + (12 companies): vivo, Apple, Ericsson, Sierra Wireless, Qualcomm, ZTE, CATT, NTT DOCOMO, Spreadtrum, CMCC, Sharp, Rakuten Mobile

FL Observation on Issue#1-2:

* At this time, there is no consensus to enhance *PUSCH-Config* and *ConfiguredGrantConfig* to support the increased maximum number of repetitions.

### [Open] Issue#1-3: DCI formats supporting the repetition factors indicated/configured via TDRA lists

In RAN1#106-e, ZTE [4] provided their proposal that DCI format 0\_0 should support the repetition number with increased maximum repetition number configured in TDRA lists. Note that, in Rel-15/16 specification, *numberOfRepetitions* can not be indicated by DCI format 0\_0 since *numberOfRepetitions* is only included in the TDRA table configured for DCI format 0\_1 and 0\_2.

1st round (Issue#1-3)

Companies are encouraged to provide their views on whether the repetition number with increased maximum repetition number configured in TDRA lists indicated by DCI format 0\_0 is also supported in Rel-17.

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| **Company** | **Comments** |
| vivo | Support enhanced repetition for non-fallback DCI is enough. It is not necessary to further extend to fallback DCI. |
| Apple | It’s not necessary for DCI format 0\_0 to support the increased maximum repetition. DCI format 0\_0 is the fallback DCI, which may not support the advance features. |
| Ericsson | Similar to repetition enhancement in NR Rel-16, TDRA tables/lists configured for DCI format 0\_1 and 0\_2 are enough in Rel-17.  DCI format 0\_0 is used also by uplink transmission before RRC connection, e.g. the retransmission of Msg3 which cannot be repeated in legacy and we do not think we need to apply the Rel-17 enhanced type A PUSCH repetition to these channels which are out of the scope of this agenda in our understanding. |
| Nokia/NSB | We share similar view with other companies that further extending *numberofrepetitions* for DCI format 0\_0 is not needed, and it could be considered as out-of-scope of this AI. On the other hand, this issue shows the need of increasing the maximum number of repetitions for other parameter(s), e.g. *pusch-AggregationFactor*, in case *numberofrepetitions* is not (or cannot be) configured in the TDRA table, e.g., for DCI format 0\_0. |
| Intel | We do not support increased maximum repetition number configured in TDRA lists indicated by DCI format 0\_0. DCI format 0\_0 is mainly for fallback DCI, which is not intended to be used for coverage enhacnement. We should reuse the existing mechanism as defined in Rel-15/16. |
| Lenovo, Motorola Mobility | We don’t see the need to introduce *numberOfRepetitions* indicated by DCI format 0\_0 |
| Sierra Wireless | Agree with all other above. |
| Qualcomm | Same thoughts are several companies above. Doesn’t seem necessary. May create unintended issues to legacy Ues as well.  Nokia makes a valid point about other PUSCH parameters governing repetitions. |
| Samsung | For RRC connected Ues, the Rel-17 increased value of number of repetitions in the TDRA table should be indicated as in Rel-16. Thus, no need to extend the indication by DCI format 0\_0. There is also no coverage limitation for the PDCCH and fallback operation is not frequent. |
| Panasonic | We think *numberOfrepetitions* is only included in the TDRA table configured for DCI format 0-1 and 0-2 as in Rel.15/16 specification is sufficient. |
| ZTE | We support that the increased maximum repetition number is also supported for DCI format 0\_0, with the following reasoning.   1. CG PUSCH type 1 and DG/CG PUSCH scheduled/activated by DCI format 0\_0 share the same TDRA table. As we already support increased maximum repetition number for CG PUSCH, i.e., including *numberOfRepetitions* in the same TDRA table already, it is nature to also support for DG/CG PUSCH scheduled/activated by DCI format 0\_0. Otherwise, more specification effort is needed. 2. The reason *numberOfRepetitions* is not included in Rel-16 for PUSCH repetition type A scheduled by DCI format 0\_0 is the number of entries of Rel-16 TDRA table in Rel-16 is enlarged. It will increase the DCI format size, which is not suitable for DCI format 0\_0 as it operates in fallback mode. However, if the number of entries of Rel-17 TDRA table size is not increased, i,e,, 16 for CG type 1 or DG PUSCH scheduled/activated by DCI format 0\_0, and 64 for CG type 2/DG scheduled/activated by DCI format 0\_1/0\_2, the increased maximum repetition number can also be supported for DCI format 0\_0. 3. In coverage limited scenario, it may more typical to use DCI format 0\_0. |
| LG | It seems not necessary. |
| CATT | We think the motivation is not strong.  DCI format 0\_0 is typically used for fallback scheduling, with small payload/low data rate, and the need for coverage enhancement is low. Prefer not supporting this capability for simplicity. |
| Spreadtrum | We don’t see the necessity. |
| CMCC | No strong motivation to enhance the DCI format 0\_0. |
| OPPO | It’s not necessary for DCI format 0\_0 to support the increased maximum repetition. |
| Xiaomi | Agree with vivo. |
| Huawei/HiSilicon | It is sufficient that *numberOfrepetitions* is only included in the TDRA table configured for DCI format 0-1 and 0-2 as in Rel.15/16 specification. |
| Sharp | No need to apply to DCI format 0\_0. |
| Rakuten Mobile | We don’t think it is necessary to enhance the fallback DCI. |
| ZTE | Before making any decision, I’d like to hear more views about our reply in the first round above.  Basically, we think support the feature for DCI format 0\_0 requires no additional spec efforts. Actually, if no conclusion is to be made, it will be automatically supported. Instead, if we artificially preclude this, it would need more spec efforts, e.g., defines new TDRA table selection rules. Detailed reasoning please find our first round of comments.  @Ericsson,@all Do you agree we need to include *numberOfrepetitions-r17* in the TDRA table (i.e., *TimeDomainAllocationList* in *pusch-Config*) to support increased maximum repetition number for CG PUSCH type 1? If so, DG/CG PUSCH scheduled/activated by DCI format 0\_0, which shares the same TDRA table with CG PUSCH type 1, would automatically support increased maximum repetition number. If *numberOfrepetitions-r17* is not configured in *TimeDomainAllocationList* in *pusch-Config,* the enhanced feature would not be supported. That is, PUSCH scheduled by DCI format 0\_0 before RRC connection would not support this enhanced feature, i.e., this is not out of scope. This is simply the same as legacy.  One way to not support this enhanced feature for DCI format 0\_0 is to define separate table for CG type 1 and DG/CG PUSCH scheduled/activated by DCI format 0\_0. It then requires new TDRA table selection rules.   |  | | --- | | - For Type 1 PUSCH transmissions with a configured grant, the following parameters are given in *configuredGrantConfig* unless mentioned otherwise:  - For the determination of the PUSCH repetition type, if the higher layer parameter *pusch-RepTypeIndicator* in *rrc-ConfiguredUplinkGrant* is configured and set to ‘pusch-RepTypeB’, PUSCH repetition type B is applied; otherwise, PUSCH repetition type A is applied;  - For PUSCH repetition type A, the selection of the time domain resource allocation table follows the rules for DCI format 0\_0 on UE specific search space, as defined in Clause 6.1.2.1.1. | |
| FL | @ZTE:  Thank you so much for the explanation. I have a bit different understanding. In Rel-16 38.214 there is the following description, and no other part saying something like “K is equal to *numberOfRepetitions* for DCI format 0\_0”. Therefore, in my understanding, unless we make some change on this part in Rel-17, “DCI format 0\_0 would automatically support the increased maximum repetition number” you mentioned above would never happens, no matter if the same TDRA table is shared or not. Anyway, let’s hear others’ views.   |  | | --- | | For PUSCH repetition Type A, when transmitting PUSCH scheduled by DCI format 0\_1 or 0\_2 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or CS-RNTI with NDI=1, the number of repetitions *K* is determined as  - if *numberOfRepetitions* is present in the resource allocation table, the number of repetitions K is equal to *numberOfRepetitions*;  - elseif the UE is configured with *pusch-AggregationFactor*, the number of repetitions *K* is equal to *pusch-AggregationFactor*;  - otherwise *K=1*. |   @Everyone:  Please provide your views on this point! |
| ZTE2 | Thanks FL for clarification.  Our understanding is, the following texts can apply to PUSCH scheduled by DCI format 0\_0, if no further spec clarification is added. Similar as CG PUSCH, *pusch-AggregationFactor* will not impact the number of repetitions for PUSCH scheduled by DCI format 0\_0. In other words, if DCI format 0\_0 is not supported here, we need additional clarification that *numberOfRepetitions* is not applied forDCI format 0\_0, although *numberOfRepetitions* is available*.*   |  | | --- | | When the UE is scheduled to transmit a transport block and no CSI report, or the UE is scheduled to transmit a transport block and a CSI report(s) on PUSCH by a DCI, the '*Time domain resource assignment'* field value *m* of the DCI provides a row index *m* + 1to an allocated table. The determination of the used resource allocation table is defined in Clause 6.1.2.1.1. The indexed row defines the slot offset *K2*, the start and length indicator *SLIV*, or directly the start symbol *S* and the allocation length *L*, the PUSCH mapping type, and the number of repetitions (if *numberOfRepetitions* is present in the resource allocation table) to be applied in the PUSCH transmission. |   We’d like to clarify again that, our intention is just to avoid more spec efforts, without any additional efforts. |

1st round summary(Issue#1-3)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* The repetition number with increased maximum repetition number configured in TDRA lists indicated by DCI format 0\_0 is supported in Rel-17
  + Support (1 company): ZTE
  + Not support (22 companies): vivo, Apple, Ericsson, Nokia/NSB, Intel, Lenovo/Motorola Mobility, Sierra Wireless, Qualcomm, Samsung, Panasonic, LG, CATT, Spreadtrum, CMCC, OPPO, Xiaomi, Huawei/HiSilicon, Sharp, Rakuten Mobile

FL Proposal on Issue#1-3:

* The repetition number with increased maximum repetition number configured in TDRA lists indicated by DCI format 0\_0 is not supported in Rel-17

2nd round (Issue#1-3)

Companies are invited to answer the following questions.

* Q1: Do you agree that 1) CG PUSCH type 1 and DG/CG PUSCH scheduled/activated by DCI format 0\_0 share the same TDRA table, for Rel-17 CovEnh?
* Q2: Do you agree that *numberOfrepetitions-r17* is included in the TDRA table (i.e., *TimeDomainAllocationList* in *pusch-Config*) to support the increased maximum repetition number for CG PUSCH type 1, according to the following agreement in RAN1#104-e?

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| Agreements:  Rel-17 PUSCH repetition Type A supports the increase of maximum number of repetitions with repetition factors configured in a TDRA list with a row index indicated either by the configured grant configuration or by TDRA field in a DCI. |

* Q3: If yes to both Q1 and Q2, do you agree that it leads to ”DG/CG PUSCH scheduled/activated by DCI format 0\_0, which shares the same TDRA table with CG PUSCH type 1, would automatically support the increased maximum repetition number.”.

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| **Company** | **Comments** |
| ZTE | Yes to all questions.  For Q3, as we commented before, the following spec texts indicate that the number of repetitions (if *numberOfRepetitions* is present in the resource allocation table) would be applied in the PUSCH scheduled/activated by DCI 0\_0. That is, support this feature for DCI 0\_0 comes for free without any additional spec impacts (actually can avoid additional spec impacts)   |  | | --- | | When the UE is scheduled to transmit a transport block and no CSI report, or the UE is scheduled to transmit a transport block and a CSI report(s) on PUSCH by a DCI, the '*Time domain resource assignment'* field value *m* of the DCI provides a row index *m* + 1to an allocated table. The determination of the used resource allocation table is defined in Clause 6.1.2.1.1. The indexed row defines the slot offset *K2*, the start and length indicator *SLIV*, or directly the start symbol *S* and the allocation length *L*, the PUSCH mapping type, and the number of repetitions (if *numberOfRepetitions* is present in the resource allocation table) to be applied in the PUSCH transmission. |   It’s much appreciated if companies could check our three comments made in the first round of discussion. |
| Sharp | Q1: No. We haven’t seen any motivation to introduce dynamic change of repetition factor by fallback DCI, as also commented by most of the companies during the 1st round. Therefore, in terms of TDRA list, we prefer de-coupling Type 1 CG-PUSCH from DCI format 0\_0 when Type 1 CG-PUSCH uses repetition factor with the increased maximum value.  Q2: Yes. In our understanding, that is aligned with what we discussed when making the agreement.  Q3: N/A. |
| Nokia/NSB | Answer to Q1: Yes, if we are talking about the current spec since in TS 38.214, Section 6.1.23, the selection of the TDRA table for Type 1 CG with PUSCH repetition type A is described as follows: “*For PUSCH repetition type A, the selection of the time domain resource allocation table follows the rules for DCI format 0\_0 on UE specific search space, as defined in Clause 6.1.2.1.1.*”  Answer to Q2: No. The agreement simply means that increasing the maximum number for the parameter *numberofrepetitions* is supported, this is the whole point why we have the FFS on supporting *pusch-AggregationFactor* and *RepK*. Let’s not forget that DCI format 0\_1 with Rel-16 TDRA table can also be used to activate Type 2 CG. That’s why CG is included in the agreement.  Answer to Q3: No. Unfortunately, our target is just “increasing the maximum number of repetitions”, this should be done by the existing parameters. We again do not see why simply increasing the maximum number of repetitions in *pusch-AggregationFactor* and *RepK* is argued as unnecessary but modifying the Rel-15 TDRA table is necessary. |
| Lenovo, Motorola Mobility | Q1: Yes  Q2: Yes  Q3: No, we cannot simply assume this. Deducing from the replies for first two question is at best an assumption but cannot be considered as an agreement. |
| Samsung | Q1: Based on 38.214 Section 6.1.2.3 and Table 6.1.2.1.1-1, the answer seems to be yes.  Q2: No. It is noted that the discussion that led to that agreement in RAN1#104-e was about whether all three parameters *pusch-AggregationFactor*, *numberofrepetitions*, and *repK* support the increased maximum number of repetitions (which is still an open issue, Issue#1-2)  Q3: N/A |
| Spreadtrum | Q1: Yes. Agree with Nokia, thanks for the exact part in the specification. We also support to reuse the same TDRA tables in Rel-17 CovEnh.  Q2: NO. The agreement only include the case of configured grant PUSCH, not all type of configured grant PUSCH. Such as activated by DCI format 0\_0 and Type 1 CG-PUSCH, which still use the REl-15 TDRA tables used for DCI 0\_0. These TDRA tables cannot including either numberOfRepetitions introduced in Rel-16 URLLC, or new numberOfrepetitions-r17.  Q3: NO |
| Panasonic | Q1: Yes  Q2: Yes  Q3: No. In our understanding, based on TS 38.214, the repetition is supported by only DCI format 0-1 and DCI format 0-2. Therefore, we think additional agreement to support the repetition for DCI format 0-0 is necessary. |
| Intel | Q1: Yes. We share similar view as Nokia.  Q2: Yes. We think the agreement also covers the CG PUSCH type 1.  Q3: No. We share similar view as other companies that this is only for DCI format 0\_1 and 0\_2. |
| CATT | Q1: Yes  Q2: Probably no. The previous agreement was reached because *numberofrepetitions* with increased repetition number may be used in Type 2 CG-PUSCH. But this does not mean all DCI related to CG-PUSCH supports increased repetition number in Rel-17.  Q3: N/A. |
| OPPO | Q1: Yes.  Q2: Yes.  Q3: No. We share similar view as other companies. |
| Apple | Q1: Yes  For DCI format 0\_0, there is no repetition indication in TDRA tables. The repetition, i.e., *pusch-AggregationFactor* , is indicated by RRC configuration. CG type 1 repetition is indicated by *RepK.*  Q2: No  Even we prefer *numberOfrepetitions-r17* to be used for CG PUSCH type 1, but the issue is still open.  Q3: No. we share the similar views as Panasonic. |
| CMCC | Q1: Yes  Q2: No  Q3: NA |
| Ericsson2 | For Q1:  In current spec., for CG Type 1, the TDRA table determination is based on table Table 6.1.2.1.1-1 in 38.213, as is shown by the spec. text recited by Nokia.  For DG/CG-Type 2, it depends on the DCI format used (i.e. DCI 0-1 will use Table 6.1.2.1.1-1 in 38.213). This is obvious for DG. Following spec. text is for type 2 CG:   |  | | --- | | For Type 2 PUSCH transmissions with a configured grant: the resource allocation follows the higher layer configuration according to [10, TS 38.321], and UL grant received on the DCI.  - The PUSCH repetition type and the time domain resource allocation table are determined by the PUSCH repetition type and the time domain resource allocation table associated with the UL grant received on the DCI, respectively, as defined in Clause 6.1.2.1. |   What is the question here?  Does it mean whether we should support new TDRA table for DCI-0-0? If this is the question, we would say no as we’ve commented in last round.  If the question is whether in legacy, Table 6.1.2.1.1-1 in 38.213 is for the cases of CG type 1 and DC/CG-Type2 with DCI0-0, the answer is yes.  For Q2:  No. The TDRA table/list to include increased number of repetitions is a R17 TDRA table separately configured. We can not modify legacy tables directly for backward compatible issue.  For Q3:  N/A. |

## The number of repetitions counted on the basis of available UL slots

For the number of repetitions counted on the basis of available UL slots, the following agreements have been made.

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| **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:  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   **Conclusion:**  Discuss further to select one of 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. The timeline requirement is per repetition basis.   **In RAN1#105-e**  Agreement:   * RV cycling is based on available slot for the Type A PUSCH repetition enhancement with repetitions counted based on available slot in Rel-17   **Conclusion:**   * The following agreement in RAN1#104-e is applied to all slots including special 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 |   Agreement:   * Each available slot identified by the UE is considered as a transmission occasion for PUSCH repetition.   + RV is cycled across transmission occasions, irrespective of whether PUSCH transmission in the transmission occasion is further omitted or not.   Agreement:   * If PUSCH symbol in a slot overlaps with flexible symbol(s) with SSB transmission, the slot is determined as not available during the counting of repetitions. As there is no PUSCH in the slot, no PUSCH omission applies to the slot.   Agreement:  Select one from the following (further refinement of the alternatives can be further discussed), for the procedure of Rel-17 PUSCH repetition Type A (other alternatives are not precluded)   * Alt 1-B consisting of two steps   + Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI   + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions. * Alt 1-B’ consisting of two steps   + Step 1: Determine K repetitions based on available slots, where the available slot is the UL slot and flexible slot indicated by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*.   + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.   + FFS: handling of dynamic signaling (e.g. UL CI, DCI for high priority channel), e.g., UE without CI capability * Alt 2-A consisting of a single step   + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic signaling (e.g. SFI, UL CI, DCI for high priority channel) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI * Alt 2-B consisting of two steps   + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic SFI in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI     - FFS timeline for the dynamic signalling   + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions. |

At the same time, the following eleven remaining issues have been identified.

* Issue#2-1: Use of dynamic signaling for the determination of available slots
* Issue#2-2: How to consider semi-static flexible symbols for the determination of available slots
* Issue#2-3: Use of Type0-PDCCH CSS set configuration for the determination of available slots
* Issue#2-4: Use of Invalid UL symbol configuration for the determination of available slots
* Issue#2-5: Use of semi-static PUCCH repetition configuration for the determination of available slots
* Issue#2-6: Use of SMTC configuration for the determination of available slots
* Issue#2-7: Use of other RRC configurations for the determination of available slots
* Issue#2-8: Limitation of overall duration of PUSCH repetitions
* Issue#2-9: Inter-Slot Frequency Hopping Cycle
* Issue#2-10: Handling of a collision between PUSCH repetition and P-SRS
* Issue#2-11: Applicability of available slot based counting method to paired spectrum
* Issue#2-12: Configurations/indications enabling CovEnh functions

### [Close] Issue#2-1: Use of dynamic signaling for the determination of available slots

In Rel-16, transmission occasions for a PUSCH with repetition type A are derived based on K consecutive slots, and then transmissions at some occasions may be omitted according to TDD configuration, dynamic SFI, PUSCH priority, and Cancelation Indication. Rel-15/16 also support PUCCH with N-time repetition in which only slots having sufficient UL/flexible symbols for the allocated PUCCH resource are counted as part of N slots, where UL/flexible symbols are determined by only semi-static configurations (i.e. TDD configuration and SSB configuration).

In RAN1#104-e, there were two different directions proposed for the determination of ”available slots for PUSCH repetition”, one was to follow Rel-16 PUSCH dropping rule, and the other was to follow Rel-15/16 PUCCH repetition rule. Both of the rules refer to TDD configuration and SSB configuration. Therefore, it is straightforward that TDD configuration and SSB configuration are also used for the dermination of available slots in Rel-17. On the other hand, companies had different views on whether or not dynamic signal (dynamic SFI, PUSCH priority, and cancelation indication) is used for the determination of available slots. This aspect was described in the following agreement in RAN1#104-e. For Alt 1, we discussed which semi-static configurations should be considerd for the available slot determination. Many companies preferred to reuse Rel-15/16 PUCCH repetition rules, i.e. using TDD configuration and SSB configuration, while a few companies wanted to use more configuration, e.g. invalid UL symbol configuration or Type0-CSS / CORESET#0 configuration. For Alt 2, we discussed which dynamic signaling should be considerd for the available slot determination. Although not many companies provided views on it, all the companies proving their views preferred to reuse Rel-16 PUSCH dropping rule, i.e. to use all of SFI, PUSCH priority and Cancelation Indication.

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| 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). |

In RAN1#105-e, further clarificaions on Alt 1 and Alt 2 were made in terms of relation between the available slots and actual transmissions of the repetitions. The most of Alt 1 proponents were assuming that, even if a given slot is determined as available, PUSCH transmission in the available slot is possibly dropped depending on the dynamic signaling. In other words, Alt 1 consists of two steps, the determination of available slots and the determination of PUSCH dropping. As for Alt 2, some proponents were assuming that Alt 2 does not require PUSCH dropping procedure and as such it consists of a single step. On the other hand, some other proponents were thinking that only dynamic SFI among dynamic signaling is considered for the determination of available slots and the other dynamic signaling such as cancellation indication and priority channel would be used for PUSCH dropping. As a results of the clarification discussions, Alt 1 and Alt 2 were further classified into four sub-alternatives and the following was agreed.

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| Agreement:  Select one from the following (further refinement of the alternatives can be further discussed), for the procedure of Rel-17 PUSCH repetition Type A (other alternatives are not precluded)   * Alt 1-B consisting of two steps   + Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI   + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions. * Alt 1-B’ consisting of two steps   + Step 1: Determine K repetitions based on available slots, where the available slot is the UL slot and flexible slot indicated by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*.   + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.   + FFS: handling of dynamic signaling (e.g. UL CI, DCI for high priority channel), e.g., UE without CI capability * Alt 2-A consisting of a single step   + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic signaling (e.g. SFI, UL CI, DCI for high priority channel) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI * Alt 2-B consisting of two steps   + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic SFI in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI     - FFS timeline for the dynamic signalling   + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions. |

According to the 4th round discussion in RAN1#105-e, companies showed the following preferences.

* Alt 1-B consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
  + Support (16 companies): CATT, vivo, Intel, Lenovo/Motorola Mobility (2nd preference), Qualcomm, Sharp, OPPO, LG, CMCC, WILUS, Ericsson, Nokia/NSB, ZTE, Xiaomi
* Alt 1-B’ consisting of two steps
  + Step 1: Determine K repetitions based on available slots, where the available slot is the UL slot and flexible slot indicated by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*.
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
  + FFS: handling of dynamic signaling (e.g. UL CI, DCI for high priority channel), e.g., UE without CI capability
  + Support (1 company): Apple
* Alt 2-A consisting of a single step
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic signaling (e.g. SFI, UL CI, DCI for high priority channel) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
  + Support (1 company): Samsung
* Alt 2-B consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic SFI in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
    - FFS timeline for the dynamic signalling
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
  + Support (2 companies): Lenovo/Motorola Mobility (1st preference), ZTE

In the discussions in RAN1#105-e, one issue on Alt 2-A and Alt 2-B was raised for CG-PUSCH, which is an RV mismatch problem between the UE and the gNB. More specifically, it is assumed that 4 slots with FUUU provided by semi-static TDD configuration, and those 4 slots are allocated for CG-PUSCH resource. The gNB sends the dynamic SFI indicating UUUU, but the UE fails to detect it. In this case, the gNB assumes that the first available slot is the first slot, while the UE determines that the first available slot is the second slot. It is better to consider this issue when discussing the down-selection from the above alternatives.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* Alt 1-B consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
    - FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)
  + Support (20 companies): vivo [2], Nokia/Nokia Shanghai Bell [3], ZTE [4], CATT [6], Rakuten Mobile [8], China Telecom [9], NEC [10], OPPO [12], Qualcomm [13], CMCC [14], LG Electronics [15], Ericsson [16], Intel [17], Sierra Wireless [18], InterDigital [19], Sharp [21], NTT DOCOMO [22], Xiaomi [23], WILUS [24] , Panasonic [7], Huawei/HiSilicon (acceptable), Lenovo/Motorola Mobility
* Alt 1-B’ consisting of two steps
  + Step 1: Determine K repetitions based on available slots, where the available slot is the UL slot and flexible slot indicated by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*.
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
    - FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)
  + FFS: handling of dynamic signaling (e.g. UL CI, DCI for high priority channel), e.g., UE without CI capability
  + Support (5 companies): CMCC [14], LG Electronics [15], Ericsson [16], Apple [20]
* Alt 2-B’ consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic SFI received earlier enough (e.g. N2 symbols before the first repetition occasion of PUSCH repetition) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
    - FFS timeline for the dynamic signalling
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules (including dynamic SFI received later), but the PUSCH repetition is still counted in the K repetitions.
    - FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)
  + Support (4 companies): Huawei/HiSilicon [1], Lenovo/Motorola Mobility [11], Samsung

Looking at the above proposals, all the alternatives meet the condition that all the available slots are determined prior to the first transmission of the PUSCH repetitions.

1st round (Issue#2-1)

Companies (especially Alt 2-A and Alt 2-B proponents) are encouraged to provide their views on the different understanding issue (e.g. RV mismatch issue) between the UE and the gNB due to DCI detection failure at the UE side.

Companies (especially Alt 1-B’ proponents) are encouraged to provide further clarifications on handling of dynamic signaling.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We support Alt 1-B. |
| Apple | We support Alt 1-B’. The UL cancellation and physical layer priority are optional feature defined in Rel.16. For Rel.17 coverage enhancement, it’s subject to UE capability whether to support these features as well.  For Alt 1-B, could proponent clarify whether flexible slot is considered as available slot with this option? |
| Ericsson | 1-B. |
| Nokia/NSB | We support Alt. 1-B for the simplicity and for the reasons mentioned in our Tdocs. |
| Intel | We support Alt 1-B as it is very clear on the procedure to determine the available slots and apply the dropping/cancellation for PUSCH repetition. |
| Lenovo, Motorola Mobility | Although we think that Alt 2-B’ provides a more accurate determination of slots available for repetition, but considering the majority support, we are okay to also support Alt 1-B where dynamic SFI is not considered for available slots determination |
| Sierra Wireless | We still support Alt 1-B. |
| Qualcomm | Support Alt 1-B. UE missing a DCI is an issue for Alt 2-A/2-B/2-B’. |
| Samsung | We support Alt. 2-B’ as Rel-17 coverage enhancement should not go backwards and ignore Rel-15 SFI operation and as the requirements for Alt. 2-B’ for SFI detection already exist in Rel-15. |
| InterDigital | We support Alt 1-B. |
| Panasonic | We support Alt.1-B. |
| ZTE | Alt.1-B. |
| FL | @All,  Based on the comments in Issue2-10, I added the sub-bullet saying “Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)” to the Alt 1-B, Alt 1-B’ and Alt 2-B’ above.  @Apple,  For Alt 1-B, flexible slot is considered as available slot, except for the case for CG-PUSCH when dynamic SFI monitoring is configured, which is discussed under Issue#2-2. For the clarification, I put a table in Issue#2-2 below. |
| LG | We don’t want to utilize any dynamic signaling to determine available slots. If FFS part on dynamic signaling in Alt 1-B’ is not deleted, we only support Alt 1-B. |
| CATT | Support Alt 1-B. Note that we already agree to take SSB into consideration for available slot determination in RAN1#105-e, with which Alt 1-B’ seems not aligned. |
| NTT DOCOMO | We support Alt 1-B. |
| Spreadtrum | We support Alt1-B  It is simple and clean. UE can decide all available slots after scheduling or N2 before transmission. UE does not need to adjust the transmission window dynamically, even if it received some further indication. |
| WILUS | We support Alt 1-B. |
| CMCC | Alt 1-B.  Agree with the FL that priority rule in the other WI should also be considered for the dropping rule. But I’m a little worried about when can we get the conclusion from the other WIs and the impact to CE’s progress. |
| OPPO | We support Alt 1-B. |
| Xiaomi | We support Alt 1-B |
| Huawei/HiSilicon | We support Alt.2-B with proper clarification on timeline for SFI, but we can accept Alt.1-B. |
| NEC | We support Alt 1-B |
| Sharp | We support Alt 1-B |
| FL | Based on the comments in 8/17 GTW2 session, I added “FFS” to the sub-bullets of the alternatives. I also added Samsung as a supporting company for Alt 1-B’. |
| China Telecom | We support Alt 1-B |
| Rakuten Mobile | We support Alt 1-B. |

1st round summary(Issue#2-1)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1-B consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
    - FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)
  + Support (26 companies): vivo, Ericsson, Nokia/NSB, Intel, Lenovo/Motorola Mobility, Sierra Wireless, Qualcomm, InterDigital, Panasonic, ZTE, LG, CATT, NTT DOCOMO, Spreadtrum, WILUS, CMCC, OPPO, Xiaomi, Huawei/HiSilicon, NEC, Sharp, China Telecom, Rakuten Mobile
* Alt 1-B’ consisting of two steps
  + Step 1: Determine K repetitions based on available slots, where the available slot is the UL slot and flexible slot indicated by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*.
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
    - FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)
  + FFS: handling of dynamic signaling (e.g. UL CI, DCI for high priority channel), e.g., UE without CI capability
  + Support (1 company): Apple
* Alt 2-B’ consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic SFI received earlier enough (e.g. N2 symbols before the first repetition occasion of PUSCH repetition) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
    - FFS timeline for the dynamic signalling
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules (including dynamic SFI received later), but the PUSCH repetition is still counted in the K repetitions.
    - FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)
  + Support (5 companies): Lenovo/Motorola Mobility, Samsung, Huawei/HiSilicon

FL Proposal on Issue#2-1:

Take Option 1-B as an agreement for the procedure of Rel-17 PUSCH repetitions counted on the basis of available slots.

* Alt 1-B consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
    - FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)

In 8/20 GTW2 session, the following agreement was made. Therefore, this issue is considered as closed.

|  |
| --- |
| Agreement  Take Option 1-B as an agreement for the procedure of Rel-17 PUSCH repetitions counted on the basis of available slots.   * Alt 1-B consisting of two steps * Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI * Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions. * FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s) |

### [Close] Issue#2-2: How to consider semi-static flexible symbols for the determination of available slots for CG-PUSCH

In RAN1#104-e, it was agreed to use at lease tdd\_ul\_dl configuration (i.e. *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated*) for the available slot determination. In RAN1#105-e, there were some discussions on how the semi-static flexible symbols should be considered for the available slot determination.

In RAN1#106-e, Panasonic [7] is proposing that, for CG-PUSCH when dynamic SFI moniroting is configured, semi-static flexible symbol should be considered as unavailable for PUSCH repetition as in Rel.15/16. Meanwhile, during the discussions in RAN1#105-e, several companies expressed their views that semi-static flexible symbol should be always considered as available for CG-PUSCH irrespective of the dynamic SFI moniroting configuration.

Table: available/unavailable for PUSCH repetitions according to *tdd-UL-DL-ConfigurationCommon*, *tdd-UL-DL-ConfigurationDedicated* and *ssb-PositionsInBurst*.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | When the monitoring of dynamic SFI is not configured | | When the monitoring of dynamic SFI is configured | |
| DG-PUSCH | CG-PUSCH | DG-PUSCH | CG-PUSCH |
| Downlink symbol by *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* | Not available | Not available | Not available | Not available |
| Uplink symbol by *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* | Available | Available | Available | Available |
| Flexible symbol by *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated*, and  SS/PBCH symbol by *ssb-PositionsInBurs* | Not available | Not available | Not available | Not available |
| Flexible symbol by *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated*, and  Not SS/PBCH symbol by *ssb-PositionsInBurs* | Available | Available | Available | To be discussed |

1st round (Issue#2-2)

Companies are encouraged to provide their views on whether semi-static flexible symbol should be considered as available or unavailable for PUSCH repetition for CG-PUSCH when dynamic SFI moniroting is configured.

Companies are also invited to provide their comments on the other part in the above table, if any.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | To avoid the available slots impacted by dynamic signaling, semi-static flexible symbol should be considered as unavailable for CG-PUSCH repetition, when dynamic SFI monitoring is configured. |
| Apple | The flexible slot is considered as available slot, the Rel. 15/16 defined rules is applied to determine whether the flexible slot is dropped. |
| Ericsson | Dynamic signaling should not be considered to determine the available slot as we discussed in issue #2-1.  Whether CG PUSCH will be cancelled due to dynamic SFI/CI depends on the rules in legacy. |
| Nokia/NSB | This issue is closely related to Issue 2-1. The main concern which has been bringing up so far by several companies is the discrepancy in counting available slots if dynamic singaling is considered. This also applies for dynamic SFI. On the other hand, the benefit of counting the F slots is only in latency reduction, which may not be a critical issue in this feature. |
| Intel | We share similar view as other companies. Flexible symbol can be considered as available for PUSCH repetition in the step 1 and dynamic SFI in the step 2 can be used to drop/cancel the CG-PUSCH. |
| Lenovo, Motorola Mobility | If Alt 1-B is agreed to be supported for issue 2-1, then even for semi-static flexible symbol, dynamic SFI should not be considered for determination of available slots and semi-static flexible symbols should be always considered as available for CG-PUSCH. |
| Qualcomm | Treat semi-static flexible symbols as being available for CG-PUSCH. |
| Samsung | If flexible symbols are considered available for repetitions and SFI detection is not supported for determining repetitions, there is no reason for having flexible symbols. Therefore, flexible symbols should be considered as unavailable for repetitions. If SFI detection is supported, flexible symbols can be considered as available. That is the same behavior as in Rel-15 for semi-statically determining whether or not to transmit in flexible symbols depending on whether or not the UE detects the SFI. |
| Panasonic | If Alt.1-B is agreed, we think semi-static flexible symbol should be considered as unavailable for PUSCH repetition for CG-PUSCH when dynamic SFI moniroting is configured as in Rel.15/16. |
| ZTE | Our understanding is semi-static flexible symbol should be always considered as available for CG-PUSCH irrespective of the dynamic SFI is configured or not, except for the case that the flexible symbol are configured for SSB. It seems no action is needed if Alt 1-B is supported. |
| LG | When a UE is configured to monitor dynamic SFI moniroting, transmission of CG-PUSCH in semi-static flexible symbol may or may not be performed. However, we don’t see the neccesity to introduce different rule for available slot determination. |
| CATT | Thanks for bringing up the interesting case. In general, we think flexible symbol should be considered as available (in Step 1 in Alt 1-B) for CG-PUSCH, and this seems still aligned with Rel-15/16 PUSCH dropping rules. According to the current TS 38.213, if the UE is configured to monitor dynamic SFI, and the following rules are applied:  (1) If the dynamic SFI is detected, any repetition of CG-PUSCH is transmitted only if SFI indicate the flexible symbol as uplink. Any overlapped symbol indicated as DL or flexible by SFI will make the UE drop the repetition of CG-PUSCH (in Step 2).  (2) If the dynamic SFI is NOT detected, then the UE should also drop the CG-PUSCH repetition overlapped with the flexible symbols (in Step 2). |
| Spreadtrum | It is related with issue 2-1. If Alt 1-B is adopted, semi-static flexible symbols are available for CG-PUSCH. |
| WILUS | If Alt 1-B is agreed in Issue#2-1, semi-static flexible symbol should be considered as available in step 1, and PUSCH repetition is dropped or not according to Rel-15/16 PUSCH dropping rules in step 2. |
| CMCC | Do not support to determine the available slot based on the SFI indication. The impact of CI and the change of SFI should be discussed in the step of dropping rule. |
| OPPO | The flexible symbol can be considered as available for CG-PUSCH before the first repetition transmission occasion, whether the available slot can transmit actual repetition depends on the Rel-15/16 PUSCH dropping rules. |
| Xiaomi | We share the same view with ZTE. And flexible symbol can be considered as available for PUSCH repetition in the step 1 and dynamic SFI in the step 2 can be considered to drop/cancel the CG-PUSCH. |
| Huawei/HiSilicon | We think flexible symbol can be considered as available for PUSCH repetition in the step 1 and dynamic SFI can be used to drop/cancel the CG-PUSCH. |
| NEC | We also think flexible symbol for CG-PUSCH should be considered as available symbol and may be omitted based on dynamic SFI as legacy. |
| Sharp | Agree with CATT. Semi-static flexible symbols should be deteremined as available. If the dynamic SFI indicating the flexible symbol as uplink is not detected, then the PUSCH repetition in the available symbol should be dropped. |
| Rakuten Mobile | We also share same opinions that the flexible symbols should be considered as available. The dropping rule can treat the symbols. |
| ZTE | Support the proposal below. |
| Panasonic2 | We are grateful to hear the views on the semi-static flexible symbol handling. Our intention was to clarify the semi-static flexible symbol handling. Then, we are OK to take the majority view, i.e., we fine with FL proposal on Issue#2-2 below. |
| FL | @Panasonic:  Thank you for being flexible. I updated the summary below accordingly. |
| Nokia/NSB2 | @FL: Thank you for the clarification on Alt. 1-B for Issue 2-1 and also for the table added above, which is very informative! With the clarification from the FL, our understanding is that there is no discrepancy in the total number of repetitions between gNB and UE when F slots are counted as available, and legacy rules on handling dynamic SFI are reused. If the FL can confirm this understanding is correct, we can support the majority view and the FL’s proposal on Issue#2-2 below. |
| FL | @ Nokia/NSB:  Thank you for the input. Yes, we are on the same page. I updated the below summary. |

1st round summary(Issue#2-2)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* For PUSCH repetition for CG-PUSCH when dynamic SFI moniroting is configured, semi-static flexible symbol is considered as:
  + “Available” (23 company): Apple, Ericsson, Lenovo/Motorola Mobility, Qualcomm, Samsung, Intel, ZTE, LG, CATT, Spreadtrum, WILUS, CMCC?, OPPO, Xiaomi, Huawei/HiSilicon, NEC, Sharp, Rakuten Mobile, Panasonic, Nokia/NSB
  + “Not available” (1 company): vivo

FL Proposal on Issue#2-2:

* For PUSCH repetition for CG-PUSCH when dynamic SFI moniroting is configured, semi-static flexible symbol is considered as available.

In 8/20 GTW2 session, the following agreements were made. Therefore, this issue is considered as closed.

|  |
| --- |
| Agreement  For PUSCH repetition Type A for Rel-17 CG-PUSCH, semi-static flexible symbol is considered as available.  Agreement  For PUSCH repetition Type A for Rel-17 DG-PUSCH, semi-static flexible symbol is considered as available.  Note: The applicability for Msg 3 is to be discussed in 8.8.3 |

### [Open] Issue#2-3: Use of Type0-PDCCH CSS set configuration for the determination of available slots

Regardless of whether dynamic signaling is used for the determination of available slots or not, at least of some RRC configurations need to be used for the determination. According to the following agreement in RAN1#104-e, it was agreed to use at lease tdd\_ul\_dl configuration (i.e. *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated*) for the available slot determination for both Alt 1 and Alt 2.

|  |
| --- |
| 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). |

In addition, the following agreement was made in RAN1#105-e, which means that SSB configuration (i.e. *ssb-PositionsInBurst*) is also referred to for the determination of available slots.

|  |
| --- |
| Agreement:   * If PUSCH symbol in a slot overlaps with flexible symbol(s) with SSB transmission, the slot is determined as not available during the counting of repetitions. As there is no PUSCH in the slot, no PUSCH omission applies to the slot. |

In RAN1#105-e, it was also discussed whether other RRC configurations should be used or not. The companies’ views on what other RRC configurations are used are summarized as follows. In this meeting, it is suggested discussing the above RRC configurations separately, as the background of each proposal seems different.

* No other RRC configurations
  + Supported by: CATT, Qualcomm, Apple, OPPO, LG, Ericsson
* CORESET0 with Type0-PDCCH CSS set
  + Supported by: Intel, Lenovo/Motorola Mobility, Sharp (study further), WILLUS, Xiaomi
* Invalid UL symbols for DL-to-UL switching purpose
  + Supported by: Intel, Xiaomi
* Semi-static PUCCH with repetitions
  + Supported by: WILUS
* SSB based measurement by SMTC
  + Supported by: vivo
* DL-to-UL switching for half duplex FDD redcap UE
  + Supported by: vivo (wait the conclusion in RedCap WI)
* All the RRC configurations that inpact on the PUSCH repetitions
  + Supported by: ZTE
* Revisit in RAN1#106-e
  + Nokia/NSB

Under Issue#2-4, whether the configuration of CORESET0 with Type0-PDCCH CSS set is used for the available slot determination or not is discussed.

In Rel-16, CORESET0 with Type0-PDCCH CSS set (for paired spectrum) is used to determine time domain resource allocation for PUSCH repetition Type B. On the other hand, any clear behaviour (including PUSCH dropping rule) has not been specified for the case PUSCH repetition Type A overlaps with CORESET0 with Type0-PDCCH CSS set.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* Should use CORESET0 with Type0-PDCCH CSS set for the available slot determination
  + Samsung [5], Intel [17], Xiaomi [23], WILUS [24]
* No need to use CORESET0 with Type0-PDCCH CSS set for the available slot determination
  + ZTE [4], CATT [6], Panasonic [7], Qualcomm [13], ~~CMCC [14]~~, LG Electronics [15], Sharp [21]

1st round (Issue#2-3)

In the operation with a fixed TDD configuration, CORESET0 with Type0-PDCCH CSS is most likely to be mapped on fixed DL symbols. DG-PUSCH cannot be scheduled on the DL symbols, and CG-PUSCH is not transmitted on DL symbols even if configured. Therefore, for the fixed TDD configuration case, PUSCH repetitions do not collide with CORESET0 with Type0-PDCCH CSS.

In the operation with a dynamic TDD configuration, CORESET0 with Type0-PDCCH CSS may be mapped on semi-static flexible symbols. CG-PUSCH on the semi-static flexible symbols is not transmitted unless the UE detects the dynamic SFI which indicates the symbols as uplink. Therefore, as long as the gNB sends appropriate SFI, any collistion between CG-PUSCH and CORESET0 with Type0-PDCCH CSS does not happen. On the other hand, for DG-PUSCH repetitions, Rel-16 specifications is not specifing any collisiton handling. This means, the Rel-16 gNB has to schedule DG-PUSCH repetitions such that the DG-PUSCH repetitions never overlap with CORESET0 with Type0-PDCCH CSS on semi-static flexible symbols. For PUSCH repetitions counted on the basis of available slots, K available slots for a TB are likely to be non-contiguous and varies depending on the UL timing. Whether or not Rel-17 gNB can handle it in the same way as Rel-16, even with the available slot based counting, would be a discussion point.

Companies are encouraged to provide their views on whether or not it is possible for Rel-17 gNB to always schedule DG-PUSCH repetitions with the available slot based counting such that the DG-PUSCH repetitions never overlap with CORESET0 with Type0-PDCCH CSS on semi-static flexible symbols in the operation with a dynamic TDD configuration.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Not necessary, it is up to NW to avoid collision with type-0 CSS. |
| Apple | The similar issue was there since Rel.15, it’s up to gNB scheduling to avoid the collision. Same handling could be used for available slot-based counting. |
| Ericsson | No other configurations are needed for available slot determination. Omission rules on overlapping between CORESET0 with Type0-PDCCH CSS set and PUSCH are clear in current spec. and can be reused. |
| Nokia/NSB | The scheduler can avoid collision. In the worst case, Rel-15/16 rules for collision handling can be applied. This may result in some loss in the actual number of repetitions, which can be avoided by configuring a high number of repetitions in the first place. |
| Intel | We support CORESET0 with Type0-PDCCH CSS set to determine available slot in the first step.  In our view, it is similar to collision handling and invalid symbols for PUSCH repetition type B transmission where symbol(s) indicated by pdcch-ConfigSIB1 in MIB for a CORESET for Type0-PDCCH CSS set. Otherwise, it is unnecessary restriction at gNB scheduler to avoid the collision between CORESET0 and PUSCH repetition. |
| Lenovo, Motorola Mobility | We also agree that gNB scheduling can avoid collision with type-0 CSS |
| Samsung | It would be useful to consider the slot unavailable when there is a CORESET0 with Type0-PDCCH CSS. The scope is to try to transmit a number of repetitions equal to the scheduled number to improve coverage. Of course the NW tries to avoid the overlap, but this becomes more difficult with a large number of repetitions. |
| Panasonic | We think scheduler can handle collision avoidance since symbols to be used for CORESET0 with Type0-PDCCH CSS is always within earlier 3 symbols in a slot. |
| ZTE | Agree that no UE behaviour (including PUSCH dropping rule) has been specified for the case PUSCH repetition Type A overlaps with CORESET0 with Type0-PDCCH CSS set. In such case, it would impose some scheduling restrictions, but still possible, for gNB to avoid collision with CORESET0 with Type0-PDCCH CSS set in case of count based on available slot. With said that, we would be ok either way. |
| LG | It’s up to gNB scheduling and no need to use CORESET0 with Type0-PDCCH CSS set for the available slot determination |
| CATT | Same as Rel-16, we think gNB is able to avoid such overlapping case by proper scheduling if it desires. So no need to consider CSS or CORESET#0 in determination of available slots.  Logically, any collision due to two dynamic scheduling/signaling (e.g. SFI vs scheduling DCI) should be avoided (explained by specification as ‘the UE is not expected to …’), and collision due to dynamic signaling and semi-static configuration can be handled by dropping rules, or avoided by proper arrangement of dynamic signaling. |
| Spreadtrum | We prefer No need to use CORESET0 with Type0-PDCCH CSS set for the available slot determination. gNB can handle this scheduling. |
| WILUS | Support. A symbol configured to receive CORESET0 can also be regarded as semi-static DL symbol like in SSB case. |
| CMCC | Support not to consider the Type0-PDCCH for the determination of the available slot. Both scheduling based mechanism or the omission rule could work for this case.  To be aligned with our contribution, we do not explicitly discuss the issue of Type0-PDCCH CSS and I removed our name from the contribution summary. |
| OPPO | It is not necessary. We also think that gNB scheduling can avoid collision with type-0 CSS. |
| Xiaomi | gNB scheduling can avoid collision with type-0 CSS. |
| Huawei/HiSilicon | Rel-15/Rel-16 rule could be used. |
| NEC | We don’t think it’s necessary. As legacy behaviour, UE can trust network’s configuration to well resolve such issue. |
| Sharp | As in Rel-15/16, gNB scheduling should avoid the collision. |
| Rakuten Mobile | NW scheduling can handle to avoid the collision. |
| ZTE | Fine |

1st round summary(Issue#2-3)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1: Collisions betwen PUSCH repetitions and CORESET0 with Type0-PDCCH CSS are handled by the available slot determination.
  + (3 companies): Intel, Samsung, WILUS
* Alt 2: Collisions betwen PUSCH repetitions and CORESET0 with Type0-PDCCH CSS are handled by gNB scheduling.
  + (19 companies): vivo, Apple, Ericsson, Nokia/NSB, Lenovo/Motorola Mobility, Panasonic, LG, CATT, Spreadtrum, CMCC, OPPO, Xiaomi, Huawei/HiSilicon, NEC, Sharp, Rakuten Mobile
* Open to either alternative
  + (1 company):ZTE

FL Proposal on Issue#2-3:

* Collisions betwen PUSCH Type A repetitions and CORESET0 with Type0-PDCCH CSS are handled by gNB scheduling.

2nd round (Issue#2-3)

In Rel-15/16, no collision handling rule exists for ovarlapping of PUSCH repetitions and CORESET0 with Type0-PDCCH CSS. The above FL proposal forces the Rel-17 gNB scheduler to always schedule PUSCH repetitions with the available slot based counting such that the PUSCH repetitions never overlap with CORESET0 with Type0-PDCCH CSS.

This round of discussion is to make sure if companies have common uinderstanding on this point. If companies would like to make an additional comment, please provide it below.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Sharp | The above scheduling restriction is in line with our interpretation of the current specifications. But, if other companies want to study further, we are open to discuss. |
| Nokia/NSB | The following paragraphs can be found in TS 38.213 Section 11.1 concerning the format configuration/determination of the set of symbols indicated for a CORESET for Type0-PDCCH CSS set (the first two paragraph) and for a CORESET in general (the third paragraph):   * “For a set of symbols of a slot indicated to a UE by pdcch-ConfigSIB1 in MIB for a CORESET for Type0-PDCCH CSS set, the UE does not expect the set of symbols to be indicated as uplink by tdd-UL-DL-ConfigurationCommon, or tdd-UL-DL-ConfigurationDedicated.” * “For a set of symbols of a slot indicated to a UE by pdcch-ConfigSIB1 in MIB for a CORESET for Type0-PDCCH CSS set, the UE does not expect to detect a DCI format 2\_0 with an SFI-index field value indicating the set of symbols of the slot as uplink.” * “A UE assumes that flexible symbols in a CORESET configured to the UE for PDCCH monitoring are downlink symbols if the UE does not detect an SFI-index field value in DCI format 2\_0 indicating the set of symbols of the slot as flexible or uplink and the UE does not detect a DCI format indicating to the UE to transmit SRS, PUSCH, PUCCH, or PRACH in the set of symbols”.   Our understanding of the above text is that collision between CORESET for Type0-PDCCH CSS and PUSCH can be handled by the gNB scheduler, following above rules from specification. In other words, gNB can make sure that collision would not happen. Otherwise, the case can be considered as an error case.  Now coming back to the problem at hand, the issue is whether we consider a F slot which has a set of symbols indicated for a CORESET for Type0-PDCCH CSS as an available slot for Step 1 in the 2-step available slot determination procedure or not (note that it’s rather straightforward that we do not count D slots in Step 1). In theory, although the set of symbols indicated for a CORESET for Type0-PDCCH CSS cannot be indicated as UL symbols, the remaining symbols in the slot can be. Therefore, if a PUSCH type A repetition with mapping type B is considered, the slot can still be utilized and counted as available slot. However, in practice, and given that we are considering coverage shortage scenario, PUSCH repetition with mapping type B may not be a relevant setup. In this regard, not counting the slot as available slot seems to be a better choice. After all, we are talking about optimization for exploiting a few symbols here within the slot.  Inspired by the question from Qualcomm, we now wonder the following. In our view, the proposal from the FL is correct. However, it is unclear whether it can solve the issue that we are considering here or not. Stated in more precise terms: although collision can be avoided by the gNB, whether the slot is still counted as available or not (and which step in the 2-step procedure will consider this) is unclear for us. |
| Samsung | Overall, given the periodicity of CORESET#0, the gNB can set the symbols for DL and avoid the issue. However, the same could be done with the SSBs but the specs allow the possibility for SSBs to be on flexible symbols which are then considered unavailable for UL transmissions. Also, for PUSCH repetition Type B, symbols of CORESET#0 are considered unavailable. Also, DCI 2\_0 cannot change symbols associated with CORESET#0 to UL. It does not make sense to have different treatment for SSB symbols and CORESET#0 symbols for PUSCH repetitions Type A, particularly when also considering that SSB and CORESET#0 transmissions are linked. |
| ZTE | After a further check, we think our comment in the first round may be not accurate.  Now our understanding is, there is collision handling rule for overlapping of PUSCH repetition and CORESET0 with Type0-PDCCH CSS in Rel-15/16 for the following cases. Please correct me if I am wrong.   * DG PUSCH vs CORESET0 with Type0-PDCCH CSS, regardless SFI is configured or not. * CG PUSCH vs CORESET0 with Type0-PDCCH CSS, if SFI is configured.   Note, we think the following analysis can apply to both PUSCH with or without repetition.  **If SFI is not configured:**  Firstly, it is clear that the symbols for CORESET for Type0-PDCCH CSS set could be flexible symbols by RRC configuration or SFI indication, according to the following.  *“For a set of symbols of a slot indicated to a UE by pdcch-ConfigSIB1 in MIB for a CORESET for Type0-PDCCH CSS set, the UE does not expect the set of symbols to be indicated as uplink by tdd-UL-DL-ConfigurationCommon, or tdd-UL-DL-ConfigurationDedicated.”*  Based on the following spec, a DG PUSCH can be scheduled on flexible symbols.  *“If a UE is not configured to monitor PDCCH for DCI format 2\_0, for a set of symbols of a slot that are indicated as flexible by tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated if provided, or when tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated are not provided to the UE*  *- the UE receives PDSCH or CSI-RS in the set of symbols of the slot if the UE receives a corresponding indication by a DCI format 1\_0, DCI format 1\_1, or DCI format 0\_1*  *- the UE transmits PUSCH, PUCCH, PRACH, or SRS in the set of symbols of the slot if the UE receives a corresponding indication by a DCI format 0\_0, DCI format 0\_1, DCI format 1\_0, DCI format 1\_1, DCI format 2\_3, or a RAR UL grant ”*  With the following, the UE will transmit DG PUSCH and not receive the PDCCH in CORESET for Type0-PDCCH CSS set.  *“For operation on a single carrier in unpaired spectrum, if a UE is configured by higher layers to receive a PDCCH, or a PDSCH, or a CSI-RS in a set of symbols of a slot, the UE receives the PDCCH, the PDSCH, or the CSI-RS if the UE does not detect a DCI format 0\_0, DCI format 0\_1, DCI format 1\_0, DCI format 1\_1, or DCI format 2\_3 that indicates to the UE to transmit a PUSCH, a PUCCH, a PRACH, or a SRS in at least one symbol of the set of symbols of the slot; otherwise, the UE does not receive the PDCCH, or the PDSCH, or the CSI-RS in the set of symbols of the slot. ”*  CG PUSCH can be transmitted on flexible symbols, but it seems not allowed for CG PUSCH transmission on the flexible symbols configured for CORESET for Type0-PDCCH CSS set, due to the following.  *‘For a set of symbols of a slot that are indicated to a UE as flexible by tdd-UL-DL-ConfigurationCommon, and tdd-UL-DL-ConfigurationDedicated if provided, the UE does not expect to receive both dedicated higher layer parameters configuring transmission from the UE in the set of symbols of the slot and dedicated higher layer parameters configuring reception by the UE in the set of symbols of the slot.’*  **If SFI is configured:**  It is also allowed to schedule DG PUSCH on the flexible symbols for CORESET for Type0-PDCCH CSS set due to the following specs.  *“For a set of symbols of a slot indicated to a UE by pdcch-ConfigSIB1 in MIB for a CORESET for Type0-PDCCH CSS set, the UE does not expect to detect a DCI format 2\_0 with an SFI-index field value indicating the set of symbols of the slot as uplink.”*  *For a set of symbols of a slot indicated to a UE as flexible by tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated if provided, or when tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated are not provided to the UE, and if the UE detects a DCI format 2\_0 providing a format for the slot using a slot format value other than 255*  *- if one or more symbols from the set of symbols are symbols in a CORESET configured to the UE for PDCCH monitoring, the UE receives PDCCH in the CORESET only if an SFI-index field value in DCI format 2\_0 indicates that the one or more symbols are downlink symbols*  *For a set of symbols of a slot that are indicated as flexible by tdd-UL-DL-ConfigurationCommon, and tdd-UL-DL-ConfigurationDedicated if provided, or when tdd-UL-DL-ConfigurationCommon, and tdd-UL-DL-ConfigurationDedicated are not provided to the UE, and if the UE does not detect a DCI format 2\_0 providing a slot format for the slot*  *- the UE transmits PUSCH, PUCCH, PRACH, or SRS in the set of symbols of the slot if the UE receives a corresponding indication by a DCI format 0\_0, DCI format 0\_1, DCI format 1\_0, DCI format 1\_1, DCI format 2\_3, or a RAR UL grant*  For CG PUSCH, it seems also allowed when SFI is received. For instance, SFI can indicate the flexible symbols for CORESET for Type0-PDCCH CSS set as UL symbols. Then, UE will not receive PDCCH while can transmit CG PUSCH.  *For a set of symbols of a slot indicated to a UE as flexible by tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated if provided, or when tdd-UL-DL-ConfigurationCommon and tdd-UL-DL-ConfigurationDedicated are not provided to the UE, and if the UE detects a DCI format 2\_0 providing a format for the slot using a slot format value other than 255*  *- if one or more symbols from the set of symbols are symbols in a CORESET configured to the UE for PDCCH monitoring, the UE receives PDCCH in the CORESET only if an SFI-index field value in DCI format 2\_0 indicates that the one or more symbols are downlink symbols*  *....*  *- if the UE is configured by higher layers to transmit PUCCH, or PUSCH, or PRACH in the set of symbols of the slot, the UE transmits the PUCCH, or the PUSCH, or the PRACH in the slot only if an SFI-index field value in DCI format 2\_0 indicates the set of symbols of the slot as uplink* |
| Spreadtrum | We support the proposal. PUCCH repetitions, and PUSCH repetition type B do not consider the collision handling for Type 0 PDCCH CSS. We cannot find the enough reasons for support this collision handling in Rel-17.  According to comments for PUSCH mapping type A and type B, PUSCH mapping type B can be start from symbol 0 to 13, the length can be 1 to 14. So from the duration side of view, PUSCH mapping type B do not have disadvantage comparing with PUSCH mapping type A. Thus, gNB scheduling does not have too much limitations according to this consideration. |
| Panasonic | We have same interpretation as what FL mentioned above. |
| WILUS | We share the similar view with Samsung. A symbol configured to receive CORESET0 can also be regarded as semi-static DL symbol like in SSB case. Although collision can be handled by gNB, it is worth to consider CORESET0 in Step 1 to guarantee more available slots for Rel-17 PUSCH repetition Type A. |
| Intel | We do not support this.  We understand that in Rel-15/16, collision handling between PUSCH repetition type A and CORESET#0 with Type0-PDCCH CSS is handled by gNB, i.e., gNB needs to ensure that there is no overlapping between PUSCH repetition type A and CORESET#0 with Type0-PDCCH CSS.  However, given the fact that PUSCH repetition type A is based on the available slots, the chance that actual repetition is much higher than before in typical TDD configuration. Our view is that purely relying on gNB implementation to avoid such collision may not be reasonable design. |
| CATT | We have the same understanding with the current conclusion.  Similar to the PUCCH repetition case based on available slot, no need to specify collision handling rule for UL repetition v.s. CSS. |
| Apple | We have the same understanding as FL. In addition, as we agreed the flexible slot is considered as available slot, then the flexible slot configured with CORESET for Type0-PDCCH CSS, it should be counted as available, but will be dropped in the second step. |
| Ericsson2 | The specs. in section 11 of 38.213 copied by companies already show that PUSCH transmission with respect to flexible symbols occupied by SS0 is well handled in NR Rel-16.  There’s no need to consider CORESET0 or any other R16 existing signals for PUSCH available slot determination since the legacy rules/UE assumptions in the 2nd step after available slot determination can make sure whether PUSCH can be transmitted. |

### [Pending] Issue#2-4: Use of Invalid UL symbol configuration for the determination of available slots

Under Issue#2-4, whether the configuration of invalid UL symbols for DL-to-UL switching gaps is used for the available slot determination or not is discussed.

Similar to CORESET0 with Type0-PDCCH CSS set, in Rel-16, invalid UL symbol configuration is used to determine time domain resource allocation for PUSCH repetition Type B. On the other hand, any clear behaviour (including PUSCH dropping rule) has not been specified for the case PUSCH repetition Type A overlaps with the invalid UL symbols.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* Should use the invalid UL symbols for DL-to-UL switching gaps for the available slot determination
  + Samsung [5], Panasonic [7], Intel [17], Xiaomi [23]
* No need to use the invalid UL symbols for DL-to-UL switching gaps for the available slot determination
  + ZTE[4] , CATT [6], Qualcomm [13], ~~CMCC [14]~~, LG Electronics [15], Sharp [21]

1st round (Issue#2-4)

In the operation with a fixed TDD configuration, DL-to-UL gaps exist only in special slots, and are configured as flexible symbols. For CG-PUSCH, if the PUSCH allocation in a special slot is configured such as to overlap with DL symbols, the special slot is determined as not available. This can be done without introducing any additional handling of DL-to UL gaps. For DG-PUSCH, the scheduler has to avoid overlapping between DC-PUSCH and DL symbols in a special slot anyway. Further avoidance of DL-to-UL gap in the same special slot does not cause any additional complexity.

In the operation with a dynamic TDD configuration, DL-to-UL gaps may be mapped on semi-static flexible symbols and likely to be further indicated as dynamic flexible symbols. CG-PUSCH on the semi-static flexible symbols is not transmitted unless the UE detects the dynamic SFI which indicates the symbols as uplink. Therefore, as long as the gNB sends appropriate SFI, any collistion between CG-PUSCH and DL-to-UL gaps does not happen. On the other hand, for DG-PUSCH repetitions, Rel-16 specifications is not specifing any collisiton handling. Similar to CORESET0 with Type-PDCCH CSS, this means that the Rel-16 gNB has to schedule DG-PUSCH repetitions such that the DG-PUSCH repetitions never overlap with DL-to-UL gaps on semi-static flexible symbols. Whether or not Rel-17 gNB can handle it in the same way as Rel-16, even with the available slot based counting, would be a discussion point.

Companies are encouraged to provide their views on whether or not it is possible for Rel-17 gNB to always schedule DG-PUSCH repetitions with the available slot based counting such that the DG-PUSCH repetitions never overlap with DL-to-UL gaps in the operation with a dynamic TDD configuration.

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| **Company** | **Comments** |
| vivo | Not necessary. It can be up to NW scheduler to avoid PUSCH repetition overlapping with the DL  -to-UL switching gap. |
| Apple | gNB could handle this by implementation. No need to introduce new rules for available slot determination. |
| Ericsson | No other configurations are needed for available slot determination. Omission rules on collision between invalid symbols and PUSCH are clear in current spec. and can be reused. |
| Nokia/NSB | Same answer as for Issue 2-3. |
| Intel | We support this DL-to-UL gaps to determine the available slots.  As mentioned above, in our view, it is similar to collision handling and invalid symbols for PUSCH repetition type B transmission. Otherwise, it is unnecessary restriction at gNB scheduler to avoid the collision between switching gap and PUSCH repetition. |
| Qualcomm | Currently, the spec introduces invalid symbols only within the context of Type B repetitions. We therefore would not like to repurpose this definition for Type A repetitions.  If such a definition is necessary for Type A repetitions, let us first agree to introduce it and then discuss how to define and handle it.  Also, we are not sure if this statement is correct: “CG-PUSCH on the semi-static flexible symbols is not transmitted unless the UE detects the dynamic SFI which indicates the symbols as uplink.”. Per our understanding, CG-PUSCH transmissions can occur on flex. symbols. Will be good to clarify. |
| Samsung | Same comment as in 2.2.3. |
| Panasonic | We think it is possible for gNB to always schedule DG-PUSCH repetitions with the available slot based counting such that the DG-PUSCH repetitions never overlap with DL-to-UL gaps in the operation with a dynamic TDD configuration via TDRA. |
| ZTE | We are hesitating to consider invalid UL symbols for DL-to-UL switching gaps for the available slot determination. If considered, it would mean we need to consider how to introduce similar mechanism/signaling (i.e., semi-static/dynamic indicated invalid symbols) defined for PUSCH repetition type B for Rel-17 PUSCH repetition type A. It would cause too much specification effort. |
| LG | It is up to gNB and it is not necessary to introduce other configurations for available slot determination. |
| CATT | Not necessary. Same as Rel-16, we think gNB is able to handle the case by proper scheduling, or handled by dropping rules in Step 2 of Alt 1-B if needed. |
| Spreadtrum | We support No need to use the invalid UL symbols for DL-to-UL switching gaps for the available slot determination |
| WILUS | We think DL-to-UL switching gap is unnecessary for available slot determination. It can be handled by gNB implementation. |
| CMCC | Do not support to determine the available slot based on the SFI indication. The impact of CI and the change of SFI should be discussed in the step of dropping rule. |
| OPPO | It is not necessary to introduce other configurations for available slot determination. |
| Huawei/HiSilicon | Agree with vivo that this could be handled by gNB implementation. No need to introduce new rules for available slot determination. |
| NEC | We think the same issue in legacy Rel-15 and Rel-16 PUSCH repetition, i.e. whether omit the PUSCH overlapping with DL-UL switching gap. We think we can reuse the legacy mechanism. DL-UL switching gap is not consider when determine available slot and UE doesn’t expect it as TS38.211. |
| Sharp | As in Rel-15/16, gNB scheduling should avoid the collision. |
| Rakuten Mobile | NW scheduling can handle to avoid the collision. |
| ZTE | Support |

1st round summary(Issue#2-4)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1: Collisions betwen PUSCH repetitions and DL-to-UL gaps are handled by the available slot determination.
  + (2 companies): Intel, Samsung
* Alt 2: Collisions betwen PUSCH repetitions and DL-to-UL gaps are handled by gNB scheduling.
  + (17 companies): vivo, Apple, Ericsson, Nokia/NSB, Panasonic, ZTE, LG, CATT, Spreadtrum, WILUS, OPPO, Huawei/HiSilicon, NEC, Sharp, Rakuten Mobile
* Do not repurpose Rel-16 invalid symbol for Type B repetition.
  + (2 company): Qualcomm, ZTE

FL Proposal on Issue#2-4:

* Collision handling betwen PUSCH Type A repetitions and DL-to-UL gaps is up to gNB scheduler.

### [Pending] Issue#2-5: Use of semi-static PUCCH repetition configuration for the determination of available slots

Under Issue#2-5, whether the configuration of semi-static PUCCH with repetitions is used for the available slot determination or not is discussed.

In Rel-15/16, overlapping of PUSCH repetition Type A and semi-static PUCCH with repetitions is handled by PUSCH dropping rules, i.e. all PUSCHs overlapping with PUCCH repetitions are dropped. Whether PUSCH resources collide with semi-static PUCCH repetitions or not is known by the UE prior to the start of PUSCH repetitions.

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| **TS38.213 v16.6.0**  9.2.6 PUCCH repetition procedure  *[Omitted]*  If a UE would transmit a PUCCH over a first number of slots and the UE would transmit a PUSCH with repetition Type A over a second number of slots, and the PUCCH transmission would overlap with the PUSCH transmission in one or more slots, and the conditions in clause 9.2.5 for multiplexing the UCI in the PUSCH are satisfied in the overlapping slots, the UE transmits the PUCCH and does not transmit the PUSCH in the overlapping slots. |

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* Should use semi-static PUCCH repetition configuration for the available slot determination
  + ZTE [4]
* No need to use semi-static PUCCH repetition configuration for the available slot determination
  + CATT [6], Panasonic [7], Qualcomm [13], ~~CMCC [14]~~, LG Electronics [15], Intel [17], Sharp [21]

1st round (Issue#2-5)

Companies are encouraged to provide their views on whether the overlapping of PUSCH repetition Type A and semi-static PUCCH with repetitions is handled by PUSCH dropping rules in the same as Rel-15/16 or is handled by the available slot determination.

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| **Company** | **Comments** |
| Apple | Rel.15/16 defined dropping rule is applied for colliding between PUCCH PUSCH repetition. |
| Ericsson | No other configurations are needed for available slot determination. Omission rules on collision between semi-static PUCCH repetition and PUSCH are clear in current spec. and can be reused. |
| Nokia/NSB | Same answer as for Issue 2-3. |
| Intel | We do not support this. |
| Lenovo, Motorola Mobility | We don’t support the use of semi-static PUCCH repetition configuration for the determination of available slots. |
| Qualcomm | Do not take semi-static PUCCH configs into account when determining available slots. |
| Samsung | Should be handled by available slot determination. There is no difference between determining available slots for repetitions based on collisions with semi-static DL slots vs. based on collisions with slots having PUCCH repetitions. |
| Panasonic | The usage itself of PUCCH for SR is dynamic (depending on SR is positive or negative). All configured PUCCH resource cannot be used for PUSCH repetition Type A is too large restriction. |
| ZTE | ~~We are hesitating to consider invalid UL symbols for DL-to-UL switching gaps for the available slot determination. If considered, it would mean we need to consider how to introduce similar mechanism/signaling (i.e., semi-static/dynamic indicated invalid symbols) defined for PUSCH repetition type B for Rel-17 PUSCH repetition type A. It would cause too much specification effort.~~  Our preference is we should either support all RRC configurations if they cause dropping of the transmission of PUSCH repetition type A as defined in Rel-16 or none of them. Considering we have already agreed for one RRC configuration (i.e., SSB transmission) for available slot determination, we could do the same for the rest of RRC configurations, including semi-static PUCCH repetition configuration, SMTC configuration and semi-static PUCCH with larger priority index. |
| LG | Rel.15/16 dropping rule can be reused. |
| CATT | Similar to Issue#2-3. This can be handled by dropping rules (Step 2 of Alt 1-B) if needed. |
| Spreadtrum | We support No need to use semi-static PUCCH repetition configuration for the available slot determination |
| OPPO | Rel.15/16 dropping rule can be reused. |
| Xiaomi | It seems not necessary |
| Huawei/HiSilicon | Same answer as issue 2-3 and 2-4. |
| NEC | Rel.15/16 dropping rule can be reused. |
| Sharp | As in Rel-15/16, the collision can be handled by PUSCH dropping rules. |
| Rakuten Mobile | No need to consider semi-static PUCCH configuration. Dropping rule in current spec is enough to support it. |
| ZTE | We are confused why we are treating different RRC configurations differently. This would only cause different implementations for both gNB and UE. We still prefer Alt 1. |

1st round summary(Issue#2-5)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1: Collisions betwen PUSCH repetitions and semi-static PUSCH repetitions are handled by the available slot determination.
  + (2 companies): Samsung, ZTE
* Alt 2: Collisions betwen PUSCH repetitions and semi-static PUSCH repetitions are handled by PUSCH dropping rules.
  + (19 companies): Apple, Ericsson, Nokia/NSB, Intel, Lenovo/Motorola Mobility, Qualcomm, Panasonic, LG, CATT, Spreadtrum, OPPO, Xiaomi, Huawei/HiSilicon, NEC, Sharp, Rakuten Mobile

FL Proposal on Issue#2-5:

* Collision betwen PUSCH repetitions and semi-static PUSCH repetitions is handled by PUSCH dropping rules.

### [Open] Issue#2-6: Use of SMTC configuration for the determination of available slots

Under Issue#2-6, whether a collision of PUSCH repetition with the SSB based measurement by SMTC configuration is take into consideration for the available slot determination or not is discussed.

In RAN1#104-e, RAN1#105-e and RAN1#106-e, vivo [2] proposed that SSB based measurement by SMTC configuration should be handling in the available slot determination step, based on the following descriptions in RAN4 specification.

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| **TS38.133**  9.2.5.3 Scheduling availability of UE during intra-frequency measurements  UE shall be capable of measuring without measurement gaps when the SSB is completely contained in the active bandwidth part of the UE. When any of the conditions in the following clauses is met, there are restrictions on the scheduling availability; otherwise, there is no scheduling restriction. Note that the SSB symbols indicated by the union set of *SSB-ToMeasure* from all the configured measurement objects on the same serving carrier which can be merged[2], if it is configured; otherwise, all *L* SSB symbols within the SMTC window duration defined in clause 4.1 of TS 38.213 [3] are included.  9.2.5.3.1 Scheduling availability of UE performing measurements in TDD bands on FR1  When the UE performs intra-frequency measurements in a TDD band, the following restrictions apply due to SS-RSRP or SS-SINR measurement  - The UE is not expected to transmit PUCCH/PUSCH/SRS on SSB symbols to be measured, and on 1 data symbol before each consecutive SSB symbols to be measured and 1 data symbol after each consecutive SSB symbols to be measured within SMTC window duration. If the high layer in TS 38.331 [2] signalling of *smtc2*is configured, the SMTC periodicityfollows *smtc2*; Otherwise SMTC periodicity follows *smtc1.*  When the UE performs intra-frequency measurements in a TDD band, the following restrictions apply due to SS-RSRQ measurement  - The UE is not expected to transmit PUCCH/PUSCH/SRS on SSB symbols to be measured, RSSI measurement symbols, and on 1 data symbol before each consecutive SSB to be measured/RSSI symbols and 1 data symbol after each consecutive SSB to be measured/RSSI symbols within SMTC window duration. If the high layer signalling of *smtc2*is configured in TS 38.331 [2], the SMTC periodicityfollows *smtc2*; Otherwise the SMTC periodicity follows *smtc1.* |

On the other hand, Sharp [21] expresses their views that, in Rel-15/16, when SSB based measurement by SMTC configuration would overlap with UL symbols, the network configures an appropriate measurement gap. Once the measurement gap is configured to the UE, the MAC layer does not transmit on UL-SCH during the gap, and therefore PHY layer does not need to handle any collision between PUSCH repetition and SSB measurement with SMTC.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* Should use SMTC configuration for the available slot determination
  + vivo [2], ZTE [4]
  + FFS: Panasonic [7]
* No need to use SMTC configuration for the available slot determination
  + CATT [6], Qualcomm [13], ~~CMCC [14]~~, LG Electronics [15], Intel [17], Sharp [21], WILUS [24]

1st round (Issue#2-6)

Companies are encouraged to provide their views on whether the overlapping of PUSCH repetition Type A and SMTC-based SSB measurement needs to be handled by the available slot determination procedure or not.

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| **Company** | **Comments** |
| vivo | The SMTC configuration is also semi-statically provided by RRC signalling, both NW and UE are aligned on the SMTC configuration and the corresponding UE behaviour. We support to handle the overlapping of PUSCH repetition Type A and SMTC-based SSB measurement by the available slot determination procedure.  Regarding sharp’s view, the PUSCH dropping during SMTC in rel-16 is caused by scheduling restriction for intra-frequency measurement. While measurement gap is configured for inter-frequency measurement, it is different story. |
| Apple | It’s not necessary to consider SMTC configuration for available slot determination. |
| Ericsson | No other configurations are needed for available slot determination. Rules on collision between SMTC configuration and PUSCH are clear in current spec. and can be reused. |
| Nokia/NSB | Same answer as for Issue 2-3. |
| Intel | We do not think we need to consider SMTC configuration for the available slot determination |
| Lenovo, Motorola Mobility | We don’t support the use of SMTC configuration for the available slot determination |
| Qualcomm | Doesn’t seem to be critical/necessary |
| Samsung | Should be handled by available slot determination. There is no apparent reason why one RRC signalling should be considered and another RRC signalling should not be considered. |
| Panasonic | Both network and UE are aware of the SMTC configurations, and therefore there is no ambiguity if these symbols are counted as not available. Therefore, we are open to consider SMTC-based SSB measurement for available slot determination procedure. |
| ZTE | Our preference is we should either support all RRC configurations if they cause dropping of the transmission of PUSCH repetition type A as defined in Rel-16 or none of them. Considering we have already agreed for one RRC configuration (i.e., SSB transmission) for available slot determination, we could do the same for the rest of RRC configurations, including semi-static PUCCH repetition configuration, SMTC configuration and semi-static PUCCH with larger priority index. |
| LG | It seems not necessary. |
| CATT | May not be critical and no strong need to consider for Rel-17 PUSCH, if Rel-15/16 PUCCH repetition does not consider SMTC, either. |
| Spreadtrum | We support No need to use SMTC configuration for the available slot determination |
| WILUS | We don’t support. Motivation and necessity are unclear. |
| OPPO | It’s not necessary. |
| Xiaomi | Not necessary |
| Huawei/HiSilicon | Same answer as issue 2-3and 2-4. |
| NEC | Not necessary, reusing legacy behavior is enough. |
| Sharp | Not necessary.  @vivo: What TS38.133 describes is more like scheduling restrictions. In addition, legacy gNBs configure measurement gaps not only for inter-frequency measurements but also for intra-frequency measurements. This had been discussed in TEI16 in RAN2 and they agreed to introduce *intraFreq-needForGap* capability report. Therefore, the collisions can be avoided by either appropriate UL scheduling or configuration of a measurement gap. |
| Rakuten Mobile | We don’t support. |
| ZTE | We are confused why we are treating different RRC configurations differently. This would only cause different implementations for both gNB and UE. We still prefer Alt 1. |
| vivo2 | @ Sharp thanks for following up.  Agree with that meas gap can also be configured for intra-frequency measurement. But the most common case is intra-frequency meas without measurement gap, and scheduling restriction is applied according to SMTC configuration for intra-frequency measurement. The UE behavior is specified in 38.133 and 38.213, not related to MAC layer and measurement gap. Mix these two things together should be avoided.  For both SSB position for the serving cell and SSB occasion provided by SMTC, the UE behavior is the same in rel-15/16, i.e., UE would not transmit PUSCH. For determine the available slots for type-A PUSCH repetition, it does not make sense to use different behavior when PUSCH is overlapping with the same physical signal/channel. |
| FL | @vivo:  Thank you for the explanation. I might be wrong, but my interpretation was as follows:  38.133 descriptions are saying that scheduling is restricted such that the UE does not have to transmit UL during the measurement configured by SMTC. In other words, such collision does not happen (e.g. such collision is avoided by scheduling or such collision is covered by a measurement gap.) In any case, MAC layer does not instruct PHY layer to transmit UL-SCH, and as such PHY layer does not need to handle this collision. Meanwhile, SSB indicated by *ssb-PositionsInBurst* may collide with CG-PUSCH, and this collision needs to be handled in PHY layer as described in 38.213. Therefore, handling of the SSB measurement configured by SMTC is clearly different from the one for SSB indicated by *ssb-PositionsInBurst*.  Anyway, let’s see other companies’ views on this. |

1st round summary(Issue#2-6)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1: Collisions betwen PUSCH repetitions and SSB based measurement by SMTC configuration are handled by the available slot determination.
  + (3 companies): vivo, Samsung, ZTE
* Alt 2: Collisions betwen PUSCH repetitions and SSB based measurement by SMTC configuration are handled by gNB scheduling.
  + (19 companies): Apple, Ericsson, Nokia/NSB, Intel, Lenovo/Motorola Mobility, Qualcomm, LG, CATT, Spreadtrum, WILUS, OPPO, Xiaomi, Huawei/HiSilicon, NEC, Sharp, Rakuten Mobile
* Open to consider.
  + (1 company): Panasonic

FL Proposal on Issue#2-6:

* Collision handling betwen PUSCH repetitions and SSB based measurement by SMTC configuration is up to gNB scheduler.

2nd round (Issue#2-6)

Companies are invited to answer the following questions.

* Q1: Do you agree that the Rel-15/16 UE behavior is the same for both SSB position for the serving cell and SSB occasion provided by SMTC?
* Q2: Do you agree that the Rel-17 UE behavior should be the same for both SSB position for the serving cell and SSB occasion provided by SMTC?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Q1: YES  Thanks for FL’s further explanation in 1st round.  The scheduling restriction in 38.133 does not mean collision does not happen, but means the collision could happen and intra-freq measurement is prioritized over PUSCH transmission. The wording in 38.133: ‘The UE is not expected to transmit PUCCH/PUSCH/SRS on SSB symbols to be measured…’ means UE does not transmit UL channels, rather than an error case like ‘UE does not expect to be scheduled in the overlapping symbols’. This collision could happen, and that is why the spec would prioritize one to the other.  For PUSCH collision with SSB configured by *ssb-PositionsInBurst*, it is clear that UE would not transmit PUSCH. Hence, the behavior is the same for these two cases in Rel-15/16.  Q2: YES  It is nature that the same rule should be applied if overlapping with SSB, although provided by different RRC parameter. |
| WILUS | Q1: No.  In Rel-15/16, SS/PBCH block that is only configured by *ssb-PositionsInBurst* in SIB1 or *ssb-PositionsInBurst* in *ServingCellConfigCommon* is used for the determination of available slots for PUCCH repetition as follows:   |  | | --- | | **TS38.213 v16.6.0**  **9.2.6 PUCCH repetition procedure**  …  A SS/PBCH block symbol is a symbol of an SS/PBCH block with candidate SS/PBCH block index corresponding to the SS/PBCH block index indicated to a UE by *ssb-PositionsInBurst* in *SIB1* or *ssb-PositionsInBurst* in *ServingCellConfigCommon*, as described in clause 4.1. |   Q2: No.  Only cell-commonly configured SSB, i.e., SSB configured by *ssb-PositionsInBurst* in SIB1 or *ssb-PositionsInBurst* in *ServingCellConfigCommon* can be considered for available slot determination. Rel-15/16 PUCCH repetition mechanism replied in Q1 can be a reference. |
| Sharp | Q1: No. Our understanding is aligned with the explanations by FL.  Q2: No. |
| Lenovo, Motorola Mobility | Q1: Yes  Q2: Yes |
| ZTE | Thanks for the good clarification in the first round.  Q1: No. Align with FL.  Q2: No.  But what matters here is not about whether the handling is the same or not between the two concerned cases. In our view, as also commented in the first round, all semi-static RRC configuration/signal can be used for slot determination, as long as the symbols for the semi-static RRC configuration/signal is not allowed for PUSCH transmission or allowed while would cause dropping of PUSCH. |
| Spreadtrum | Q1: NO. Agree with FL.  Q2: NO. We want to reuse Rel-15/16. |
| Panasonic | Q1: Yes. We agree to vivo’s interpretation.  Q2: Yes. If the answer of Q1 is Yes, to apply same rule is reasonable. |
| Intel | Q1: No. as explained by FL in the first round.  Q2: No. Same behavior as in Rel-15/16. |
| CATT | Q1: No. Only SSB indicated by *ssb-PositionsInBurst* in SIB1 or *ssb-PositionsInBurst* in *ServingCellConfigCommon* is explicitly taking part in collision handling in 38.213 in Rel-15/Rel-16.  Q2: No. |
| CMCC | Q1: NO  Q2: NO.  For the determination of available slot, the SSB should be considered. But for the configuration of SMTC, it should be included in the part of collision resolutions. |
| Ericsson2 | What’s the intention of such questions? We’re a bit confused by wasting time on discussing how Type A PUSCH is transmitted with respect to the resources which could be used by Rel-16 existing signals.  There’s no need to consider SMTC configured SSBs or any other R16 existing signals for PUSCH available slot determination, since the legacy rules/UE assumptions/error cases etc. in the 2nd step after available slot determination can make sure whether PUSCH can be transmitted. If collision between SMTC SSBs and Type A PUSCH in NR Rel-16 is not clear, we would recommend proponent companies to propose clear solutions in NR Rel-16 CR discussions instead.  We’re open to discuss potential collision handling only among Rel-17 signals in the 2nd step after the available slot is determined. |

### [Pending] Issue#2-7: Use of other RRC configurations for the determination of available slots

Issue#2-7 discusses other RRC configurations than the ones discussed in Issues #2-3 to #2-6.

In RAN1#105-e ZTE proposed all the RRC configurations should be taken into consideration to determine available slots.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* Should use semi-static PUCCH with larger priority index for the available slot determination
  + ZTE [4]
* No need to use other RRC configurations for the available slot determination
  + CATT [6], Qualcomm [13], ~~CMCC [14]~~, LG Electronics [15], Intel [17], Sharp [21]

1st round (Issue#2-7)

Companies are encouraged to provide their views on the use of other RRC configurations for the determination of available slots.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Semi-static PUCCH with larger priority index can be handled by reusing Rel-15/16 PUSCH dropping rules. There is no need to consider the use of semi-static PUCCH with larger priority index and other RRC configuration for the available slot determination procedure. |
| Apple | Rel.15/16 defined dropping rules are applied if PUCCH and PUSCH are colliding. |
| Ericsson | No other configurations are needed for available slot determination. Rules in current spec. are clear and can be reused. |
| Nokia/NSB | Same answer as for Issue 2-3. |
| Intel | This should be considered in the second step. |
| Lenovo, Motorola Mobility | We also agree that no other RRC configurations are needed to determine the available slots |
| Qualcomm | We don’t see any strong need to include other RRC configurations. Open to discuss any critical items that are worth including in the exclusion list. |
| Samsung | Agree with the proposal from ZTE, especially for relatively frequent collisions that are determined by RRC. |
| Panasonic | At least for semi-static PUCCH with larger priority index, we think there is no need to use it for the available slot determination. |
| ZTE | Our preference is we should either support all RRC configurations if they cause dropping of the transmission of PUSCH repetition type A as defined in Rel-16 or none of them. Considering we have already agreed for one RRC configuration (i.e., SSB transmission) for available slot determination, we could do the same for the rest of RRC configurations, including semi-static PUCCH repetition configuration, SMTC configuration and semi-static PUCCH with larger priority index. |
| LG | It is not necessary to introduce other configurations for available slot determination. |
| CATT | This can be handled by dropping rules (Step 2 of Alt 1-B) if needed. |
| Spreadtrum | We support No need to use other RRC configurations for the available slot determination |
| OPPO | It’s not necessary. |
| Xiaomi | There is no need to introduce extra configurations and factors to the workload. |
| Huawei/HiSilicon | No need to use other RRC configurations for the available slot determination. |
| Sharp | No need to use other RRC configurations. |
| Rakuten Mobile | No need to use other RRC configurations. Current dropping rules can cover it. |
| ZTE | We are confused why we are treating different RRC configurations differently. This would only cause different implementations for both gNB and UE. |

1st round summary(Issue#2-7)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Other RRC configurations to be used for the available slot determination:
  + All the RRC configurations should be used.
    - (2 companies): Samsung, ZTE
  + No other RRC configuration is identified
    - (18 companies): vivo, Apple, Ericsson, Nokia/NSB, Lenovo/Motorola Mobility, Qualcomm, Panasonic, LG, CATT, Spreadtrum, OPPO, Xiaomi, Huawei/HiSilicon, Sharp, Rakuten Mobile
  + Study further (1 company): Intel

FL Proposal on Issue#2-7:

* No other RRC configuration is used for the available slot determination.

### [Open] Issue#2-8: Limitation of overall duration of PUSCH repetitions

In RAN1#104-e and 105-e, several companies proposed having a time window/limitation of overall time duration for a signle set of PUSCH repetitions so that an excessive delay can be avoided. Meanwhile, more companies thought that the network can control the overall time duration by setting an appropreate repetition factor.

* Alt 1: Count of available slots continues until reaching the indicated/configured repetition factor.
* Alt 2: Count of available slots continues until reaching the indicated/configured repetition factor or reaching the limitation of overall duration for a set of PUSCH repetitions, whichever comes first.
  + Supported by: OPPO, Intel, Samsung, Lenovo/Motrola Mobility

At the same time, it was also mentioned that whether this issue needs to be discussed depends on the outcome of Issue#2-1, because the overall duration is certainly deterministic and controlable if the available slots are determined by semi-static configurations only while the postponement of PUSCH repetition due to dynamic scheduling may lead to difficulty to predict when the repetitions finish. Therefore, this discussion has been deferred, since we have not yet concluded the discussion on use of dynamic signaling for the determination of available slots.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* For CG-PUSCH with repetitions, overall duration of PUSCH repetitions should not exceed the configured periodicity of the configured PUSCH (similar to Rel-15/16).
  + Huawei/HiSilicon [1], Qualcomm [13]
  + Should be discussed: Panasonic [7]
* For DG-PUSCH with repetitions, no need to introduce upper limit of overall duration of PUSCH repetitions
  + Panasonic [7]
* A PUSCH transmission scheduled in a non-available slot is postponed to a next available slot where the PUSCH transmission is counted – the postponement is done 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.
  + Samsung [5], Lenovo/Motorola Mobility [11], Intel [17], InterDigital [19]

For DG-PUSCH, 4 companies are proposing introducing the cap of over all duration for a set of PUSCH repetitions.

For CG-PUSCH, Rel-15/16 has the following restriction on the repetition configuration. It would be discussed if similar limitation for overall duration of a set of PUSCH repetitions needs to be applied to Rel-17.

|  |
| --- |
| **TS38.214**  6.1.2.3.1 Transport Block repetition for uplink transmissions of PUSCH repetition Type A with a configured grant  *[Omitted]*  The UE is not expected to be configured with the time duration for the transmission of *K* repetitions larger than the time duration derived by the periodicity *P*. If the UE determines that, for a transmission occasion, the number of symbols available for the PUSCH transmission in a slot is smaller than transmission duration *L*, the UE does not transmit the PUSCH in the transmission occasion. |

1st round (Issue#2-8)

Companies are encouraged to provide their views on the follwoing proposals.

For DG-PUSCH with counting based on the available slots,

* Alt 1: Count of available slots continues until reaching the indicated/configured repetition factor.
* Alt 2: Count of available slots continues until reaching the indicated/configured repetition factor or reaching the limitation of overall duration for a set of PUSCH repetitions, whichever comes first.

For CG-PUSCH with counting based on the available slots,

* Overall duration of PUSCH repetitions should not exceed the configured periodicity of the configured PUSCH (similar to Rel-15/16).

🡪Proposad modification: ”Count of available slots continues until reaching the indicated/configured repetition factor or reaching the end of CG period, whichever comes first.”

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | For DG-PUSCH, support Alt 1.  For CG-PUSCH, support the same/similar way as Rel-15/16. |
| Apple | It’s not necessary to set the cap for repetition, if the delay is the concern, the gNB could schedule the PUSCH with less repetitions. Alt 1 is ok. |
| Ericsson | For DG-PUSCH, it’s up to gNB to configure the number of repetitions, there’s no need of a limitation.  For CG PUSCH, legacy specification is enough, no specification change is expected. |
| Nokia/NSB | For DG-PUSCH, support Alt 1 with same understanding as Apple.  For CG-PUSCH, support the same/similar way as Rel-15/16. |
| Intel | For DG-PUSCH, we support Alt. 1 as gNB can flexibly indicate the repetition number  For CG-PUSCH, we are fine with the proposal. |
| Lenovo, Motorola Mobility | We support Alt 2 for DG-PUSCH to control the overall duration and not allow large overall duration to accommodate the indicated repetition factor. |
| Qualcomm | For DG-PUSCH, support Alt 1. Support proposal on CG-PUSCH. |
| Samsung | For DG, Alt.1 is not sufficient because in a configuration with many DL slots, which is typical, the PUSCH can be postponed for several slots, e.g. due to likely collisions with PUCCH. The amount of postponing is a trade-off between reliability and latency/resources for a PUSCH transmission. As for CG, there should be a limit to postponing. |
| InterDigital | For CG, TDD frame structure can be different from one CG period to another CG period. Thus, the number of available UL slots can be different from one CG period to another. We support opportunistic usage of available UL slots in a CG period, i.e., keep transmitting repetitions until the count reaches the configured/indicated number of repetitions or until the end of CG period. |
| Panasonic | For DG PUSCH, if Alt.1-B is agreed in Issue 2-1, we support Alt.1. For Alt.1-B, we don’t see the need of the upper limit since the duration of repetition span can be deterministic when UE receives the scheduling DCI at least for DG PUSCH. If Alt.2-A or 2-B is supported in Issue 2-1, upper limit would be required.  For CG PUSCH, we are fine to the proposal. To reuse Rel.15/16 principle would provide simpler implementation. |
| ZTE | Alt 1. for DG PUSCH, and fine with the proposal for CG PUSCH. |
| CATT | For DG-PUSCH: Prefer Alt 1. Dynamic scheduling should be flexible enough, which is able to indicate a proper repetition number and no need for additional limitation.  For CG-PUSCH: we would like to hear more clarification first. Does it mean ‘the configuration that CG-PUSCH repetitions exceed the configured periodicity’ is NOT allowed, or such configuration is allowed but UE will drop the repetition(s) outside the periodicity? |
| NTT DOCOMO | For DG-PUSCH, we support Alt.1. |
| Spreadtrum | We support Alt 1 for DG-PUSCH. The requirement of overall duration should be guaranteed by gNB.  We support the proposal for CG-PUSCH. |
| CMCC | For DG-PUSCH, support Alt 1.  For CG-PUSCH, support the same/similar way as Rel-15/16. |
| OPPO | For DG-PUSCH, support Alt 1.  Support proposal on CG-PUSCH. |
| Xiaomi | Alt 1. for DG PUSCH, and fine with the proposal for CG PUSCH. |
| Huawei/HiSilicon | Support Alt 1. for DG PUSCH.  Support the proposal for CG PUSCH. Agree with Interdigital that for CG, TDD frame structure can be different from one CG period to another CG period. Thus, the number of available UL slots can be different from one CG period to another. We support opportunistic usage of available UL slots in a CG period, i.e., keep transmitting repetitions until the count reaches the configured/indicated number of repetitions or until the end of CG period. |
| Sharp | For DG-PUSCH, support Alt 1.  For CG-PUSCH, support the proposal. As for the point raised by CATT, we think further discussion on whether or not this has spec impact is necessary. |
| FL | In the original FL proposal, DG-PUSCH refers to the indicated/configured repetition factor while CG-PUSCH does not. This is not true, as CG-PUSCH needs to be limited the indicated/configured repetition factor, too. Therefore, I added modified descrption for the CG-PUSCH (yellow part) such that it is aligned with the DG-PUSCH. |
| Rakuten Mobile | We support Alt 1 for DG-PUSCH, and the modified proposal for CG-PUSCH. |
| InterDigital 2 | We support the FL’s modified proposal for CG-PUSCH. |
| ZTE | Agree in principle.  For CG PUSCH, there is another condition for canceling all remaining repetitions. On the other hand, how to interpret the highlighted condition is still under discussion in [106-e-NR-7.1CRs-01]. So, it may be better to change the proposal something like:   * For CG-PUSCH with counting based on the available slots, count of available slots continues until reaching the indicated/configured repetition factor or satisfying other conditions defined in Rel-16 ~~reaching the end of CG period~~, whichever comes first.   **TS38.214, Section 6.1.2.3.1:**  For any RV sequence, the repetitions shall be terminated after transmitting *K* repetitions, or at the last transmission occasion among the *K* repetitions within the period *P*, or from the starting symbol of the repetition that overlaps with a PUSCH with the same HARQ process scheduled by DCI format 0\_0 or 0\_1, whichever is reached first. |
| Panasonic2 | We support the FL Proposal on Issue#2-8 below. |
| FL | @ZTE:  Thank you for the information about [106-e-NR-7.1CRs-01]. Understood. Let’s see other companies’ views.  @Panasonic:  Thank you for your support. |

1st round summary(Issue#2-8)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* For DG-PUSCH with counting based on the available slots,
  + Alt 1: Count of available slots continues until reaching the indicated/configured repetition factor.
    - Support (companies): vivo, Apple, Ericsson, Intel, Qualcomm, Panasonic, ZTE, CATT, NTT DOCOMO, Spreadtrum, CMCC, Xiaomi, Huawei/HiSilicon, Sharp, Rakuten Mobile
  + Alt 2: Count of available slots continues until reaching the indicated/configured repetition factor or reaching the limitation of overall duration for a set of PUSCH repetitions, whichever comes first.
    - Support (companies): Lenovo/Motorola Mobility, Samsung
* For CG-PUSCH with counting based on the available slots,
  + Overall duration of PUSCH repetitions should not exceed the configured periodicity of the configured PUSCH (similar to Rel-15/16).
    - Support (companies): vivo, Nokia/NSB, Intel, Qualcomm, Samsung?, Panasonic, ZTE, Spreadtrum, CMCC, OPPO, Xiaomi, Sharp
    - Legacy specification is enough (companies): Ericsson
    - Need more clarification (companies): CATT
    - Should modify as below (companies): InterDigital, Huawei/HiSilicon, Rakuten Mobile, Panasonic
    - 🡪Proposad modification: ”Count of available slots continues until reaching the indicated/configured repetition factor or reaching the end of CG period, whichever comes first.”

FL Proposal on Issue#2-8:

* For DG-PUSCH with counting based on the available slots, count of available slots continues until reaching the indicated/configured repetition factor.
* For CG-PUSCH with counting based on the available slots, count of available slots continues until reaching the indicated/configured repetition factor or reaching the end of CG period, whichever comes first.

2nd round (Issue#2-8)

Companies are encouraged to provide their views on the following proposal.

FL Proposal on Issue#2-8:

* For DG-PUSCH with counting based on the available slots, count of available slots continues until reaching the indicated/configured repetition factor.
* For CG-PUSCH with counting based on the available slots, count of available slots continues until reaching the indicated/configured repetition factor, reaching the end of CG period or being overlapped by DG-PUSCH with the same HARQ process number, whichever comes first.
  + Note: For the overlapping by DG-PUSCH, Rel-16 timeline conditions apply.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support. |
| WILUS | Support. |
| Sharp | Support |
| Nokia/NSB | Support. |
| Lenovo, Motorola | Although we don’t prefer the option for DG-PUSCH listed in the proposal, but for the sake of progress, we are okay to support the proposal |
| Samsung | Given that available slots are determined by RRC (SFI is not considered), and given that a CG-PUSCH transmission with Type-A repetitions will span multiple periods of an UL-DL configuration, the gNB can set the number of repetitions and consideration of a limit is not needed for CG-PUSCH.  Also, we do not support the condition about a DG-PUSCH with the same HARQ number because it is an unnecessary complication as there is no shortage of HARQ processes and there is no reason for a gNB to create such conflict (which the gNB can trivially avoid).  In general, there is no reason for different conditions for DG-PUSCH and CG-PUSCH. |
| ZTE | Support in principle. Sorry that we again bring another issue here....  As discussed in [106-e-NR-7.1CRs-01], even if the CG and DG are not overlapping, the DG can override the CG, at last in case of CGT is configured and running. Note that, the following is a common understanding as summarized by FL (while no explicit conclusion), and it is for both overlapping and non-overlapping case.  *For the case when CGT is configured and is running at an occasion for a CG PUSCH repetition, the CG-PUSCH repetition termination follows the behaviour defined in TS38.321, Section 5.4 (i.e. the CGT invalidates the CG occasion(s) for a given HARQ process once the UL grant is received for the same HARQ process).*  With said above, we are not sure whether we need to explicitly mention the details. Maybe, we can make it more general, e.g., ‘continues until satisfying the conditions defined in legacy Rel-16 ’ for both DG and CG. |
| Spreadtrum | Support |
| Panasonic | Support the FL proposal. |
| InterDigital | We support the FL’s proposal. |
| Intel | We are fine with the FL’s proposal. |
| CATT | Support. |
| OPPO | Support. |
| Apple | We support the first bullet. For the second bullet, it’s not fully clear to us what is the reason to introduce additional rules in Rel.17 and what is the consequence if no new rule is introduced. |
| CMCC | Support the first bullte. |
| Ericsson2 | We share similar view as ZTE that there’s no need to list the details, and by saying “‘continues until satisfying the conditions defined in legacy Rel-16’ for both DG and CG” is enough. No additional specification changes are expected in Rel-17 on this. |

### [Close] Issue#2-9: Inter-Slot Frequency Hopping Cycle

In RAN1#105-e, Qualcomm raises the issue related to inter-slot frequency hopping. In Rel-15/16, inter-slot frequency hopping cycle is determined on the basis of consecutive physical slots. More specifically, hop index in a slot is determined based on whether the slot index within a radio frame is odd or even.

|  |
| --- |
| **TS38.214v16.6.0**  6.3.1 Frequency hopping for PUSCH repetition Type A  *[Omitted]*  In case of inter-slot frequency hopping, the starting RB during slot  is given by:  ,  where  is the current slot number within a radio frame, where a multi-slot PUSCH transmission can take place,  is the starting RB within the UL BWP, as calculated from the resource block assignment information of resource allocation type 1 (described in Clause 6.1.2.2.2) and is the frequency offset in RBs between the two frequency hops. |

However, the hopping based on physical slot indices causes an uneven distribution of hops in TDD system. InterDigital also mentions the same issue. In order to resolve this issue, Qualcomm’s proposal was that, for inter-slot frequency hopping, hop index is determined based on indexing within the determined available slots.

Companies’ views expressed in RAN1#105-e are summarized as follows. Although the majority was thinking Rel-16 inter-slot frequency hopping works with the counting based on available slots, several companies were still thinking some more discussions were necessary.

* For PUSCH repetition Type A without joint channel estimation, inter-slot frequency hopping is based on physical slot index as in Rel-15/16.
  + ZTE, Apple, Lenovo/Motorola Mobility, Sharp, CATT, LG, Nokia/NSB, Xiaomi, Huawei, HiSilicon (12 companies)
* No need to make any agreement on inter-slot frequency hopping cycle
  + Samsung, CMCC, Panasonic, Intel (4 companies)
* Good to discuss inter-slot frequency hopping cycle issue with AI8.8.1.3
  + Ericsson, OPPO (2 companies)
* Modifications on inter-slot frequency hopping cycle should be considered
  + Qualcomm (1 company)

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* For PUSCH repetition type A without joint channel estimation, inter-slot frequency hopping is based on physical slot index as in Rel-15/16.
  + ZTE [4], Ericsson [16]
* To support joint channel estimation, the frequency hopping pattern optimization can be discussed in the JCE topic.
  + Ericsson [16]
* For PUSCH repetition type A without joint channel estimation, both inter-slot frequency hopping based on physical slot index as in Rel-15/16 and hopping pattern for joint channel estimation can be supported.
  + Sharp [21]

For this meeting, there is no company proposing inter-slot frequency hopping cycle based on available slots.

1st round (Issue#2-9)

Companies are encouraged to provide their views on the follwoing proposal.

Proposed conclusion:

* For Rel-17 PUSCH repetition Type A without joint channel estimation, no new inter-slot frequency hopping cycle is introduced.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support. |
| Apple | Ok with this conclusion. |
| Ericsson | Looks fine. |
| Nokia/NSB | Support. |
| Intel | We are fine with this proposed conclusion. |
| Lenovo, Motorola Mobility | Support the proposed conclusion |
| Panasonic | We are fine with the proposed conclusion. |
| ZTE | Support the intention, while the wording ‘frequency hopping cycle’ is not very clear for us. Should be better to go with the following directly?   * For PUSCH repetition type A without joint channel estimation, inter-slot frequency hopping is based on physical slot index as in Rel-15/16. |
| LG | We are ok with the conclusion. |
| CATT | Support FL’s proposal. |
| NTT DOCOMO | We support the conclusion. |
| CMCC | Fine with the proposal. |
| OPPO | Support the proposal. |
| Xiaomi | Support |
| Huawei/HiSilicon | Support |
| NEC | Support |
| Sharp | Support the proposal. |
| FL | As the following agreement was made in 8/17 GTW2 session, this Issue is now closed.   |  | | --- | | Agreement:   * For Rel-17 PUSCH repetition Type A without joint channel estimation, no new inter-slot frequency hopping mechanism is introduced. | |

### [Pending] Issue#2-10: Handling of a collision between PUSCH repetition and P-SRS

In RAN1#105-e, Huawei proposed studying the case when PUSCH repetition Type A overlaps with SRS. In Rel-15/16, the specifications are not specifing any special handling of collisions between PUSCH and SRS, except for the case of overlaping between high priorirty PUSCH and low priority SRS. The reason is because the gNB can schedule PUSCH and SRS such that any collision between them does not happen. Huawei expressed their views that such a strict TDRA limitation leads to more resource waste of UL symbols when the PUSCH is repeated across more slots, and proposed the following option in order to avoid the wast of uplink resources.

* If symbols in the slot indicated by TDRA for a PUSCH repetition overlaps with the symbols still intended for other UL transmission ( but not for this PUSCH transmission), such as higher priority URLLC signal or periodic SRS or cancellation indication, non-overlapped UL symbols within the overlapped UL slot can be used for one PUSCH repetition to make a full utilization of uplink resources.

During the discussions in RAN1#105-e, the large majority expressed their views that this proposal (i.e. partial dropping of PUSCH) violates PUSCH repetition Type A nature, i.e. the same symbol allocation for all the repetitions.

This issue was discussed in the GTW session in RAN1#105-e, but no agreement/conclusion was made. Mr. chairman suggested revisiting this issue in RAN1#106-e.

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* For collision between enhanced Type A PUSCH repetitions and other UL channels.
  + Reuse existing collision handling rules
    - Qualcomm [13]
  + Define a priority rule
    - Ericsson [16]
  + FFS
    - CMCC [14]

For this meeting, there is no company proposing the following proposal:

* If symbols in the slot indicated by TDRA for a PUSCH repetition overlaps with the symbols still intended for other UL transmission ( but not for this PUSCH transmission), such as higher priority URLLC signal or periodic SRS or cancellation indication, non-overlapped UL symbols within the overlapped UL slot can be used for one PUSCH repetition to make a full utilization of uplink resources.

1st round (Issue#2-10)

Companies are encouraged to provide their views on the follwoing proposal.

Proposed conclusion:

* Rel-17 PUSCH repetition Type A does NOT support the following partial PUSCH transmisssion:
  + If symbols in the slot indicated by TDRA for a PUSCH repetition overlaps with the symbols still intended for other UL transmission ( but not for this PUSCH transmission), such as higher priority URLLC signal or periodic SRS or cancellation indication, non-overlapped UL symbols within the overlapped UL slot can be used for one PUSCH repetition to make a full utilization of uplink resources.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support the proposed conclusion. |
| Apple | OK with this conclusion. |
| Ericsson | In our understanding:   * If CI or a grant of other UL transmission from the UE with higher priority is received either prior to transmission of the first repetition or during the transmission of PUSCH repetitions, this indicates one of the available slots is to be preempted, the UE cancels the transmission of PUSCH repetition in this slot. * For the case that one particular slot is determined as an available slot for multiple time-overlapping UL channels or signals (type A PUSCH repetition enhancement option 2, enhanced A-SRS in Rel-17 FeMIMO topic, or enhanced SPS HARQ-ACK in Rel-17 URLLC topic), RAN1 may need to define the priority of these multiple time-overlapping UL transmissions enhanced in Rel-17. The UE only transmits the channel or signal with the highest priority in overlapping symbols in the slot.   It would be good to make this clear with minimum specification changes after we agree on how to determine available slot for Type A PUSCH. |
| Nokia/NSB | We are fine with the proposed conclusion. |
| Intel | We are fine with the proposed conclusion. We should maintain same resource allocation in time for PUSCH repetition type A |
| Lenovo, Motorola Mobility | Support the proposed conclusion |
| Qualcomm | Conclusion seems unnecessary. In some cases, the cancellation indication can occur after a PUSCH transmission has started. |
| Samsung | Support the conclusion. |
| Panasonic | We are fine with the proposed conclusion. |
| ZTE | Fine |
| FL | @Ericsson,  Good point. If FeMIMO and/or URLLC define new dropping rules, those should also apply. To clarify this point, I updated the alternatives discussed in Issue#2-1. Please see the updates. |
| LG | We are ok with the conclusion. |
| CATT | Support FL’s proposal. |
| Spreadtrum | We support the main bullet with the intension. However, partial PUSCH transmission can the result of UL cancelation. It needs to exclude this UL cancelation case. |
| CMCC | Do not support. There is no need to limited the available slot only within the TDD band.  A unified design is preferred. |
| OPPO | Support the proposal. |
| Xiaomi | Support |
| Huawei/HiSilicon | It overlaps with issue#2-1. Thus, this conclusion seems unnecessary. |
| NEC | Support |
| Sharp | Support the proposal. |
| Rakuten Mobile | Support |

1st round summary(Issue#2-10)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* • Rel-17 PUSCH repetition Type A does NOT support partial PUSCH transmisssion due to overlapping with A-SRS.
  + - Support (18 companies): vivo, Apple, Nokia/NSB, Intel, Lenovo/Motorola Mobility, Qualcomm, Samsung, Panasonic, LG, CATT, Spreadtrum, OPPO, Xiaomi, NEC, Sharp, Rakuten Mobile
    - Clarify if Rel-17 dropping rules are also applied (1 company): Ericsson
    - The conclusion is not necessary (1 company): Huawei/HiSilicon

FL Observation on Issue#2-10:

* At this time, there is no consensus to support partial PUSCH transmisssion due to overlapping with A-SRS for Rel-17 PUSCH repetition Type A.

### [Pending] Issue#2-11: Applicability of available slot based counting method to paired spectrum

In the 4th round discussion in RAN1#105-e, Qualcomm suggested collecting companies’ views on the following proposal.

* For PUSCH Type A repetitions, counting based on available slots is only applicable to unpaired spectrum.

The companies’ views on the above proposal in RAN1#105-e are summarized as follows.

* + Support: CATT, Intel, Qualcomm, Apple, LG, Ericsson, Nokia/NSB, ZTE, Xiaomi
  + Defer the discussion until concluding what semi-static configurations to be used for the detemination of available slots: Sharp, Panasonic, WILUS
  + No need: CMCC

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* For Rel-17 PUSCH repetition Type A, counting based on available slots is only applicable to unpaired spectrum.
  + Qualcomm [13], Sierra Wireless [18], Sharp [21]
* For Rel-17 PUSCH repetition Type A, counting based on available slots is applicable to unpaired and paired spectrum.
  + ZTE [4]

The discussion point would be what components are used for the determination of available slots for paired spectrum. The components which have been agreed so far to be used for the available slot determination are only *tdd-UL-DL-ConfigurationCommon*, *tdd-UL-DL-ConfigurationDedicated* and *ssb-PositionsInBurst*. All of there three components are valid only for unpaired spectrum, as there would no collision between DL and UL for paired spectrum, except for Half-duplex FDD discussed in RedCap WI.

1st round (Issue#2-11)

Companies are encouraged to provide their views on the follwoing proposal.

* For PUSCH Type A repetitions, counting based on available slots is only applicable to unpaired spectrum.

|  |  |
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| **Company** | **Comments** |
| vivo | For unified design, there is no need to introduce this restrction on the applicability.  Besides, for Half duplex FDD redcap UEs, how to handle PUSCH repetition overlapping with SSB is still under discussion, so it seems too early to say the counting on available slots only apply to TDD spectrum. |
| Apple | OK with this proposal. |
| Ericsson | Seems fine, and as long as the available slot determination is clear, such proposal is obvious. |
| Nokia/NSB | We are fine with the FL’s proposal. |
| Intel | We are fine with the proposal. |
| Lenovo, Motorola Mobility | Support the proposal |
| Sierra Wireless | Support proposal. |
| Qualcomm | Taking Half Duplex FDD Redcap UEs into consideration, we reconsider our original position. As vivo suggests, perhaps we should exercise restraint in introducing this restriction and leave it to gNB to decide. |
| Samsung | Can revisit later depending on other decisions for available slots and on a conclusion how to address HD-FDD UEs. The proposal is not agreeable now. |
| Panasonic | We are fine with the proposal. |
| ZTE | Suggest discussing this issue after concluding on Issue 2-5, 2-6 and 2-7. |
| LG | We support the proposal. |
| CATT | OK with this proposal. |
| NTT DOCOMO | We support the proposal. |
| OPPO | OK with this proposal. |
| Xiaomi | support |
| Huawei/HiSilicon | Too early to make such conclusion because RAN1 designs are usually band agnostic. |
| Sharp | Fine with the proposal, but also OK to defer the discussion. |
| Rakuten Mobile | We are OK for the proposal. |

1st round summary(Issue#2-11)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* For PUSCH Type A repetitions, counting based on available slots is only applicable to unpaired spectrum.
  + Support (18 companies): Apple, Ericsson, Nokia/NSB, Intel, Lenovo/Motorola Mobility, Sierra Wireless, Panasonic, LG, CATT, NTT DOCOMO, OPPO, Xiaomi, Sharp, Rakuten Mobile
  + No such limitation needed (1 company): vivo, Qualcomm
  + Defer the discussion (1 company): vivo, Samsung, ZTE, Huawei/HiSilicon, Sharp

FL recommendation on Issue#2-11:

* Continue discussion.

### [Pending] Issue#2-12: Configurations/indications enabling CovEnh functions

As described in the WID, two enhancements for PUSCH repetition type A would be supported. In RAN1#105-e, it was discussed whether/how to activate those enhancements.

The first aspect is, when UE is capable of CovEnh enhancement and reported it to the Rel-17 gNB, whether the Rel-17 gNB still have a choice to configure the UE with legacy repetition scheme. The large majority answered ”Yes” to the question. As Rel-17 gNB may want to use the legacy repetition scheme or may not have the ability of the CovEnh ennhancement, most of the companies think that Rel-17 gNB should not be forced to use the CovEnh enhancement function, even if the UE is capable of it.

And the second aspect discussed was whether two enhancements can be applied at the same time.

The following proposals were provided by FL which covered the above two aspects, and were discussed in GTW session.

* Rel-17 supports the configurability of “the counting based on available slots” function.
* Rel-17 supports the configuration enabling “the increased maximum number of repetitions”.
* FFS: whether to support only one of the two functions at the same time or simultaneous use of the two functions by a single UE capable of both functions.

However, no consensus was made in GTW session, and it was suggested more focusing on the functions themselves rather than configurations of the functions. After the GTW, the above proposals were reformulated as below and then companies’ views on them were collected again for further discussions.

* “The counting based on available slots” is enabled via RRC signaling. If not enabled, the Rel-17 UE uses “the counting based on physical slots” (i.e. the same repetition counting as in Rel15/16).
* Rel-17 RRC parameter(s) relating to “the increased maximum number of repetitions” is provided via RRC signaling to a UE which performs PUSCH repetitions with “the increased maximum number of repetitions”. If not provided, the UE performs PUSCH repetitions subject to Rel-15/16 configuration.
* FFS:
  + Alt 1: A single UE can be configured with both “the counting based on available slots” and the Rel-17 RRC parameter(s) relating to “the increased maximum number of repetitions” at the same time.
    - Support: CATT, OPPO, ZTE, Xiaomi
  + Alt 2: A single UE can be configured with only one of “the counting based on available slots” and the Rel-17 RRC parameter(s) relating to “the increased maximum number of repetitions” but not both at a given time.
    - Support: vivo, Ericsson

Support all bullets: Intel, Sharp, CMCC, Nokia/NSB, Xiaomi

Support 1st bullet, no need 2nd bullet: Qualcomm

Revisit in RAN1#106-e: Samsung, Panasonic, LG, Nokia/NSB

Companies’ views according to the contributions for RAN1#106-e are summarized as follows.

* A single UE can be configured with both “the counting based on available slots” and the Rel-17 RRC parameter(s) relating to “the increased maximum number of repetitions” at the same time.
  + ZTE [4]
* One of three options (legacy repetition Type A and two Rel-17 enhancements) is configured to a UE
  + Ericsson [16]
* The enhancements are always tied to each other and are always enabled/disabled at the same time.
  + Nokia/Nokia Shanghai Bell [3], Panasonic [7]
* Dynamic switching between two enhancements should be supported
  + Lenovo/Motorola Mobility [11]

Looking at the proposals in companies’ contributions for this meeting, there are three alternatives in terms of configurations of two enhancements. Note that UE feature discussions for CovEnh would be done later and the discussions in this meeting should focus on configurations of enhancements and the associated behaviors.

1st round (Issue#2-12)

Companies are encouraged to provide their views on the follwoing alternatives.

* Alt 1:
  + “The counting based on available slots” is enabled via RRC signaling. If not enabled, the Rel-17 UE uses “the counting based on physical slots” (i.e. the same repetition counting as in Rel15/16).
  + Rel-17 RRC parameter(s) relating to “the increased maximum number of repetitions” is provided via RRC signaling to a UE which performs PUSCH repetitions with “the increased maximum number of repetitions”. If not provided, the UE performs PUSCH repetitions subject to Rel-15/16 configuration.
* Alt 2:
  + A single Rel-17 RRC parameter enabling both “The counting based on available slots” and “the increased maximum number of repetitions” is introduced. If not enabled, the Rel-17 UE uses “the counting based on physical slots” (i.e. the same repetition counting as in Rel15/16) and performs up to 16 repetitions subject to existing configuration.
* Alt 3:
  + A single Rel-17 RRC parameter indicating one of the following three combinations is introduced.
    - “The counting based on physical slots” and “the existing maximum number of repetitions”
    - “The counting based on physical slots” and “the increased maximum number of repetitions”
    - “The counting based on available slots” and “the existing maximum number of repetitions”

Companies are encouraged also to provide their views on whether to support dynamic switching between the counting based on available slots and the couning based on physical slots.

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| **Company** | **Comments** |
| vivo | Support Alt 1. |
| Apple | Alt 3 is preferred. The “the existing maximum number of repetitions” can be removed from third sub-bullet, due to no repetition was agreed in Rel.16 for available slot counting. |
| Ericsson | Alt 3 is preferred though we want to include some details to make sure our understanding of the proposal is correct.  In our understanding, in Rel-17 we will have 3 types of Type A PUSCH repetitions:   * + - Repetition Type A0 (legacy):       * “The counting based on physical slots” and “the existing maximum number of repetitions” will use the RRC configured legacy TDRA list which is already in the specification     - Repetition Type A1:       * “The counting based on physical slots” and “the increased maximum number of repetitions” is the function 1 which requires RRC configured new TDRA list with increase number of repetitions for backward compatibility     - Repetition Type A2:       * “The counting based on available slots” and “the existing maximum number of repetitions” is the function 2 which will reuse legacy RRC configured TDRA list though the repetitions should be counted based on available slot.   In Rel-17, whether Type A or Type B is selected is based on RRC signaling *pusch-RepTypeIndicatorDCI-0-x-r16*, if Type A is selected, UE will determine whether Type A0/A1/A2 is used can be based on another *pusch-RepTypeIndicatorDCI-0-x-r17* signaling corresponding to related DCI format in Rel-17, see below example RRC signaling.  PUSCH-Config ::= SEQUENCE {  …  pusch-RepTypeIndicatorDCI-0-2-r16 ENUMERATED { pusch-RepTypeA, pusch-RepTypeB} OPTIONAL, -- Need R  pusch-RepTypeIndicatorDCI-0-1-r16 ENUMERATED { pusch-RepTypeA, pusch-RepTypeB} OPTIONAL, -- Need R  pusch-RepTypeIndicatorDCI-0-1-r17 ENUMERATED { pusch-RepTypeA0, pusch-RepTypeA1, pusch-RepTypeA2} OPTIONAL, -- Cond RepTypeA  pusch-RepTypeIndicatorDCI-0-2-r17 ENUMERATED { pusch-RepTypeA0, pusch-RepTypeA1, pusch-RepTypeA2} OPTIONAL, -- Cond RepTypeA  …  }  It should also be fine that we define type A0 as a default repetition type if the *pusch-RepTypeIndicatorDCI-0-x-r17* is not present, meaning that there will be only 2 values (Type A1 and A2) for this Rel-17 repetition type signaling (in this case, is it Alt 1?). |
| Nokia/NSB | Alt. 2. We support a unified solution in Rel-17 since the whole point of having two counting approaches is unclear to us. If increasing the maximum number of repetitions for counting on consecutive physical slots appears to be an acceptable solution for everyone, why don’t we simply use only that counting approach and introduce even a higher maximum number of repetitions? This would result in the same number of actual repetitions as counting on available slots with a limited maximum number of repetitions. |
| Intel | We support Alt. 1. It does not necessarily combine these two features for PUSCH coverage enhancement. |
| Lenovo, Motorola Mobility | We support Alt 2, but would like to clarify following:  Basically, the RRC parameter enables whether Rel-17 behavior is applied or not. Then if Rel-17 behavior is applied based on the enabling of this RRC parameter, the UE applies counting based on available slots if max repetitions is 16 or less, otherwise UE applies counting based on physical slots. |
| Qualcomm | Dynamic switching between counting methods is not required.  Alt 1 is closest to what we would prefer. Same thoughts as Intel. |
| Samsung | This is pending to a previous discussion on whether to allow the use of increased maximum number of repetitions with the counting of available slots. It can be discussed afterwards. |
| Panasonic | Our preference is Alt.2 since single UE function would better to avoid fragmentation of the market. If both are each enhancement is separate UE feature, we assume UE would implement only “the increased maximum number of repetitions” as it would not have so much incentive to implement “the counting based on available slots” for UE side because of the complexity.  Although our preference is Alt.2, we are open to have separate UE functions (i.e., Alt.1 or Alt.3).  We don’t think dynamic switching is necessary. |
| ZTE | Suggest discussing this issue after concluding on Issue 1. |
| FL | @Proponents of Alt2 (e.g. Nokia/NSB, Lenovo, Motorola Mobility, Panasonic)  According to the following agreement in RAN1#105-e, Rel-17 supports the combination between “32 repetitions” and “counting based on physical slots”, irrespective of whether Alt 1 or Alt 2 is agreed. Could you clarify how this combination is achieved with Alt 2?   |  | | --- | | Agreement:   * Down-selection in RAN1#106-e: * Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method, * Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots. | |
| CATT | We think this issue depends on the outcome of issue#1-1. |
| NTT DOCOMO | We support Alt.1. These features are independent, so that they can be configured separately. |
| CMCC | Both Alt1 and Alt 2 are fine with us.  The Alt 2 integrate both function into one configuration.  The Alt 3 is too complicated. Whether support the increased maximum repetition number could be realized through the configuration of the maximum number of 16 or 32. |
| OPPO | We want to clarify whether the two RRC parameters can be configured at the same time for Alt1. |
| Xiaomi | We prefer alt 1. |
| Huawei/HiSilicon | This topic should be discussed after issue#1-1 is resolved, because the proposal has already implied that 32 repetition number would have been agreed for the counting based on available slots. |
| NEC | Support alt1. |
| Sharp | We prefer alt 1. |
| Rakuten Mobile | We support Alt 1 but share same opinion with OPPO. It needs to clarify whether both configurations can be provided at the same time. |
| Nokia/NSB2 | @FL: Our understanding on “The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method” is that “irrespective of counting method” doesn’t mean “counting based on physical slots” is also enhanced in Rel-17. It simply means that the value “32” is adopted and the counting method is resolved later. |

1st round summary(Issue#2-12)

Companies’ views according to their inputs during the 1st round discussion are summarized as follows.

* Alt 1:
  + “The counting based on available slots” is enabled via RRC signaling. If not enabled, the Rel-17 UE uses “the counting based on physical slots” (i.e. the same repetition counting as in Rel15/16).
  + Rel-17 RRC parameter(s) relating to “the increased maximum number of repetitions” is provided via RRC signaling to a UE which performs PUSCH repetitions with “the increased maximum number of repetitions”. If not provided, the UE performs PUSCH repetitions subject to Rel-15/16 configuration.
  + Support (9 companies): vivo, Intel, Qualcomm, NTT DOCOMO, CMCC, Xiaomi, NEC, Sharp, Rakuten Mobile
* Alt 2:
  + A single Rel-17 RRC parameter enabling both “The counting based on available slots” and “the increased maximum number of repetitions” is introduced. If not enabled, the Rel-17 UE uses “the counting based on physical slots” (i.e. the same repetition counting as in Rel15/16) and performs up to 16 repetitions subject to existing configuration.
  + Support (6 companies): Nokia/NSB, Lenovo/Motorola Mobility, Panasonic, CMCC
* Alt 3:
  + A single Rel-17 RRC parameter indicating one of the following three combinations is introduced.
    - “The counting based on physical slots” and “the existing maximum number of repetitions”
    - “The counting based on physical slots” and “the increased maximum number of repetitions”
    - “The counting based on available slots” and “the existing maximum number of repetitions”
  + Support (2 companies): Apple, Ericsson
* Discuss later
  + (3 companies): Samsung, ZTE, CATT
* Need clarification on whether two configurations can be enabled at the same time
  + (4 companies): OPPO, Huawei/HiSilicon, Rakuten Mobile

FL recommendation on Issue#2-11:

* Discuss after concluding Issue#1-1.

# References

1. R1-2106495 Discussion on coverage enhancements for PUSCH repetition type A Huawei, HiSilicon
2. R1-2106611 Discussion on enhancement for PUSCH repetition type A vivo
3. R1-2106655 Enhancements on PUSCH repetition type A Nokia, Nokia Shanghai Bell
4. R1-2106739 Discussion on enhanced PUSCH repetition type A ZTE
5. R1-2106902 Enhancements on PUSCH repetition type A Samsung
6. R1-2106988 Discussion on enhancements on PUSCH repetition type A CATT
7. R1-2107116 Discussion on enhancements on PUSCH repetition Type A Panasonic Corporation
8. R1-2107121 Discussion on enhancements on PUSCH repetition type A Rakuten Mobile, Inc
9. R1-2107123 Enhancements on PUSCH repetition type A China Telecom
10. R1-2107140 Discussion on PUSCH repetition type A NEC
11. R1-2107190 Enhancements on PUSCH repetition type A Lenovo, Motorola Mobility
12. R1-2107256 Enhancements on PUSCH repetition type A OPPO
13. R1-2107359 Enhancements on PUSCH Repetition Type A Qualcomm Incorporated
14. R1-2107417 Discussion on enhancements on PUSCH repetition type A CMCC
15. R1-2107548 Discussions on PUSCH repetition type A enhancements LG Electronics
16. R1-2107559 PUSCH Repetition Type A Enhancement Ericsson
17. R1-2107602 Enhancements on PUSCH repetition type A Intel Corporation
18. R1-2107634 Design considerations for PUSCH repetition Type A Enhancements Sierra Wireless, S.A.
19. R1-2107650 Type-A PUSCH repetition for coverage enhancement InterDigital, Inc.
20. R1-2107753 Discussion on PUSCH repetition type A enhancement Apple
21. R1-2107799 Enhancements on PUSCH repetition type A Sharp
22. R1-2107872 Enhancements on PUSCH repetition type A NTT DOCOMO, INC.
23. R1-2107935 Enhancements on PUSCH repetition type A Xiaomi
24. R1-2108157 Discussion on enhancements on PUSCH repetition type A WILUS Inc.

# List of agreements

## 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

Agreements:

Rel-17 PUSCH repetition Type A supports the increase of maximum number of repetitions with repetition factors configured in a TDRA list with a row index indicated either by the configured grant configuration or by TDRA field in a DCI.

* FFS: increasing the maximum number of repetitions with repetition factor configured in *PUSCH-Config* and/or *ConfiguredGrantConfig*.

**Conclusion:**

Discuss further to select one of 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. The timeline requirement is per repetition basis.

## Agreements in RAN1#105-e

Agreement:

* RV cycling is based on available slot for the Type A PUSCH repetition enhancement with repetitions counted based on available slot in Rel-17

Agreement:

* Down-selection in RAN1#106-e:
* Alt 1: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is 32, irrespective of counting method,
* Alt 2: The maximum number of repetitions supported by Rel-17 PUSCH repetition Type A is: 32 for the counting based on physical slots; and 16 (i.e. no change from Rel-16) for the counting based on available slots.

**Conclusion:**

* The following agreement in RAN1#104-e is applied to all slots including special slots.

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| 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 |

Agreement:

In addition to {1, 2, 3, 4, 7, 8, 12, 16} and {32}, the following additional value set for repetition factor is supported in Rel-17.

* {20, 24, 28}

Agreement:

* Each available slot identified by the UE is considered as a transmission occasion for PUSCH repetition.
  + RV is cycled across transmission occasions, irrespective of whether PUSCH transmission in the transmission occasion is further omitted or not.

Agreement:

* If PUSCH symbol in a slot overlaps with flexible symbol(s) with SSB transmission, the slot is determined as not available during the counting of repetitions. As there is no PUSCH in the slot, no PUSCH omission applies to the slot.

Agreement:

Select one from the following (further refinement of the alternatives can be further discussed), for the procedure of Rel-17 PUSCH repetition Type A (other alternatives are not precluded)

* Alt 1-B consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
* Alt 1-B’ consisting of two steps
  + Step 1: Determine K repetitions based on available slots, where the available slot is the UL slot and flexible slot indicated by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*.
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
  + FFS: handling of dynamic signaling (e.g. UL CI, DCI for high priority channel), e.g., UE without CI capability
* Alt 2-A consisting of a single step
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic signaling (e.g. SFI, UL CI, DCI for high priority channel) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
* Alt 2-B consisting of two steps
  + Step 1: Determine available slots for K repetitions based on RRC configuration(s) and dynamic SFI in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
    - FFS timeline for the dynamic signalling
  + Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.

## Agreements in RAN1#106-e

Agreement:

* For Rel-17 PUSCH repetition Type A without joint channel estimation, no new inter-slot frequency hopping mechanism is introduced.

Agreement

Take Option 1-B as an agreement for the procedure of Rel-17 PUSCH repetitions counted on the basis of available slots.

* Alt 1-B consisting of two steps
* Step 1: Determine available slots for K repetitions based on RRC configuration(s) in addition to TDRA in the DCI scheduling the PUSCH, CG configuration or activation DCI
* Step 2: The UE determines whether to drop a PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules, but the PUSCH repetition is still counted in the K repetitions.
* FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)

Agreement

For PUSCH repetition Type A for Rel-17 CG-PUSCH, semi-static flexible symbol is considered as available.

Agreement

For PUSCH repetition Type A for Rel-17 DG-PUSCH, semi-static flexible symbol is considered as available.

Note: The applicability for Msg 3 is to be discussed in 8.8.3