3GPP TSG RAN WG1 #106bis-e R1-210xxxx

**e-Meeting, October 11th – 19th, 2021**

**Agenda item: 8.8.3**

**Title: Feature lead summary #2 on support of Type A PUSCH repetitions for Msg3**

**Source: Moderator (ZTE Corporation)**

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

# Introduction

One objective of the coverage enhancement WID is to specify mechanism(s) to support Type A PUSCH repetitions for Msg3. This contribution provides a summary of proposed Msg3 enhancements in contributions submitted under AI 8.8.3 and AI 8.8.4.

# Proposals for GTW discussion

# Summary of Tdocs

## Differentiation and triggering mechanisms for Msg3 repetition

In RAN1#105-e, it was agreed to use separate preamble with share ROs for requesting Msg3 repetition while other solutions are FFS.

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| Agreement:   * For requesting Msg3 PUSCH repetition, support the following:   + Use separate preamble with shared RO configured by the same PRACH configuration index with legacy UEs.     - FFS whether to introduce a PRACH mask to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition for a UE.     - FFS definition of shared RO (e.g., whether the shared RO can be an RO with preamble(s) for 4-step RACH only or with preambles for both 4-step RACH and 2-step RACH).   + FFS whether or not to additionally support one (& only one) more option:     - E.g., option 2: Use separate RO configured by a separate PRACH configuration index from legacy UEs     - E.g., Option 3: Use separate RO, which include       * the separate RO configured by a separate RACH configuration index from legacy UE, and       * the remaining RO (if any) configured, by the same PRACH configuration index with legacy UEs, that cannot be used by legacy rules for PRACH transmission. |

### [Closed] Issue#1: Additional support of using separate RO for requesting Msg3 repetition

In addition to using separate preamble, there are two additional candidate options for a UE requesting Msg3 PUSCH repetition. In this section, companies’ detailed views are summarized as follows.

**Option 2:** Use separate RO configured by a separate PRACH configuration index from legacy UEs

* Support: [5, vivo], [6, CATT], [8, Xiaomi], [10, Intel], [13, Panasonic], [16, Nokia/NSB], [17, Ericsson], [22, LG]
  + [5, vivo], [17, Ericsson]: If separate ROs are configured for requesting Msg3 repetition, RA-RNTI overlapping issues should be avoided, e.g., introduce a new RA-RNTI computation method.
* Depending on RAN2 discussion: [1, Huawei, HiSilicon], [3, Spreadtrum Communications], [4, ZTE], [8, Xiaomi], [25, Xiaomi], [12, Qualcomm]
  + [4, ZTE]: Do not support additional options (i.e., using separate RO) for requesting Msg3 repetition, unless RAN2 concludes to support with taking other features into account.
  + [8, Xiaomi], [25, Xiaomi] and [12, Qualcomm] propose to design the PRACH partitioning together with RedCap. FL’s understanding is this will be discussed in the common session in RAN2.

There are many companies pointing out that this issue is related to other Rel-17 features, which will be discussed in the common session in RAN2. That is, how to design PRACH resources partitioning for multiple Rel-17 features (SDT, CovEnh, RedCap and RAN slicing), with also taking into account the legacy features that using PRACH partitioning, i.e., selected SSB, contention mode (CFRA vs CBRA), payload size (preamble group A vs group B), random access type (2-step vs 4-step RA). **Therefore, FL suggests postponing the discussion for this issue until more progress in RAN2.**

### [Open] Issue#2: Separate RRC parameters for requesting Msg3 repetition with shared RO

### [Open] Issue#2-1: RRC parameters in RACH-ConfigCommon

In Table 1, a summary of RRC parameters in RACH-ConfigCommon for requesting Msg3 repetition with shared RO in 4-step CBRA procedure is provided. For the green highlighted parameters, RAN2 has made decision already. For the yellow highlighted ones, RAN2 explicitly asked RAN1 views based on RAN2 LS in R1-2108712. For the rest of RRC parameters, FL’s understanding is that there is no need to introduce separate Rel-17 RRC parameters for requesting Msg3 repetition with shared RO.

Table 1 RRC parameters in RACH-ConfigCommon for requesting Msg3 repetition with shared RO in 4-step CBRA procedure

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| **RRC parameters in RACH-ConfigCommon** | | **Descriptions in Rel-15/16** | **Necessity for a separate parameter in Rel-17** |
| RACH-ConfigGeneric | prach-ConfigurationIndex | PRACH configuration index | No need for shared RO |
| msg1-FDM | PRACH configuration in frequency domain | No need for shared RO |
| msg1-FrequencyStart | No need for shared RO |
| zeroCorrelationZoneConfig | N-CS configuration | No need for shared RO |
| preambleReceivedTargetPower | The target power level at the network receiver side | TBD as requested by RAN2 |
| preambleTransMax | Max number of RA preamble transmission performed before declaring a failure | TBD as requested by RAN2 |
| powerRampingStep | Power ramping steps for PRACH | TBD as requested by RAN2 |
| ra-ResponseWindow | Msg2 (RAR) window length in number of slots | No need as agreed by RAN2 |
| totalNumberOfRA-Preambles | | Total number of preambles used for CB and CF 4-step or 2-step RA defined in *RACH-ConfigCommon*, excluding preambles used for other purposes (e.g. for SI request). | No need for shared RO |
| ssb-perRACH-OccasionAndCB-PreamblesPerSSB | | The number of SSBs per RO and the number of CB preambles per SSB | No need for shared RO |
| groupBconfigured | ra-Msg3SizeGroupA | Random access preamble Group B related parameters | TBD as requested by RAN2 |
| messagePowerOffsetGroupB |
| numberOfRA-PreamblesGroupA |
| ra-ContentionResolutionTimer | | The initial value for the contention resolution timer | No need as agreed by RAN2 |
| rsrp-ThresholdSSB | | RSRP threshold for SSB selection | No need for shared RO |
| rsrp-ThresholdSSB-SUL | | An RSRP threshold for the selection between the NUL carrier and the SUL carrier | No need for shared RO |
| prach-RootSequenceIndex | | PRACH root sequence index | No need for shared RO |
| msg1-SubcarrierSpacing | | Subcarrier spacing of PRACH | No need for shared RO |
| restrictedSetConfig | | Configuration of an unrestricted set or one of two types of restricted sets | No need for shared RO |
| msg3-transformPrecoder | | Enabling of the transform precoder for Msg3 transmission | No need for shared RO |

#### First round

Based on above summary, FL would like to collect companies’ views about the following question.

**Q1: Except for the following RRC parameters related to the LS from RAN2, do you agree that, from RAN1 perspective, there is no need to separately configure other legacy RACH parameters configured in *RACH-ConfigCommon* for requesting Msg3 PUSCH repetition with shared RO?**

* + preambleReceivedTargetPower
  + preambleTransMax
  + powerRampingStep
  + ra-Msg3SizeGroupA
  + messagePowerOffsetGroupB
  + numberOfRA-PreamblesGroupA

Note that, FL suggests to discuss above parameters under the email thread for the rely LS to RAN2.

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| **Company** | **Comments** |
| LG | We agree that there is no need to separately configure other legacy RACH parameters for requesting Msg3 PUSCH repetition with shared RO. Also, we are fine with FL’s suggestion to discuss some parameters under email thread for discussing reply LS to RAN2. |
| Intel | We are fine with the first three parameters to be reused from the legacy RACH parameters.  For the last three parameters related to group B, we have not made decision whether to support this or not for requesting Msg3 repetition. We suggest to defer the discussion once the conclusion is made for this.  From our understanding, configuration of random access preamble Group B with Msg3 repetition may not be needed. This is because Msg3 PUSCH repetition is mainly targeted for cell edge UEs. In this case, it is not expected that relatively large payload size is carried by Msg3 PUSCH with repetition. |
| Sharp | We are OK with FL proposal. |
| vivo | Not sure for rsrp-ThresholdSSB.  For legacy 4 step CBRA, UE may select SSB, whose RSRP is higher than rsrp-ThresholdSSB, to initiate a RACH attempt. And considering RAN2 have already agreed that ‘A separate RSRP threshold is introduced for requesting Msg3 repetition’, a separated parameter ‘rsrp-ThresholdSSB-Msg3Repetition’ maybe needed to ensure UE to select proper SSB to initiate RACH procedure with Msg3 repetition, i.e., UE should select SSB whose RSRP is above this threshold, if any, to initiate RACH attempt with requesting Msg3 repetition. |
| Panasonic | We are the similar view with vivo. Separate parameter may be needed for rsrp-ThresholdSSB. |
| CATT | We understand that separate RACH parameters may brought flexibility, but such parameters are not essential or necessary for Msg3 repetition. |
| Samsung | For shared RO, how to determine the preamble set for RACH with msg3 repetition? Two parameters for the starting position and the number of preambles to be used should be introduced. |
| Nokia/NSB | Agree with vivo and Panasonic. If a new parameter is not considered, number of UEs requesting msg3 repetitions may cause scalability issues.  Concerning the last 3 parameters in the list in Q1, we fully agree with Intel. Random access preamble Group B with Msg3 repetition already requires a measured received power that is above what could be experienced by a coverage constrained device. The logic in this case would be similar to the logic we used to exclude 2SR from optimizations targeting CovEnh: we should focus on practically relevant use cases and RA preamble Group B with Msg3 is not relevant in the context of coverage shortage. |
| NTT DOCOMO | Separate  *preambleTransMax* should be configured for UE requesting Msg3 repetition. Only RSRP has been defined as a condition to request Msg3 repetitions so far. However, it could be difficult to estimate the uplink channel quality based on only RSRP of the downlink pathloss reference. To solve that, the number of Msg1 attempts should be referred as additional condition to request Msg3 repetitions, where the threshold to fallback Msg1 requesting Msg3 repetition from non-request is *preambleTransMax*. |
| Xiaomi | For *rsrp-ThresholdSSB*, we share the same view as vivo. The RSRP threshold for SSB selection of CE UEs can be smaller to ensure CE UEs obtain more accurate DL beam direction at cell edge.  Since supplementary uplink carrier transmission is an optional feature for uplink coverage enhancement, the relationship between PUSCH repetition type A for Msg.3 and supplementary uplink carrier tx should be clarified. And, whether a separate parameter *rsrp-ThresholdSSB-SUL* is needed for msg.3 repetition should be further studied. |
| ZTE | Agree with other companies, separately configure rsrp-ThresholdSSB and rsrp-ThresholdSSB-SUL could be potentially useful, and we are fine to leave to RAN2 for decision. |
| Ericsson1 | Regarding *rsrp-ThresholdSSB* for SSB selection so that a corresponding PRACH resource is selected, we have following understandings*.*  When Msg3 repetition is supported in a cell with ROs configured for transmission of preambles for requesting Msg3 repetition and legacy PRACH preambles, there will be 2 steps of selecting PRACH resources:   * one step is to decide whether SSB is **above** a *rsrp-ThresholdSSB* value so that a SSB will be selected, and the preambles mapped to the selected SSB will be considered for PRACH transmission * another step is to check whether the RSRP of the downlink pathloss reference is **lower** than an RSRP threshold so that whether the preamble set for requesting msg3 repetition or the legacy preamble set will be determined   RAN2 needs to decide whether SSB selection is performed first, or preamble set selection should be performed first.  If the preamble set selection is performed first, a separate *rsrp-ThresholdSSB* may be preferred as the RSRP threshold for checking whether to use the preamble resource set for requesting Msg3 repetition should be larger than the *rsrp-ThresholdSSB* specific for RA with Msg3 repetition.  If the SSB selection is performed first, an additional *rsrp-ThresholdSSB* specific for RA with Msg3 repetition may still be preferred so that a loose SSB RSRP condition (for requesting msg3 repetition) can be allowed for SSB selection.  According to above, we also think a separate *rsrp-ThresholdSSB* is needed for RA with Msg3 repetition requested. |
| Huawei, HiSilicon | Firstly, the proposal should be clarified with that “For a given UL”, in order not to couple with the discussion of reply LS.  It seems separate RACH parameters doesn’t bring performance gain for Msg3. So, we don’t prefer introducing separate RACH parameters, e.g. preambleReceivedTargetPower, preambleTransMax, powerRampingStep.  Additionally, we also don’t support introducing last three parameters related to group B. For coverage limited UE, the large payload carried by Msg3 PUSCH needs more transmission PRBs and/or higher MCS, which results in performance degradation. So, the payload carried by Msg3 PUSCH should not be very large.  Finally, a general clarification is suggested to FL. This discussion is specific to RRC parameters, it could overlap with the discussion of the RRC-specific email thread. It is OK for us to take either email thread to discuss such RRC parameter issue. But if any plan to avoid any overlapping discussion, it is appreciated that FL could share it a bit. |
| Qualcomm | We think separate parameters for rsrp-ThresholdSSB and preambleTransMax can be useful. |
| FL | @ Intel, Nokia/NSB, NTT, Huawei, HiSilicon, The listed parameters in the question will be discussed in the email thread for reply LS to RAN2. Here, we are only discussing other parameters.  @ Samsung, Here, the question is only for ‘**legacy RACH parameters configured in *RACH-ConfigCommon***’. The parameters you mentioned are discussed in Issue 2-3.  @vivo, Panasonic, Nokia/NSB, Xiaomi, Ericsson, Qualcomm. From FL perspective, I can understand it might be potentially beneficial to separately introduce rsrp-ThresholdSSB and rsrp-ThresholdSSB-SUL if Msg3 PUSCH repetition is supported on SUL. However, the threshold issues are under discussion in RAN2, and it could be better to leave to RAN2 decision.  @Huawei, HiSilicon, For your first comment, I added ‘on a given carrier’ to address your concern.  Regarding your last comment, my intention is:   1. discuss RRC parameters directly related to RAN2 LS in the email thread for the reply LS 2. discuss RRC parameters for request of Msg3 repetition other than 1) in this email thread. It expects some GTW discussion is needed. 3. discuss the relatively stable RRC parameters in the email thread specific for RRC, where it will mainly focus on the detailed RRC structure. No GTW discussion is expected. |

**Proposal for Issue#2-1: Include the following into the reply LS to R1-2108712(R2-2109195).**

* **From RAN1 perspective, there is no need to separately configure the following legacy RACH parameters configured in *RACH-ConfigCommon* for requesting Msg3 PUSCH repetition with shared RO on a given carrier.**
* ***prach-ConfigurationIndex***
* ***msg1-FDM***
* ***msg1-FrequencyStart***
* ***zeroCorrelationZoneConfig***
* ***totalNumberOfRA-Preambles***
* ***ssb-perRACH-OccasionAndCB-PreamblesPerSSB***
* ***rsrp-ThresholdSSB***
* ***rsrp-ThresholdSSB-SUL***
* ***prach-RootSequenceIndex***
* ***msg1-SubcarrierSpacing***
* ***restrictedSetConfig***
* ***msg3-transformPrecoder***
* **From RAN1 perspective, it may or may not need to separately configure *rsrp-ThresholdSSB* and *rsrp-ThresholdSSB-SUL* (if Msg3 PUSCH repetition is supported on SUL) for requesting Msg3 PUSCH repetition with shared RO on a given carrier, and it’s up to RAN2 for final decision.**

**Please provide your comment below only if you have strong concerns.**

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| **Company** | **Comments** |
| LG | In general, we are fine with the FL’s proposal for Issue#2-1.  However, we are still doubting whether operating Msg3 PUSCH repetition on SUL is necessary. |
| Sharp | Shouldn’t we delete “***rsrp-ThresholdSSB***”, “***rsrp-ThresholdSSB-SUL***” under the first bullet? |
| Panasonic | We agree to Sharp’s comment. Considering 2nd bullet, *rsrp-ThresholdSSB* and *resp-ThresholdSSB-SUL* should be removed in the list of first bullet. |
| Xiaomi | We share the same view as Sharp and Panasonic. |
| Nokia/NSB | We understand the spirit of the proposal, however we find it very loose. We think that RAN2 can only appreciate if RAN1 provides guidance on whether separate *rsrp-ThresholdSSB* and *resp-ThresholdSSB-SUL* are needed for Msg3 repetition. After all, this is about physical aspects of the channel, i.e., the received power, which are directly mapped to coverage conditions, which in turn entail the need (or not) for Msg3 repetitions. We are rather puzzled by the decision. RAN2 should discuss the structure of the signaling, depending on indications received by RAN1. Otherwise, what is the point of discussing aspects of *rsrp-ThresholdSSB* and *resp-ThresholdSSB-SUL* in the first place? |
| CATT | Fine and agree with Sharp, Panasonic and Xiaomi. |
| Ericsson2 | At least *CB-PreamblesPerSSB* may be needed to determine the number of preambles per SSB for requesting msg3 repetition, so it should be excluded from the list in our understanding.  Regarding *rsrp-ThresholdSSB* and *rsrp-ThresholdSSB-SUL*, as we commented in RRC mail discussions, isn’t *rsrp-ThresholdSSB-SUL* a redundant parameter since *rsrp-ThresholdSSB* will also be configured in the BWP (*RACH-ConfigCommon* will be included in the SUL initial UL BWP) for SUL? These signaling optimizations should be discussed by RAN2 though we also think for NUL and SUL, different threshold values of should be able to be configured from RAN1 perspective. |
| Intel | Agree with Sharp.  We have separate discussion in another thread. Suggest to discuss the support of SUL in that thread. |
| Apple | Support FL’s proposal: although we prefer to remove the last sub-bullet, as in our view no need to have new/separate threshold for SUL. In our view: there is one threshold for SSB selection (same as legacy), there is a new/separate threshold for repetition demand on NUL, there is a legacy threshold for SUL selection. If a UE (capable/not capable to support Msg3 repetition) cannot achieve RSRP (with/without repetition) on NUL, it will select NUL. |
| FL | Indeed, there is no need to separately configure rsrp-ThresholdSSB-SUL, which is used for selection of NUL and SUL. rsrp-ThresholdSSB is used for SSB selection which can be already configured differently for NUL and SUL based on current signaling.  @Ericsson2, ssb-perRACH-OccasionAndCB-PreamblesPerSSB also configures the association of SSB and RO, which doesn’t need to be separately configured. So, I would like to keep this in the list, while introduce a new RRC parameter (instead of simply separately configure a legacy one) for the number of preambles per SSB as discussed in Issue#2-3 and also its detailed structure in the email thread for RRC.  As for the need of separately configuring rsrp-ThresholdSSB, let’s further discuss in the next round.  **Proposal-v1 for Issue#2-1: Include the following into the reply LS to R1-2108712(R2-2109195).**   * **From RAN1 perspective, there is no need to separately configure the following legacy RACH parameters configured in *RACH-ConfigCommon* for requesting Msg3 PUSCH repetition with shared RO on a given carrier.** * ***prach-ConfigurationIndex*** * ***msg1-FDM*** * ***msg1-FrequencyStart*** * ***zeroCorrelationZoneConfig*** * ***totalNumberOfRA-Preambles*** * ***ssb-perRACH-OccasionAndCB-PreamblesPerSSB*** * ***~~rsrp-ThresholdSSB~~*** * ***rsrp-ThresholdSSB-SUL*** * ***prach-RootSequenceIndex*** * ***msg1-SubcarrierSpacing*** * ***restrictedSetConfig*** * ***msg3-transformPrecoder*** * **~~From RAN1 perspective, it may or may not need to separately configure~~ *~~rsrp-ThresholdSSB~~* ~~and~~ *~~rsrp-ThresholdSSB-SUL~~* ~~(if Msg3 PUSCH repetition is supported on SUL) for requesting Msg3 PUSCH repetition with shared RO on a given carrier, and it’s up to RAN2 for final decision.~~** |
| FL | The following has been agreed in GTW session.  **Agreement**  **Include the following into the reply LS to** [**R1-2108712**](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106b-e\Docs\R1-2108712.zip)**(R2-2109195).**   * **From RAN1 perspective, there is no need to separately configure the following legacy RACH parameters configured in *RACH-ConfigCommon* for requesting Msg3 PUSCH repetition with shared RO on a given UL carrier.** * ***prach-ConfigurationIndex*** * ***msg1-FDM*** * ***msg1-FrequencyStart*** * ***zeroCorrelationZoneConfig*** * ***totalNumberOfRA-Preambles*** * ***ssb-perRACH-OccasionAndCB-PreamblesPerSSB*** * ***FFS: rsrp-ThresholdSSB*** * ***rsrp-ThresholdSSB-SUL*** * ***prach-RootSequenceIndex*** * ***msg1-SubcarrierSpacing*** * ***restrictedSetConfig*** * ***msg3-transformPrecoder*** |

#### Second round

In the first round discussion, six companies (vivo, Panasonic, Nokia/NSB, Xiaomi, Ericsson, Qualcomm) think it is necessary to separately configure RRC parameter rsrp-ThresholdSSB, e.g., the comments from Ericsson copied below.

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| When Msg3 repetition is supported in a cell with ROs configured for transmission of preambles for requesting Msg3 repetition and legacy PRACH preambles, there will be 2 steps of selecting PRACH resources:   * one step is to decide whether SSB is **above** a *rsrp-ThresholdSSB* value so that a SSB will be selected, and the preambles mapped to the selected SSB will be considered for PRACH transmission * another step is to check whether the RSRP of the downlink pathloss reference is **lower** than an RSRP threshold so that whether the preamble set for requesting msg3 repetition or the legacy preamble set will be determined   RAN2 needs to decide whether SSB selection is performed first, or preamble set selection should be performed first.  If the preamble set selection is performed first, a separate *rsrp-ThresholdSSB* may be preferred as the RSRP threshold for checking whether to use the preamble resource set for requesting Msg3 repetition should be larger than the *rsrp-ThresholdSSB* specific for RA with Msg3 repetition.  If the SSB selection is performed first, an additional *rsrp-ThresholdSSB* specific for RA with Msg3 repetition may still be preferred so that a loose SSB RSRP condition (for requesting msg3 repetition) can be allowed for SSB selection. |

Thus, FL would like to check whether all companies see the necessity/benefits to separately configure RRC parameter rsrp-ThresholdSSB. As this is only to provide RAN1 understanding to RAN2, it could be sufficient to keep it in a general manner without adding too much details.

**Proposal 2 for Issue 2-1: Include the following into the reply LS to R1-2108712(R2-2109195)**

* **From RAN1 perspective, it can be beneficial to separately configure *rsrp-ThresholdSSB* for requesting Msg3 PUSCH repetition with shared RO on a given UL carrier.**

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| **Company** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| Nokia/NSB | Support the proposal. However, we wonder if we shouldn’t also at least say if such threshold is lower or higher than the legacy one. |
| Intel | We are fine with the proposal. We thought this was already agreed in RAN2. Do we need to add this to LS reply?   * A separate RSRP threshold is introduced for requesting Msg3 repetition |
| Panasonic | We support the proposal. |
| Ericsson3 | Fine. |
| vivo | Support the proposal.  We also notice the agreement made by RAN2 quoted by intel. However, the agreement is not clear to us. In our understanding, the RAN2 agreement means, only when the RSRP is lower than certain threshold, UE can request Msg3 repetition.  While intention of proposal 2 is, it may be beneficial to have another RSRP threshold, when UE initiate RACH attempt with Msg3 repetition, UE should select a SSB whose RSRP is higher than this threshold, to ensure UE select the proper SSB to request Msg3 repetition.  It seems no harm to provide this information to RAN2. |
| OPPO | We support the proposal. |
| LG | Supportive. |
| Sharp | We are fine with FL proposal. |

### [Open] Issue#2-2: Support of a PRACH mask (i.e., *msgA-SSB-SharedRO-MaskIndex*)

In addition to RRC parameters in *RACH-ConfigCommon*, some companies propose to introduce a PRACH mask (i.e., similar parameter as *msgA-SSB-SharedRO-MaskIndex*that introduced for 2-step RACH in Rel-16) to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition for a UE.

* Support: [4, ZTE], [8, Xiaomi]*,*[10, Intel], [13, Panasonic], [14, Samsung], [18, Sharp], [23, WILUS]
  + The main motivation includes:
    - Similar to 2-step RACH, it offers more flexibility for the NW for RACH resources allocation depending on the number of UEs requiring 2-step RACH.
    - There are other Rel-17 features also needs separate preambles for differentiation. If most of the features (including both Rel-16 and Rel-17 features) are supported at the same time for a given UE, there may be no sufficient preambles in one RO. Thus, support separate preambles for one Rel-17 feature only in a sub-set of ROs could save the needed separate PRACH preambles.
* Not support: [6, CATT], [16, Nokia/NSB]
* Postponed until RAN2 concludes the design for PRACH resources partitioning for multiple Rel-17 features: [1, Huawei, HiSilicon]

#### First round

FL’s understanding is, though it also depends on PRACH partitioning under discussion in the common session in RAN2, it would be better to inform RAN2 about our RAN1 views on support of this parameter, based on the following agreements in RAN2.

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| **Agreements:**  Preamble partitioning is defined on a feature and/or feature combination basis. FFS on signalling. 2step RA and CE is excluded, if RAN1 decided to exclude  A common RRC CR capturing the signalling framework for RACH resource configuration across all the WIs should be used and this CR should be maintained as part of the common RACH agenda item. Each WI is expected to provide the necessary parameters to include in the signalling. |

Therefore, FL suggests to discuss the following proposal:

**Proposal for Issue#2-2: Inform RAN2 that RAN1 thinks it is beneficial to introduce a PRACH mask to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition for a UE. It’s up to RAN2 to decide whether to finally introduce the PRACH mask or not.**

Note: The intention is to include above text within the reply LS for RAN2 LS in R1-2108712

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| **Company** | **Comments** |
| LG | We do not support proposal for issue#2-2.  We think that introducing PRACH mask is kind of further optimization for RACH resource utilization. In addition, it would be better to wait a conclusion of RAN2 discussion regarding RACH resource partitioning for utilizing CE, SDT, Redcap. |
| Intel | We are fine with the proposal in principle. We suggest to update the proposal as  “**requesting Msg3 repetition with shared RO for a UE**” |
| Sharp | We are OK with FL proposal. |
| vivo | Agree with LG. |
| Panasonic | We are fine with the FL proposal. |
| CATT | We do not support the proposal.  ROs shared between legacy UE and coverage enhancement UE, which has impact on the capacity of random access for legacy UE. The purpose of the PRACH mask is to reduce the impact by using fewer shared ROs. However, PRACH mask can only be acknowledged by CE-capable UEs in Rel-17. A legacy UE is unable to distinguish whether a selected RO is included in the PRACH mask or not. The PRACH mask does not help to improve the capacity of legacy UE. |
| Samsung | Our preference is to conclude in RAN1 to support. But we can live with FL’s proposal and also fine with intel’s revision.  To LGE and vivo, the PRACH mask is not purely a “nice” thing to have, similar to what happened with 2step RACH, the number of UE to be conducted msg3 repetition is unclear, this PRACH mask is essential for gNB to control the resources used for that purpose. |
| Nokia/NSB | As explained by CATT, PRACH mask would be usable only by Rel-17 CE, hence it would have the effect to reduce the number of ROs CE UEs could use to request Msg3. Not only this would not help increasing capacity for legacy UE, but would also reduce capacity for CE UEs, i.e., more collisions would be observed for the latter. Additionally, it should be noted that up to 8 ROs can be FDMed in FR1. The application of a mask in this context would then reduce frequency diversity for CE UEs, which “not so coincidentally” would be the ones needing frequency diversity the most. Please note that, for instance, this would not apply to 2SR UEs, which by definition are UEs in good coverage conditions. We do not support the introduction of the PRACH mask for CE UEs (while we think RAN2 should be completely free to decide whether masks are needed for other features making use of PRACH resources, such as SDT, Redcap etc.) |
| NEC | Support the proposal. We think PRACH mask for msg3 repetition has some benefit to preamble utilization. As we know, 2-step RACH supports PRACH mask, and if msg3 repetition also supports PRACH mask and PRACH mask for 2-step RACH and msg3 repetition are configured complementary, then higher preamble utilization can be achieved. |
| Xiaomi | We share the same view as Samsung. |
| ZTE | We have the same view as Samsung.  @Nokia. Our understanding is it would not increase collisions or reduce frequency diversity for CE UEs. Because, it’s fully under control by gNB. If there is only few CE UEs in the cell, gNB could configure few preambles only in some of ROs for Msg3 repetition, and in such case gNB could configure more preambles in the rest of ROs for other Rel-17 features. It can provide more flexibility for gNB configuration. |
| Ericsson1 | We’re fine to agree on introducing a PRACH mask so that a subset of ROs will be used by this CE feature and other ROs can be used by other feature combinations. But whether such mask should be per SSB index per SSB to RO mapping cycle can be up to RAN2 to decide when a unified solution is identified by RAN2. |
| Qualcomm | We are fine with the proposal |
| FL | Support: Intel, Sharp, vivo, Panasonic, Samsung, NEC, Xiaomi, ZTE, Ericsson, Qualcomm  Not support: LG, CATT, Nokia/NSB  @ All, It should be clear that introduction of a PRACH mask would provide more flexibility for gNB to control the PRACH resources allocated to Msg3 repetition, though companies may have different understanding on the necessity for such optimization. In such case, FL would like to check whether the following compromised proposal could be acceptable for all companies. |

**Proposal-v1 for Issue#2-2: Include the following into the reply LS to R1-2108712(R2-2109195).**

* **RAN1 thinks it could provide network for flexibility for PRACH configuration for Msg3 repetition by introducing a PRACH mask to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition with shared RO for a UE. However, RAN1 has no consensus to introduce the PRACH mask and it’s up to RAN2 for final decision.**

**Please provide your comment below only if you have strong concerns.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | In the proposal-v1 for Issue#2-2, the preceding sentence only states that introducing the PRACH mask is beneficial. Obvious disadvantages mentioned by Nokia should be added also in that sentence. We suggest to update the proposal as   * **RAN1 thinks it could provide network for flexibility for PRACH configuration for Msg3 repetition, and RAN1 also thinks it could result in more collisions for CE UE if limited number of RO for msg3 repetition are designated by introducing a PRACH mask to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition with shared RO for a UE. ~~However,~~ RAN1 has no consensus to introduce the PRACH mask and it’s up to RAN2 for final decision.** |
| Nokia/NSB | From our perspective, it is undeniable that adding a PRACH mask has beneficial and detrimental effects, which may change depending on which application makes use of them. We keep our position in this sense. Furthermore, it should be noted that that argued benefit in terms of flexibility increase in base on the assumption that NW is always able to know how many CE UEs are in the cell. This is a wrong assumption, since:   1. It is not always possible in general, since NW will never know how many CE UEs have not attempted initial access yet. 2. It is **never** possible, if we do not agree that Msg3 repetition capability is reported after successful RRC connection establishment.   It is not about preferences but about facts. We ask facts to be captured by RAN1.  Furthermore, it is worth repeating that a PRACH mask for 2SR (or possible for RedCap, or SDT) has different benefit/cost trade off as compared to PRACH mask for Msg3 repetition request.  We ask to write the proposal in such a way that benefits and costs are properly described, for completeness. RAN2 should have a **clear and non-ambiguous reply** to work on, not just a reply which captures only half of the story. Suggest the following modification, based on what companies have said so far, and including the structure “whether … or not” in all bullets for fairness (the list can be updated):  **RAN1 thinks that introducing a PRACH mask, to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition with shared RO for a UE, could have both beneficial and detrimental effects. Beneficial effects are:**   * **Flexibility for PRACH configuration for Msg3 repetition, to control the PRACH resources allocated to Msg3 repetition, depending on whether NW knows the exact number of CE UEs in the cell or not.**   **Detrimental effects are:**   * **Frequency diversity reduction for CE UEs, depending on whether more than 1 RO is FDMS per OFDM symbol or not.** * **Capacity reduction for CE UEs, which in turn can increase number of collisions, depending on whether limited number of RO for Msg3 repetition are designated by the mask, to preserve capacity of non-CE UEs, or not.**   **No consensus exists in RAN1 to introduce the PRACH mask and it’s up to RAN2 for final decision.** |
| Samsung | This updated proposal is even weaker than previous, but we can live with it.  **Proposal-v1 for Issue#2-2: Include the following into the reply LS to R1-2108712(R2-2109195).**   * **RAN1 thinks it could provide network ~~for~~ flexibility for PRACH configuration for Msg3 repetition by introducing a PRACH mask to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition with shared RO for a UE. However, RAN1 ~~has no consensus~~ needs RAN2 confirmation to introduce the PRACH mask ~~and it’s up to RAN2 for final decision~~.** |
| CATT | Thanks FL for the effort.  But we really don’t see it helpful to introduce a RACH mask on top of current complicated RACH partitioning design in Rel-17. As explained by LG, Nokia and our previous comments, there is shortage and limitation brought by such ‘optimization’ (not essential to support Msg3 repetition).  If we have to reply the LS beyond simply mentioning ‘no consensus’, the detrimental part shall also be included, as suggested by LG and Nokia.  PS: We think vivo shall be counted as ‘not support’ in the 1st round summary. |
| Ericsson2 | Fine. |
| Intel | We are fine with the proposal. |
| Apple | We share similar view as CATT/Nokia/LG, but we can live with FL’s proposal (no revision by Samsung). |
| FL | Support: Intel, Sharp, Panasonic, Samsung, NEC, Xiaomi, ZTE, Ericsson, Qualcomm, Apple  Not support: LG, CATT, Nokia/NSB, vivo, Apple  @Nokia, If frequency diversity is really important, gNB can choose not to configure a mask or a mask choosing the two edge ROs in frequency. Anyway, the mask could provide additional flexibility, and it would not cause worse diversity. Regarding collision issues, it looks reasonable if no UE capability reporting is supported, in which case NW may not know the exact the number of CE UEs |

#### Second round

From FL perspective, the following proposal reflects the current situation in a more fair manner. **If still companies cannot reach consensus, FL would deprioritize the discussion in RAN1 as this is only information for RAN2 and RAN2 will anyway discuss whether to introduce a PRACH mask or not.**

**Proposal-v2 for Issue#2-2: Include the following into the reply LS to R1-2108712(R2-2109195).**

**RAN1 thinks it could provide network flexibility for PRACH configuration for Msg3 repetition, and RAN1 also thinks it may result in more collisions for CE UEs if limited number of RO for Msg3 repetition are designated, by introducing a PRACH mask to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition with shared RO for a UE. Whether to introduce the PRACH mask is up to RAN2 for decision.**

**Please provide your comment below only if you have strong concerns.**

|  |  |
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| **Company** | **Comments** |
| Intel | Not sure whether the above information is necessary. We can simply say there is no consensus to introduce PRACH mask in RAN1. It is up to RAN2 decision to introduce.  The pros/cons are not necessary to be included in the reply LS. |
| Ericsson3 | We do not think that a PRACH mask will cause collision issues since the PRACH mask can also configure all ROs are shared when necessary.  We’re fine to not make any agreement in RAN1 and let RAN2 to decide when they try to find a unified solution for all features requiring separate PRACH resource configuration. |
| OPPO | Share similar view as Intel and Ericsson. Conclusion in RAN1 perspective may not be necessary for RAN2 further decision. |

### [Closed] Issue#2-3: Indication of preambles for shared RO

* Option 1: Explicitly indicates the preamble number and preamble starting index
  + Support: [13, Panasonic], [14, Samsung] and [18, Sharp], [22, LG]
* Option 2: Only indicates the number of preambles needed for requesting Msg3 repetition, and the preamble starting index is from the end of the preamble group for a SSB in a RO
  + Support: [14, Samsung]

[17, Ericsson]: Whether the preambles for requesting Msg3 repetition should be outside the total number of preambles configured should be discussed. A unified solution of preamble grouping should be supported for requesting Msg3 repetition as well as for indicating other new features in NR Rel-17.

#### First round

Similar as Issue#2-2, FL suggests to discuss the following proposal:

**Proposal for Issue#2-3: Inform RAN2 that RAN1 thinks at least the number of preambles per SSB for request of Msg3 repetition, i.e., *CB-PreamblesPerSSB*, is needed. It’s up to RAN2 whether to indicate the start of preamble index for request of Msg3 repetition.**

Note: The intention is to include above text within the reply LS for RAN2 LS in R1-2108712

|  |  |
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| **Company** | **Comments** |
| LG | We are fine with the FL’s proposal for Issue#2-3. |
| Intel | We are fine with the proposal in principle. We suggest to update the proposal as  “**request of Msg3 repetition with shared RO**” |
| Sharp | We are OK with FL proposal. |
| Vivo | Support. |
| Panasonic | We are fine with the FL proposal. |
| China Telecom | Support. |
| CATT | Support. |
| Samsung | This two aspects were decided by RAN1 in R15/16 RACH design, not sure why this is necessary to kick the ball to RAN2. |
| Nokia/NSB | Support. |
| NTT DOCOMO | Support the proposal. |
| NEC | We think it’s better to make decision in RAN1. Since TS38.213 has to decide the start of preamble used for msg3 repetition no matter starting signalled or not. From RAN1 perspective, it should have preference of explicit determine or implicit determine the starting position. |
| Xiaomi | We are OK with FL proposal. |
| OPPO | We are fine with FL proposal. |
| ZTE | Support |
| Ericsson1 | Agree. |
| Huawei, HiSilicon | OK. |
| Qualcomm | Fine with the proposal |
| FL | @Samsung and NEC, The situation is different compared to Rel-15/16. As you know, there is a common session in RAN2 discussing how to jointly design PRACH partitioning for all related Rel-17 features require. Depending on RAN2 discussion, it may no need to indicate the starting index similar as 2-step RACH case.  In any case, I don’t think RAN1 can make consensus on support of the starting index. We could add ‘RAN1 has no consensus to introduce the start of preamble index’ while FL thinks this is unnecessary as the current wording already implies that. |

**Proposal-v1 for Issue#2-3: Include the following into the reply LS to R1-2108712(R2-2109195).**

* **RAN1 thinks at least the number of preambles per SSB for request of Msg3 repetition, i.e., *CB-PreamblesPerSSB*, is needed. It’s up to RAN2 whether to indicate the start of preamble index for request of Msg3 repetition with shared RO.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| LG | Support. |
| Panasonic | We are fine with the proposal. |
| Xiaomi | Support. |
| Nokia/NSB | Support. |
| China Telecom | Support the FL proposal. |
| CATT | Support.  In addition, RAN2 may give a new name for the RRC IE to indicate the number of preambles per SSB for request of Msg3 repetition (not exactly the same with ***CB-PreamblesPerSSB***). It should also be up to RAN2. |
| Ericsson2 | Fine. |
| Intel | We are fine with the proposal. |
| FL | It seems the proposal is fine to companies. FL would like to suggest deleting the parameter name based on the comment from CATT. This would also align with the discussion in email discussion specific for RRC.  **Proposal-v2 for Issue#2-3: Include the following into the reply LS to R1-2108712(R2-2109195).**   * **RAN1 thinks at least the number of preambles per SSB for request of Msg3 repetition~~, i.e.,~~ *~~CB-PreamblesPerSSB~~*~~,~~ is needed. It’s up to RAN2 whether to indicate the start of preamble index for request of Msg3 repetition with shared RO.** |
| FL | The following has been agreed in GTW session.  **Agreement**  **Include the following into the reply LS to** [**R1-2108712**](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106b-e\Docs\R1-2108712.zip)**(R2-2109195).**  **RAN1 thinks at least the number of preambles per SSB per RO for request of Msg3 repetition~~, i.e.,~~ *~~CB-PreamblesPerSSB~~*~~,~~ is needed. It’s up to RAN2 whether to indicate the start of preamble index for request of Msg3 repetition with shared RO.** |

## Indication of the number of repetitions for Msg3

### [Closed] Issue#3: Candidate values for Msg3 initial/re-transmission repetitions

In RAN1#106-e, the repetition factor K = {1, 2, 4}was agreed for Msg3 repetition, and other values are FFS [4].

|  |
| --- |
| **Agreement**   * Support at least repetition factor K = {2, 4} for Msg3 PUSCH repetition. * FFS whether to support other values, e.g., 8. * Note: K=1 is supported and how to support K=1 is FFS. |

Companies’ views on the candidate values including the maximum number of repetitions are summarized below

* [1, Huawei, HiSilicon]: Support at least repetition factor K = {2, 4, 8} for Msg3 PUSCH repetition. The maximal repetition number up to 16 can be considered for Msg3 PUSCH repetition.
* [2, OPPO], [5, vivo], [9, InterDigital], [13, Panasonic]: Repetition factor K ={1, 2, 4, 8} is supported for Msg3 PUSCH repetition.
* [4, ZTE]: NR Rel-16 repetition factor set {1, 2, 3, 4, 7, 8, 12, 16} is supported for Msg3 repetition.
* [8, Xiaomi]: The maximum number of repetitions for type A PUSCH repetition in release 17 can be adopt for Msg.3 repetition.
* [10, Intel]: ~2dB performance gain can be achieved for Msg3 PUSCH when the repetition level is doubled.
* [12, Qualcomm]: Support repetition factor K = 8 and 16 for Msg3 PUSCH repetition.
* [19, CMCC]: Support repetition factor K={2,4} for Msg3 PUSCH repetition, no need to support other values.
* [16, Nokia/NSB]: Supported Msg3 repetition numbers other than K=1 should be limited to already agreed . If RAN1 agrees that a larger number of configurable values is need, then K should not exceed 12.

In addition to repetition factor K= {1, 2, 4}, it seems a clear majority prefers to additionally support K =8. And many companies are fine to support larger values up to 16. **As this issue is directly related to the information field for repetition indication, FL suggests to discuss together with Issue#4 where a joint proposal is made.**

### [Open] Issue#4: Indication of the number of repetitions for Msg3 initial transmission

For Msg3 initial transmission, the following WA was reached for repetition indication in RAN1#106-e.

|  |
| --- |
| **Working Assumption**  Down-select only one from the following methods for indication of the number of repetition of Msg3 initial transmission.   * Alt 1: If TDRA information field is chosen, introducing a new configurable TDRA table including the repetition factors.   + The new TDRA table is configured by SIB1, with selecting one of the two options below.     - Option 1: The new TDRA table includes separate new indication for K2, mapping type, SLIV and repetition factor.     - Option 2: The new TDRA table includes legacy indication for K2, mapping type and SLIV from legacy TDRA table, and new indication for repetition factor.   + If a new TDRA table is not configured, the legacy default TDRA table is used, and repetition factor K=1 is applied.     - ~~K=1.~~ * Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.   + X MSB bits of the MCS information field are used for repetition indication.     - FFS the value of X.     - FFS whether the X bits are directly used for indicating the repetition factor (i.e., the decimal value of X is equal to the repetition factor) or used for selecting one repetition factor from a predefined/SIB1 configured set. * Alt 3: If TPC information field is chosen, repurpose the TPC information field by selecting one of the two options below.   + Option 1: X LSB bits of the TPC information field are used for repetition indication.     - FFS the value of X.     - FFS whether the X bits are directly used for indicating the repetition factor (i.e., the decimal value of X is equal to the repetition factor) or used for selecting one repetition factor from a predefined/SIB1 configured set.   + Option 2: A predefined TPC command table with including repetition factor K is introduced.     - FFS details. |

Companies’ views are summarized in the following table.

Table 2.2-1 Summary of companies’ views for repetition indication for Msg3

|  |  |  |  |
| --- | --- | --- | --- |
| **Information field** | **Support** | **Concern** | **Detailed views** |
| TDRA | Sharp, CATT, Ericsson, vivo, Xiaomi, Panasonic, ZTE, CMCC, OPPO, [China Telecom], InterDigital, ~~[Samsung]~~, ETRI, LG, Spreadtrum Communication, Lenovo/Motorola Mobility, NEC | Apple, Nokia, NSB, Intel, Huawei/ HiSilicon, Qualcomm | Option 1: Sharp, CATT, Ericsson, vivo, ZTE, InterDigital, ETRI  Option 2: Sharp, CATT, Panasonic, OPPO, Xiaomi, LG, Lenovo, Motorola Mobility, vivo, Spreadtrum Communications, NEC  **Pros:**   * Use similar mechanism defined for regular PUSCH repetition in Rel-16, which may require less spec efforts   **Cons:**   * Impact the flexibility of time domain resource indication. * Either more signaling overhead (Option 1) or may have impact on legacy UEs (Option 2) |
| MCS | Apple, Intel, Samsung, Huawei/HiSilicon Nokia/NSB, DCM, China Telecom | [CATT, Ericsson, LG, OPPO], Sharp | **Pros:**   * Less signaling overhead or impact to legacy UEs   **Cons:**   * Impact the flexibility of MCS indication; * New rules on split of MCS bit field |
| TPC | QC, WILUS, Xiaomi, InterDigital | [CATT, Ericsson, DCM, LG, OPPO] Huawei, HiSilicon, Sharp, Samsung | Option 1: WILUS, InterDigital (1st preference), Xiaomi  Option 2: Qualcomm  **Pros:**   * Less signaling overhead or impact to legacy UEs   **Cons:**   * Impact the flexibility of TPC indication; * New rules on split of TPC bit field |

Except the pros&cons summarized above, the following additional views are provided from companies.

|  |
| --- |
| [1, Huawei, HiSilicon]:   * The(MCS=4, repetition=2) and the (MCS=7, repetition=4) have worse performance than the MCS0 without repetition, and will not be scheduled for the coverage limited UE. * The (MCS=4, repetition=4, SE=0.6016/4), the (MCS=5, repetition=4, SE=0.7402/4) and the (MCS=6, repetition=4, SE=0.8770/4) have almost the same performance and spectrum efficiency (SE) as the (MCS=1, repetition=2, SE= 0.3022/2), the (MCS=2, repetition=2, SE=0.3774/4) and the (MCS=0, repetition=1, SE=0.2344), however they utilize the time domain resource more inefficiently. * UP to 2 bits of MCS information field can be used to indicate the repetition number for Msg3 initial transmission, and MCS 0 to MCS3 are sufficient for the coverage limited UE. * For option 1 in Alt 1,the payload of the new TDRA table that includes the repetition number in SIB1 will increase the SIB1 payload size by 18~24%, and the increased payload size of SIB1 will result in coverage performance degradation of 1dB. * The assumption is that Rel-17 SIB1 with increased payload is transmitted in the same amount of frequency domain resource, and MCS0 is used for the transmission of the legacy SIB1, while MCS1 will be used for the transmission of the Rel-17 SIB1 due to the increased payload size. |
| [5, vivo]:  Each row of the new TDRA table can be configured by a combination of {row-idx, repetition factor}, where the row-idx indicates {mapping type, k2, S, L} corresponding to the row index in the legacy default TDRA table.  Besides, the large payload may be transmitted in Msg3, e.g., for data transmission, and the payload can be up to hundreds of bits. It may require the grant for Msg3 with high MCS. The MCS table should not be compressed too much, at least QPSK modulation corresponding to MCS 0~7, should be supported. |
| [10, Intel], [11, Apple], [16, Nokia/NSB]: X = 1 or 2. X bits are used to indicate repetition factor from a set of values which are configured by SIB1. |
| [12, Qualcomm]: For initial Msg3 transmission, the number of repetitions is indicated by reinterpreting TPC command in the UL grant scheduling initial Msg3 transmission. |

#### First round

Below, FL tries to provide more detailed and quantitative analysis for each solution.

**TDRA based solution**

* **Signaling overheard:** From companies’ input, the total number of bits for SIB1 could be 1000 bits~2976 bits. Companies are encouraged to further check the exact range.
  + For Option 1 of TDRA based solution, it requires X rows \* (0 or 6 bits for K2 + 1 bit for mapping type + 7 bits for SLIV + 2~4 bits for repetition factor) = X\*(12~18) bits, where X is the number of configured rows ranging from 1 to 16. That is, the minimum overhead increase is 12 bits/2976 bits = 0.43% in case of X=1, and the maximum overhead increase is 18 bits\*16/1000 bits = 28.8% in case of X= 16. In theory, the overhead increase for Option 1 is 0.43%~28.8%, which is under control of NW depending on the number of rows configured and whether to use default K2 value.
  + For Option 2 of TDRA based solution, the overhead increase is very minor, even assuming a 16-row TDRA table is configured.
* **Impact on legacy UEs:** Option 2 sharing the same {K2, mapping type, SLIV} between legacy UEs and CE UEs could impact the flexibility of time domain indication for all UEs.
  + To avoid causing any impacts on legacy UEs, NW could configure the {K2, mapping type, SLIV} fully depend on only legacy UEs. Then, it would mean the flexibility of time domain indication including the number of repetitions for Rel-17 CE UEs could be then potentially limited. For instance, for those rows, if any, configured with a short Msg3 PUSCH, e.g., 4-OS, it may not be suitable for Rel-17 CE UEs.
    - In practical, most of the rows may be configured with a length L>=10 symbols for Msg3 PUSCH, similar as the default TDRA table A where 13 out of 16 rows are configured with L>=10. In such case, most of rules configured for legacy UEs could also applied to Rel-17 CE UEs.

With said above, FL encourages the proponents of TDRA based solution to choose Option 2 which is supported by slightly more companies.

**MCS based solution**

The controversial part is whether NW should sacrifice the flexibility of MCS indication for repetition indication. One company [1, Huawei, HiSilicon] shows that only MCS 0 to MCS3 are sufficient for the coverage limited UE, based on some evaluation for a given Msg3 payload size. It is argued by other companies that the payload can be up to hundreds of bits, and it may require high MCS.

As for how many bits of MCS information field could be chosen, it seems the majority of the proponents are fine with X=2 bits, and the repetition factor could be chosen from a SIB1 configured set.

**TPC based solution**

Based on the inputs, only 4 companies show support for using TPC information field for repetition indication, where 2 of them are also fine with other information field. In addition, many companies have showed concerns on using TPC. The main concerns are summarized as below.

* The measured DL path loss for the UL Tx power determination may be inaccurate. There could quite difference between DL and UL path loss, e.g., 6dB, thus the negative value in the TPC could still be used adjust to power to a proper level for UL transmission.
* The power of PRACH will be inherited for the msg3 PUSCH transmission power determination. Since the detection/decoding requirement for sequence and modulated data symbol are different, a negative is still needed.

With above, FL suggests dropping Alt 3 (TPC based solution).

In summary, FL suggests further discussing the following proposal as a starting point.

**Proposal for Issue#4 (RRC related): Down-select only one from the following methods for indication of the number of repetition of Msg3 initial transmission.**

* **Alt 1: If TDRA information field is chosen, Option 2 is supported.** 
  + **The candidate values for repetition factor could be chosen from {1, 2, 3, 4, 7, 8, 12, 16}**
* **Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.**
  + **2 MSB bits of the MCS information field are used for selecting one repetition factor from a SIB1 configured set with 4 candidate values.**
    - **The set of candidate values for repetition factor could be chosen from {1, 2, 3, 4, 7, 8, 12, 16}**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | We support FL’s proposal for Issue#4.  Also, we can continue to discuss for selecting exact values. |
| Intel | We are fine with the proposal in principle.  We share similar view as LG that the exact values can be FFS.  Minor editorial correction “**number of repetitions**” in the main bullet. |
| Sharp | We are OK with FL proposal.  For further down-selection: Msg 3 TBS value is key factor for scheduling. The gNB needs to have flexibility to schedule msg3 PUSCH at least with 56/72 bits. On top of that, larger TBS may be required for SDT with msg3 repetition. Therefore, we don’t think the direction with MCS information field which sacrifices flexibility of MCS values as a candidate solution. |
| Vivo | Fine with FL proposal.  For opt-2 of Alt-1, we prefer each row of the new TDRA table can be configured by a combination of {row-idx, repetition factor}, where the row-idx indicates {mapping type, k2, S, L} corresponding to the row index in the legacy default TDRA table.  For MCS based method, another drawback we mentioned in our contribution, that is, the MCS filed length are 4bits in RAR UL grant and 5 bits in DCI format 1-0 with TC-RNTI. If MCS based method is adopted, how to repurpose MCS bitfield in these two UL grants will be separately discussed. |
| Panasonic | We are fine with FL proposal. |
| China Telecom | Support the FL’s proposal. We are fine that the set of candidate values be chosen from {1, 2, 3, 4, 7, 8, 12, 16}. The exact 4 candidate values can be further discussed. |
| CATT | We can live with this direction.  However, whether ‘1’ shall be included in the repetition factor depends on the discussion in Issue#5. For example, in Issue#5, in option 1, repetition factor K=1 is included in the TDRA table. But K=1 is not include in Option 2.  Suggest the following minor update with a note:  **Proposal for Issue#4 (RRC related): Down-select only one from the following methods for indication of the number of repetition of Msg3 initial transmission.**   * **Alt 1: If TDRA information field is chosen, Option 2 is supported.**    + **The candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, 12, 16}** * **Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.**   + **2 MSB bits of the MCS information field are used for selecting one repetition factor from a SIB1 configured set with 4 candidate values.**     - **The set of candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, 12, 16}**   **Note: Whether ‘1’ is included depends on the outcome of interpretation of the selected information field.** |
| Samsung | Fine in principle.  Regarding the details,  1. for repetition values, {1, 2, 3, 4, 7, 8, 12, 16} seems too many, {1,2,4,8} or {2,4,8,16} could be considered; how to handle the “1”, we can discuss.  2. with above comments, in alt.2, I don’t think there is a need to use SIB1 to further configure this 4 values; |
| Nokia/NSB | Agree with CATT on whether “1” is included in the list.  Additionally, we would like to observe that maybe keeping the door open to use only X=1 bit in Alt. 2 may help addressing some of concerns expressed by other companies (e.g., vivo). We are not advocating for the exclusion of X=2 from the possibilities, obviously. However, we think that if “1” is not included in the list of explicitly configurable values (to improve flexibility of the signalling via MCS, for instance) then 1 bit could already provide 3 possible configurable values overall, e.g., {1,2,4}. Having said this, our preference in this sense would still be X=2, if agreeable, given that we do not consider larger Msg3 payload use case to be relevant for coverage enhancement. If a UE is in coverage shortage, only very small payloads would be possible (56/72). If the UE could transmit a larger payload, it would also mean the measured RSRP during SSB reception is already sufficiently high to use group B preambles. |
| NTT DOCOMO | We support the proposal. |
| Xiaomi | We are generally fine with the proposal for the sake of meeting progress.  For the candidate values of msg.3 repetition, we think the set of {1, 2, 4, 7, 8, 12, 16} is reasonable. Several values among them can be selected by gNB and configured by SIB1, which will not affect the bit size of the indication field in RAR UL grant and/or scheduling DCI. |
| OPPO | We are fine with FL’s proposal. For Alt2, actually only 4 candidate values for repetition factor can be indicated. Additional SIB1 bits are required for the configuration of 4 candidate values. |
| ZTE | We are fine with the proposal. We are Ok with CATT’s suggestion. |
| Ericsson1 | We’re generally fine with the proposal and TDRA based method is preferred as we discussed in last meeting. For the detailed candidate values of repetition factors, we’re open to discuss, and up to 8 or 16 repetitions should be enough given we can have retransmissions for Msg3 for coverage already. |
| Huawei, HiSilicon | Fine with the proposal.  In response to the concern to MCS information field:  The payload size for Msg3 PUSCH can be determined by gNB, but it is also mainly limited by available UL power. For a coverage limited UE, as we discuss in Issue 2-1, the large payload typically needs more PRBs, which requires more UL power that the coverage limited UE cannot afford. So, the payload carried by Msg3 PUSCH for a coverage limited UE should not be very large. |
| Qualcomm | We are fine with the proposal |
| InterDigital | We are ok with the proposal. |
| FL | Support/fine: LG, Intel, Sharp, vivo, Panasonic, China Telecom, CATT, Nokia/NSB?, NTT DOCOMO, Xiaomi, OPPO, ZTE, Ericsson1, Huawei, HiSilicon, Qualcomm, InterDigital  @Samsung, I can understand your point. However, considering the clear majority and the urgency of moving on for this proposal, and SIB1 configuring would provide additional flexibility with very minor overhead, the current proposal seems the best we can have now, and hope this could be also acceptable for you.  @Nokia, As your preference is X=2, which aligns with the proposal, let’s not keep other values open. We have to move on for this important issue.  @All, I will summarize the pros and cons for these two alternatives when making down-selection later. |

**Proposal-v1 for Issue#4 (RRC related): Down-select only one from the following methods for indication of the number of repetitions of Msg3 initial transmission.**

* **Alt 1: If TDRA information field is chosen, Option 2 is supported.** 
  + **The candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, 12, 16}**
* **Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.**
  + **2 MSB bits of the MCS information field are used for selecting one repetition factor from a SIB1 configured set with 4 candidate values.**
    - **The set of candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, 12, 16}**

**Note: Whether ‘1’ is included depends on the outcome of interpretation of the selected information field.**

**Please provide your comment below only if you have strong concerns.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | 1. the gap for msg3 in SI shows that not a very large repetition is needed, the SNR gap is that large;  2. if I remember correctly, we agree the repetition will be counted based on available slots, so the number of repletion will be likely to be actually transmitted.  Really don’t see the necessity to have additional larger value. |
| Apple | Support FL’s proposal |
| FL | @Samsung, Many companies pointed out larger value could be useful especially for FR2. From FL perspective, we have similar situation as discussed in AI 8.8.1.1 before, where whether 32 should be supported for counting based on available slot. In such situation, we have to move on based on the clear majority. |
| CMCC | Sorry for jump at a late time. As proposed in our contribution, we don’t think the large repetition factor is necessary for Msg 3 repetition, considering the coverage of Msg 3 is not that worse as PUSCH. considering only a below 100bits would be transmitted.  And from the perspective of flexibility of other filed (e.g. MCS) and reduce the collisions (as in the flexible slots) we do not think the large repetition number is preferred. Please note our concern for beyond repetition factor 4 at least for FR1. Similar view that it is till not efficient to use a large amount repetitions for FR2, which induce collisions of flexible slots. |
| FL | The following WA has been reached in GTW session.  **Working Assumption**  **Down-select only one from the following methods for indication of the number of repetitions of Msg3 initial transmission.**   * **Alt 1: If TDRA information field is chosen, Option 2 is supported.**    + **The candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, [12], [16]}** * **Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.**   + **2 MSB bits of the MCS information field are used for selecting one repetition factor from a SIB1 configured set with 4 candidate values.**     - **The set of candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, [12], [16]}**   **Note: Whether ‘1’ is included depends on the outcome of interpretation of the selected information field.** |

#### Second round

Based on the latest WA, there are only two alternatives are on the table, and the details for each alternative is clear enough now. So, the next step is to make down-selection based on the pros&cons.

|  |  |  |  |
| --- | --- | --- | --- |
| **Information field** | **Support** | **Concern** | **Detailed views** |
| TDRA | Sharp, CATT, Ericsson, vivo, Xiaomi, Panasonic, ZTE, CMCC, OPPO, [China Telecom], InterDigital,, ETRI, LG, Spreadtrum Communication, Lenovo/Motorola Mobility, NEC | Apple, Nokia, NSB, Intel, Huawei/ HiSilicon, Qualcomm | **Pros:**   * Use similar mechanism defined for regular PUSCH repetition in Rel-16, which may require less spec efforts   **Cons:**   * Impact the flexibility of time domain resource indication. * It may or may not impact the flexibility of time domain resource indication for legacy UEs, depending on NW configuration. (More detailed analysis please find in the Note 1 below). |
| MCS | Apple, Intel, Samsung, Huawei/HiSilicon Nokia/NSB, DCM, China Telecom | [CATT, Ericsson, LG, OPPO], Sharp | **Pros:**   * May have less impact to legacy UEs   **Cons:**   * Impact the flexibility of MCS indication; * The MCS filed length are 4 bits in RAR UL grant and 5 bits in DCI format 1-0 with TC-RNTI. It would require additional effort to discuss how to repurpose MCS bit field for Msg3 re-transmission. |

Note 1: Impact on legacy UEs for Alt1: Alt 1 withsharing the same {K2, mapping type, SLIV} between legacy UEs and CE UEs could impact the flexibility of time domain indication for all UEs.

* To avoid causing any impacts on legacy UEs, NW could configure the {K2, mapping type, SLIV} fully depend on only legacy UEs. Then, it would mean the flexibility of time domain indication including the number of repetitions for Rel-17 CE UEs could be then potentially limited. For instance, for those rows, if any, configured with a short Msg3 PUSCH, e.g., 4-OS, it may not be suitable for Rel-17 CE UEs.
  + In practical, most of the rows may be configured with a length L>=10 symbols for Msg3 PUSCH, similar as the default TDRA table A where 13 out of 16 rows are configured with L>=10. In such case, most of rules configured for legacy UEs could also applied to Rel-17 CE UEs.

In this round, FL would like to collect companies’ views about the Pros&Cons summarized in above table for each alternative based on the latest WA.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| NTT DOCOMO | Prefer MCS-based indication.  The discussion point is either to prioritize MCS flexibility or TDRA flexibility. For UE in cell edge, low MCS indexes are sufficient to support. On the other hand, TDRA flexibility is important to harness available resources efficiently to enhance coverage performances. |
| WILUS | We prefer Alt 2 (i.e., MCS). Since CE UE is more likely to be indicated with low code rate and modulation order, some of bits/code-points corresponding to high MCS index can be reused. It requires no additional signaling overhead since some of bits/code-points in existing field would be truncated. |
| Nokia/NSB | Alt. 1 forces NW to select only from very few rows of the TDRA table, for any given configurable value. This is an obvious impact on UL transmissions of other UEs. Conversely, Alt. 2 clearly offers a more flexible method if all NW operations are considered. Two additional observations:   * The problem we are considering is not general, but a problem where coverage is constrained. As explained by other companies, when coverage constraints are considered, Alt. 2 does not reduce flexibility in practice. Higher MCS indices will never be used in practice. This is very different from what one could say about an RRC\_CONNECTED PUSCH, when coverage is good. * If we agreed to go for Alt.2 and use, say, the 2 LSB/MSB of the MCS information field of the UL grant carried by Msg2 to indicate the repetition factor, then it would be rather straightforward to agree to use the 2 LSB/MSB of the MCS information field of DCI format 1-0 with TC-RNTI. The same logic would apply. We do not see any problem. |
| Intel | We prefer Alt. 2.  We share similar view as above. For cell edge UE, it is likely to be scheduled with low MCS. Alt 1 may have issue with scheduling flexibility. |
| Panasonic | In our view, TDRA-table indication reduces flexibility of time domain resource allocation, while MCS field indication reduces the flexibility of MCS choice. Either direction would be acceptable flexibility reduction as CSI based link adaptation is not available for Msg.3. |
| Ericsson3 | Alt1 is preferred.  TDRA table based dynamic repetition avoids repurposing expensive DCI/RAR fields and is more forward compatible, and it is aligned with what we did for introducing dynamic normal PUSCH repetition in NR Rel-16.  We do not think the flexibility of signaling repetition factors via TDRA table based method is a problem, the flexibility is the same as a normal PUSCH dynamic repetition which is enough for msg3 repetition. |
| vivo | Prefer Alt-1 TDRA based solution.  For Alt-1, we prefer each row of the new TDRA table can be configured by a combination of {row-idx, repetition factor}, where the row-idx indicates {mapping type, k2, S, L} corresponding to the row index in the legacy default TDRA table. And row of legacy entry and repetition number can be configured semi-statically by SIB.  We do not understand the cons for Alt-1 that is impacts flexibility of time domain resource indication for UEs. For type-A PUSCH repetition for normal PUSCH, only 16 rows configured in the TDRA table, and the repetition number range is from 1 to 32, the flexibility seems not an issue for that case, while for Msg3 repetition it is an issue with lower repetition number.  With more 16 rows and 2 bits from MCS field, it results in 64 combinations for TDRA+repetitions can be dynamically indicated. Besides, according to FG 11-6, current UE capability only requires repetition number jointly coded in TDRA table. With up to 64 combinations to be dynamically indicated with non-joint coded indication, it requires even higher capability than rel-16 URLLC type-A repetitions. Hence, not preferred.    Besides, using limited MCS entries will force NW to schedule more PRBs for transmit large TB. For example, for groupB or SDT if supported together with Msg3 repetition, the number of bits could be up to 1000 bits. Small number of PRBs + higher MCS will provide higher flexibility for NW scheduling in frequency domain in some use cases. |
| OPPO | We prefer Alt1. TDRA based repetition factor indication shares the same mechanisms with legacy PUSCH repetition and PUSCH coverage enhancement in Rel-17. We do not find any additional flexibility and signaling overhead issues on TDRA based solution. The indication in TDRA is based on configuration, which is forward compatible. No bit domain is repurposed for Alt1, which as less standard efforts. |
| China Telecom | We prefer Alt.2. As also analyzed by other companies, we think high MCS is not useful for coverage limited UEs. We don’t think there is an obvious impact on flexibility of MCS indication. |
| LG | Regarding Alt2, in the previous GTW session, the one concern about the SIB1 overhead for additional indication of 4 candidate values among {1,2,3,4,7,8,12,16} was raised.  We think one method to resolve this concern would be to set default value of 4 candidate values, e.g., {1,2,4,8}. Without indication to set the values in SIB1, a UE use the default values. If gNB want to configure another values, then gNB would do so via SIB1 and the UE will override the default values. |
| Sharp | Concern on Alt.2.  Multiple TBS size should be supported from the network perspective. 56 bits are for CCCH SDU with RRC setup request. 72 bits are for CCCH SDU with RRC resume request. Further, for handover or SDT, larger TBS may be needed. In that sense, sacrificing MCS availability for msg3 PUSCH repetition makes msg3 scheduling inefficient.  For example,  when a msg3 PUSCH repetition is scheduled with 1 PRB and 14 OFDM symbols, MCS 3 provides 64 bits TBS and MCS 4 provides 72 bits TBS. On the other hand,  when a msg3 PUSCH repetition is scheduled with 2 PRB and 14 OFDM symbols, MCS 0 provides 56 bits TBS and MCS 1 provides 80 bits TBS. Further,  when a msg3 PUSCH repetition is scheduled with 1 PRB and 12 OFDM symbols, MCS 4 provides 64 bits TBS and MCS 5 provides 72 bits TBS. Further,  when a msg3 PUSCH repetition is scheduled with 2 PRB and 12 OFDM symbols, MCS 1 provides 64 bits TBS and MCS 2 provides 80 bits TBS.  Then, with the limited set of settings, MCS0,1,2,3,4,5 is required. Then, I would like to ask which of limited set of 4 MCS values are preferred for proponents of Alt.2? |

### [Closed] Issue#5: How to interpret the information field (legacy or new interpretation)

As for how a UE is managed to know whether to use legacy interpretation or new interpretation on the bit field indicating the number of repetitions, there are the following two options agreed in RAN1#106-e.

|  |
| --- |
| **Agreement**  Down-select one of the two options on how a UE should interpret the selected information field for indication of the number of repetitions.   * Option 1: * When a UE requests Msg3 repetition, the new TDRA table or repurposed information field is applied. gNB schedules Msg3 with or without repetition for the UE requesting Msg3 repetition.   + Repetition factor K=1 is included in the TDRA table or one entry/codepoint of the repurposed information field. * When the UE doesn’t request Msg3 repetition (including legacy UE), the legacy TDRA table or legacy information field is applied. gNB schedules Msg3 without repetition for the UE not requesting Msg3 repetition. * Option 2: * When a UE requests Msg3 repetition, gNB schedules Msg3 with or without repetition by respectively using the new TDRA table or legacy TDRA table; or gNB schedules Msg3 with or without repetition by respectively using repurposed information field or legacy interpretation of information field. Whether the UE should apply the new or the legacy TDRA table, or apply repurposed or legacy interpretation of the information field, is indicated by gNB.   + FFS details, e.g. implicit or explicit indication or predefined.   + Repetition factor K=1 is NOT included in the TDRA table or one entry/codepoint of the repurposed information field. * When the UE doesn't request Msg3 repetition (including legacy UE), gNB schedules Msg3 without repetition. The UE applies the legacy TDRA table, or the legacy interpretation of the information field. |

Companies’ support of each option is summarized below.

* Option 1:
  + Support: [1, Huawei, HiSilicon], [2, OPPO], [3, Spreadtrum Communications], [4, ZTE], [5, vivo], [7, China Telecom], [8, Xiaomi], [9, InterDigital], [10, Intel], [12, Qualcomm], [13, Panasonic], [15, ETRI], [17, Ericsson], [18, Sharp], [19, CMCC], [22, LG], [23, WILUS], [26, NEC]
* Option 2:
  + Support: [6, CATT], [11, Apple], [14, Samsung] (for TDRA based solution), [16, Nokia/NSB]
  + [6, CATT]: CSI request bit field can be used as an explicit indication of which TDRA table is used for time domain resource allocation.
  + [11, Apple]: A reserved bit in DCI 1-0 to indicate repurposing some of the bit fields in RAR UL grant.
  + [16, Nokia/NSB]: The indication of which interpretation of the UL grant is to be used by UE is provided implicitly to the latter (e.g., using TC-RNTI).

The fundamental difference between Option 1 and Option 2 is whether to introduce additional indication to implicitly or explicitly indicate how the UE should interpret the TDRA table/ repurposed information field. Based on companies’ input, it is clear that the majority prefer Option 1, i.e., they don’t see the necessity to introduce such additional indication. Even among companies preferring Option 2, the proposed indication methods are rather different.

From FL perspective, Option 2 is kind of further optimization to provide additional flexibility for repetition indication while the necessity might not be strong. In addition, this also depends on which information field is chosen and how much flexibility it can offer to indicate the candidate repetition factors. **FL suggests further discussing this issue after more progress on Issue #3 and Issue #4.**

### [Closed] Issue#6: Indication of the number of repetitions for Msg3 re-transmission

For Msg3 re-transmission, the following agreements were reached for repetition indication in RAN1#105-e.

|  |
| --- |
| Agreement: For repetition indication of Msg3 re-transmission, select one options from the following two options.   * Option 1: Use the same mechanism as supported for Msg3 initial transmission. * Option2: Use HARQ process number bit field in DCI format 0\_0 with CRC scrambled by TC-RNTI. |

Companies’ preference for the two options about repetition indication for Msg3 re-transmission are summarized below.

* Option 1: Use the same mechanism as supported for Msg3 initial transmission
  + [1, Huawei, HiSilicon], [ 2, OPPO], [4, ZTE], [5, vivo], [6, CATT], [8, Xiaomi], [13, Panasonic], [14, Samsung] (if initial transmission adopts TDRA based method), [15, ETRI], [17, Ericsson], [22, LG]
* Option2: Use HARQ process number bit field in DCI format 0\_0 with CRC scrambled by TC-RNTI.
  + - [10, Intel], [11, Apple], [12, Qualcomm], [14, Samsung] (if initial transmission doesn’t adopt TDRA based method), [23, WILUS]

[16, Nokia/NSB]: Discussion on the indication of the repetition number for Msg3 re-transmission should be postponed until a solution for the indication of repetition number for Msg3 initial transmission is agreed.

**FL suggests to postpone the discussion on this issue until there is a clear solution for initial transmission.**

## Counting on the basis of available slots for Msg3 repetition

In RAN1#105-e, the following agreements were reached for counting the number of repetitions on the basis of available slots for Msg3 repetition.

|  |
| --- |
| Agreement: Available slot for Msg3 PUSCH repetition doesn’t depend on dynamic SFI in DCI format 2-0.  Agreement**:** Available slots for Msg3 PUSCH repetition do not depend on *tdd-UL-DL-ConfigurationDedicated*.  Agreement: Available slot for Msg3 PUSCH repetition doesn’t depend on UL CI.  Agreement**:** Available slot for Msg3 PUSCH repetition depends on *TDD-UL-DL-Configcommon*.   * A slot is determined as available for Msg3 repetition only if the consecutive symbols allocated for Msg3 repetition in the slot are all available symbols.   + UL symbols indicated by *TDD-UL-DL-Configcommon* are determined as available for Msg3 repetition.   + FFS whether and how to use flexible symbols indicated by *TDD-UL-DL-Configcommon*.   **Agreement**   * The available slot of Msg3 PUSCH repetition is only determined by the tdd-UL-DL-ConfigurationCommon and ssb-PositionsInBurst, no other additional Rel-16 signals/signalings will be considered.   + If a symbol for Msg3 repetition in a slot overlaps with SSB transmission [FFS:N Gap symbols after SSB], the slot is determined as not available during the counting of repetitions. As there is no Msg3 repetition in the slot, no Msg3 repetition omission applies to the slot. |

### [Open] Issue #7 whether to introduce additional indication for use of flexible slots/symbols indicated via *TDD-UL-DL-Configcommon*

Regarding whether to additionally introduce explicit indication for indicating whether flexible slots/symbols indicated via *TDD-UL-DL-Configcommon* can be used for Msg3 repetition, companies’ views are summarized below.

Flexible symbol indicated by tdd-UL-DL-ConfigurationCommon can be regarded as available symbols for Msg3 PUSCH repetition with repetition factor K>1.

Support: [2, OPPO], [5, vivo], [8, Xiaomi], [12, Qualcomm], [13, Panasonic], [14, Samsung], [6, CATT], [10, Intel], [13, Panasonic], [16, Nokia/NSB], [19, CMCC], [22, LG], [23, WILUS]

* + Option 1-A: Additional explicit indication is introduced to indicate whether flexible slots/symbols configured via TDD-UL-DL-Configcommon are available for Msg3 repetition.
    - [2, OPPO], [5, vivo], [8, Xiaomi], [12, Qualcomm], [13, Panasonic], [14, Samsung], [18, Sharp]
  + Option 1-A1: Introduce 1 bit RRC parameter in SIB1.
    - Support: [2, OPPO], [18, Sharp]
    - If the parameter is provided, flexible symbol indicated via TDD-UL-DL-Configcommon is available for Msg3 repetition, otherwise, they are not available.
  + Option 1-A2: Introduce InvalidSymbolPattern in SIB1.
    - Support: [8, Xiaomi], [14, Samsung]
    - The signaling design of InvalidSymbolPattern is the same as Rel-16.
  + Option 1-A3: Introduce a bitmap indication in DCI format 1-0 scrambled with RA-RNTI or DCI format 0-0 scrambled with TC-RNTI
    - Support: [5, vivo], [12, Qualcomm], [13, Panasonic]
      * [5, vivo]: The bitmap size can be configured or predefined;
      * [5, vivo]: The number of slots associated with each bit can be implicitly determined according to the bit size and number of slots with flexible symbols in the indication period;
      * [5, vivo]: The availability information is cycled every indication period, and the indication period is multiple of periodicity of TDD-UL-DL-Pattern in TDD-UL-DL-Configcommon which can be configurable.
  + Option 1-C: No need additional indication.
    - [6, CATT], [10, Intel], [13, Panasonic], [22, LG], [16, Nokia/NSB]

Note: For a UE requesting Msg3 PUSCH repetition while scheduled without repetition, Rel-16 rules are reused i.e., flexible symbol indicated by tdd-UL-DL-ConfigurationCommon is regarded as available symbols.

#### First round

In RAN1#106-e, companies reached a common understanding that the flexible symbols indicated by t*dd-UL-DL-ConfigurationCommon* can be regarded as available symbols for Msg3 PUSCH repetition. While there is no consensus about whether to additionally introduce explicit indication for indicating whether flexible slots/symbols indicated via *TDD-UL-DL-Configcommon* can be used for Msg3 repetition.

As the example shown in Figure 3.3-1 of FL summary in [27], if one Msg3 repetition transmitting on flexible symbols indicated by *dd-UL-DL-ConfigurationCommon* can be canceled, it may cause ambiguity between gNB and UE about whether a Msg3 repetition is transmitted or not. In Rel-16, there are two cancellation cases:

* Case a): Downlink symbols indicated by *tdd-UL-DL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*.
* Case b): Symbols configured for SSB transmission.
* Note that, Msg3 transmission would not be canceled by SFI based on legacy rules. Detailed legacy collision rules are summarized in Appendix A.

However, it has already been agreed that *tdd-UL-DL-ConfigurationCommon* and SSB transmission are used for available slot determination. In other words, *tdd-UL-DL-ConfigurationCommon* and SSB transmission would not be used for canceling Msg3 repetition as there is no Msg3 repetition in the slot with DL symbols or SSB transmission that would overlap with Msg3 repetition. Then, the only canceling case is due to ‘downlink symbols indicated by *tdd-UL-DL-ConfigurationDedicated’.*

Then, one way is to change legacy cancellation rule, by prohibiting canceling Msg3 PUSCH by downlink symbols indicated by *tdd-UL-DL-ConfigurationDedicated.* In other words, Msg3 PUSCH can be scheduled on flexible symbols indicated by *tdd-UL-DL-ConfigurationCommon* and gNB can configure part of these symbols to downlink symbols by *tdd-UL-DL-ConfigurationDedicated*, while Msg3 PUSCH can still be transmitted.

Another way is to simply leave to gNB implementation. Then, the fundamental question would be: 1) ‘whether it is possible/efficient for gNB to avoid canceling Msg3 repetition due to changing flexible symbols to downlink symbols by *tdd-UL-DL-ConfigurationDedicated.* 2) Or, if ambiguity happens due to cancellation, whether it is affordable for gNB to solve this issue by implementation, e.g., do some blind decoding*?*

* Specifically for 1), whether the following ways could be possible/efficient?
  + 1) gNB does not configure too much flexible symbols by *tdd-UL-DL-ConfigurationCommon,* e.g., only few flexible symbols for DL-UL switching.
  + 2) The flexible symbols configured by *tdd-UL-DL-ConfigurationCommon* cannot be changed to DL symbols semi-statically b*y tdd-UL-DL-ConfigurationDedicated,* while gNB can still schedule DL transmissions dynamically on flexible symbols.
  + 3) The flexible symbols configured by *tdd-UL-DL-ConfigurationCommon* can be carefully changed to DL symbols semi-statically b*y tdd-UL-DL-ConfigurationDedicated,* while gNB cannot schedule Msg3 repetition on these DL symbols.

Firstly, the following is a common understanding based on the discussion in the last meeting, and should be agreeable. Companies are encouraged to provide you views below. If any concerns, please provide your detailed reasoning with taking all the discussion before into account.

**Proposal 7-1 for Issue#7: Flexible symbol indicated by *tdd-UL-DL-ConfigurationCommon* can be regarded as available symbols for Msg3 PUSCH repetition.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | We are generally fine with the FL’s proposal 7-1 for issue#7. But, it needs to be described some condition (e.g., timing gap after DL symbol(s)) for determining whether OFDM symbol for msg3 PUSCH repetition is available for not. |
| Intel | We are fine with the proposal. Just want to confirm our understanding that this is only for the case when flexible symbols no used for SSB transmission, right? In other words, if flexible symbols are used for SSB transmission and overlaps with Msg3 repetition, Msg3 repetition is dropped. |
| Sharp | We are OK with FL proposal with adding a note indicating that support for an additional indication of availability of the flexible symbol is FFS. Further, we agree with Intel. |
| vivo | Fine with the proposal. |
| Panasonic | We are fine with the FL proposal. |
| CATT | Based on the previous agreement below, we think the current version is a bit ambiguous.   |  | | --- | | **Agreement**   * The available slot of Msg3 PUSCH repetition is only determined by the tdd-UL-DL-ConfigurationCommon and ssb-PositionsInBurst, no other additional Rel-16 signals/signalings will be considered.   + If a symbol for Msg3 repetition in a slot overlaps with SSB transmission [FFS:N Gap symbols after SSB], the slot is determined as not available during the counting of repetitions. As there is no Msg3 repetition in the slot, no Msg3 repetition omission applies to the slot. |   Suggest with the following modification:  **Proposal 7-1 for Issue#7: Flexible symbol indicated by *tdd-UL-DL-ConfigurationCommon* and not overlapped with SSB symbols indicated by *ssb-PositionsInBurst* can be regarded as available symbols for Msg3 PUSCH repetition.**  Note that, according to the agreement, SSB symbols are NOT used to ‘cancel’ Msg3 repetition, but to determine the available symbol. |
| Nokia/NSB | Agree with CATT. |
| NTT DOCOMO | We are fine with the proposal. |
| Xiaomi | We are fine with the proposal. |
| OPPO | We are fine with the proposal. |
| WILUS | Support. Also fine with the CATT’s modification. |
| ZTE | Fine with the proposal. |
| Ericsson1 | Fine with the proposal. |
| Qualcomm | Fine with the proposal |
| FL | @LG, We have already agreed that ‘The available slot of Msg3 PUSCH repetition is only determined by the tdd-UL-DL-ConfigurationCommon and ssb-PositionsInBurst, no other additional Rel-16 signals/signalings will be considered’. So, no need to add other conditions to determine available slot.  @Sharp, According to previous agreement, we already have an FFS about how to use flexible symbols indicated by TDD-UL-DL-Configcommon. The additional FFS seems not necessary and we anyway will discuss based on the Table 2.3-1 below  @Intel, CATT, CATT’s modification looks reasonable and could address Intel’s question. |

**Proposal 7-v1 for Issue#7: Flexible symbol indicated by *tdd-UL-DL-ConfigurationCommon* and not overlapped with SSB symbols indicated by *ssb-PositionsInBurst* can be regarded as available symbols for Msg3 PUSCH repetition.**

**Please provide your comment below only if you have strong concerns.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | @FL, Thanks for your kind explanation. We are also fine with the modifications if it is the common understanding of other companies. |
| Apple | We are fine the latest FL’s proposal after adding **symbols indicated by *pdcch-ConfigSIB1* in *MIB* for a CORESET for Type0-PDCCH CSS set** |
| FL | @LG Thanks for the constructive discussion.  @Apple We only agreed tdd-UL-DL-ConfigurationCommon and ssb-PositionsInBurst for available slot determination. In addition, flexible symbols indicated by pdcch-ConfigSIB1 in MIB for a CORESET for Type0-PDCCH CSS set can be used for Msg3 transmission in legacy. Detailed analysis please find in the Appendix. |

**Regarding how to solve the collision issue on flexible symbols, companies are encouraged to indicate your position in Table 2.3.-1 , with also providing your justification below. Note that, if no consensus can be made, as a consequence, Alt 3 would be the default solution.**

Table 3.3-1

|  |  |  |
| --- | --- | --- |
| **Alternative solutions for Issue#7** | **Support** | **Concern** |
| Alt 1: Additional explicit indication is introduced to indicate whether flexible slots/symbols configured via TDD-UL-DL-Configcommon are available for Msg3 repetition. | Sharp, vivo, Panasonic, Samsung, Xiaomi,OPPO, Qualcomm | Intel, CATT, Nokia/NSB, Ericsson, LG |
| Alt 2: The actual transmission of Msg3 PUSCH repetition in an available slot cannot be canceled by downlink symbols indicated by *tdd-UL-DL-ConfigurationDedicated.* | Sharp, DCM | Intel, vivo, CATT, Nokia/NSB, Ericsson, LG |
| Alt 3: No need additional indication and legacy dropping rules are applied in case of collision with downlink symbols indicated by *tdd-UL-DL-ConfigurationDedicated.* | Intel, Panasonic, CATT, Nokia/NSB, Ericsson, WILUS, LG | Sharp, vivo, OPPO, DCM |

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Intel | We do not think additional indication is needed. Our view is that as Msg3 PUSCH repetition is based on repetition type A where same time domain resource allocation in different slots is employed, gNB schedule can make proper decision similar to Msg3 PUSCH without repetition. |
| Sharp | Alt 3 causes ambiguity on cancellation behavior at gNB/UE side. Since the gNB doesn’t know to which UE it scheduled msg3 repetition, the UE cannot identify whether the scheduled UE omitted some repetitions based on *tdd-UL-DL-ConfigurationDedicated.* |
| vivo | Regarding potential ways provided by FL, we have the following comments.   * 1) gNB does not configure too much flexible symbols by *tdd-UL-DL-ConfigurationCommon,* e.g., only few flexible symbols for DL-UL switching.   [vivo]: Although it is possible for NW to work this way. However, for deployment with *tdd-UL-DL-ConfigurationCommon* with more flexible symbols, it also has Msg3 coverage issue. Msg3 repetition feature should not be target for certain kind of TDD UL/DL configuration.   * 2) The flexible symbols configured by *tdd-UL-DL-ConfigurationCommon* cannot be changed to DL symbols semi-statically b*y tdd-UL-DL-ConfigurationDedicated,* while gNB can still schedule DL transmissions dynamically on flexible symbols.   [vivo]: If flexible symbols configured by *tdd-UL-DL-ConfigurationCommon* cannot be changed to DL symbols semi-statically b*y tdd-UL-DL-ConfigurationDedicated*’, it limits the NW flexibility on changing semi-static UL/DL configurations, which is already supported in rel-15/16. The price of supporting Msg3 repetition seems too much, if the NW flexibility on dedicated UL/DL configuration is limited in such way. Hence, it is not an efficient solution.   * 3) The flexible symbols configured by *tdd-UL-DL-ConfigurationCommon* can be carefully changed to DL symbols semi-statically b*y tdd-UL-DL-ConfigurationDedicated,* while gNB cannot schedule Msg3 repetition on these DL symbols.   [vivo]: Similar to previous question, NW ‘carefully’ configuration of semi-static DL symbols also limits UL/DL configuration flexibility already supported in Rel-15/Rel-16.  Besides, not only tdd-UL-DL-ConfigurationDedicated, NW may also configure semi-static DL transmissions on flexible symbols configured by tdd-UL-DL-ConfigurationCommon, e.g., PDCCH monitoring, NW may uniformly configure the monitoring occasions in time domain, for low latency services for some UEs, which is also transparent to idle/inactive UEs. Carefully configuring semi-static DL means Msg3 repetition feature is not well coexisted with other features in a NW.  Hence, it is not an efficient solution.  For the three alternatives, no need to discuss Alt-2, since we already have following agreements. And *tdd-UL-DL-ConfigurationDedicated* is transparent to idle/inactive UEs.  Agreement**:** Available slots for Msg3 PUSCH repetition do not depend on *tdd-UL-DL-ConfigurationDedicated*.  If Alt-3 is adopted for Msg3 repetition, as we commented above, it is un-efficient that the applicable deployment seems fallback to era that flexible symbols are not supported as in LTE. |
| Panasonic | In our view, Alt.1 could provide efficient utilization of UL resource. Alt.3 also can work at the cost of less efficiency of resource utilization. Although our slight preference is Alt.1, Alt.3 is also acceptable. |
| CATT | We share the same view as intel. Whether to schedule Msg3 with repetition is decided by gNB. The concern proposed by Sharp will not exist. The gNB can ensure no other downlink transmissions would be scheduled on the flexible slots/symbols configured via *tdd-UL-DL-ConfigurationCommon* overlapping with Msg3 PUSCH repetition.  Alt.3 is preferred. |
| Samsung | Alt.1 is important for gNB to flexibliy utilize the UL resource according to the network situation timely. |
| Nokia/NSB | Alt. 3 is preferred for the reasons explained by CATT and Intel. It is also worth noting that the time we would need to spend to discuss optimization may be too much (i) given the limited available time, and (ii) given that we cannot all agree on the actual relevance of this use case. |
| NTT DOCOMO | When UE transmits Msg3, the networks does not know which UE is transmitting and the configuration of that UE. As a result, network and UE might have different understanding about TDRA if *Configuration Dedicated* is considered for procedures. |
| OPPO | Alt.1 is preferred. Alt.3 will bring large scheduling restriction on Msg3 repetition, since gNB should find the whole available UL symbols satisfying Msg3 repetition. The situation is more severe when large repetition factor is to be scheduled. We share the same view as Samsung. gNB can flexibly utilize the UL resource with Alt.1. |
| WILUS | Alt. 3 is preferred. Additionally, we propose to add a note for the first repetition, which indicated via TDRA. At least the same mechanism with Rel-15/16 should be guaranteed for the first repetition and should be applied regardless of which option is selected.  Note: If a UE indicated with Msg3 PUSCH on flexible symbol configured by tdd-UL-DL-ConfigurationCommon, Msg3 PUSCH transmission is guaranteed at least for the first repetition, i.e., no collision occur. |
| Ericsson1 | Similar view as Intel, there’s no need to consider the dedicated TDD configurations for msg3 repetitions, similar to msg3 repetition without repetition. |
| Huawei, HiSilicon | We haven’t seen the necessary to cancel the actual transmission of Msg3 repetition in an available slot according to *tdd-UL-DL-ConfigurationDedicated*. The gNB can ensure no downlink transmission in an available slot even though such available slot contains downlink symbol(s) indicated by *tdd-UL-DL-ConfigurationDedicated*.  Regarding the agreement quoted by vivo, we share the same view as vivo that Alt 2 is not in line with the agreement. |
| Qualcomm | We prefer Alt. 1. We think indication via SIB1 can be used for this purpose. |
| FL | @Huawei, HiSilicon I am a bit confused about your position. One one hand, you proposed Alt 2 in your contribution, which seems align with your first comment while seems contradictory with your second comment. Could you clarify more?  @All, The discussion is still open. I will make a proposal for this issue later. |
| NTT DOCOMO2 | The only difference between Alt2 and Alt3 is whether or not to refer to *tdd-UL-DL-ConfigurationDedicated.* As companies supporting Alt3 does not give any method for gNB to know if UE is in RRC connected or not before Msg3, Alt3 does not seem to be qualified due to misalignment between UE and gNB. |
| LG | We prefer Alt3. We have same view with all the proponent of Alt3. |
| Sharp2 | Our concern is that Alt.3 will cause misalignment issue between UE and gNB. If RAN1 agrees that gNB can ensure no potential misalignment issue between UE and gNB by proper scheduling, as indicated by CATT, we are fine with Alt.3 with adding the following note.  “The gNB has to ensure no other downlink transmissions would be scheduled on the flexible slots/symbols configured via *tdd-UL-DL-ConfigurationCommon* overlapping with Msg3 PUSCH repetition”. |
| Xiaomi | We share the same view as Samsung and Alt.1 is preferred by our company. |
| Nokia/NSB | All UL and DL transmissions in the cell occur only if NW scheduled/configured them, explicitly or implicitly. If this were not the case, the system would not work. It is hard to understand why NW shouldn’t be able to handle the problem considered by this issue by proper scheduling/configuration, as usual. Alt. 3 does not have any problem.  We are fine discussing what WILUS proposes.  Note sure we need what Sharp proposes. NW and UE should not be mandated any behavior. Operations always rely on the fact that smart NW and smart UE exist in the cell… |
| CATT2 | Echoing Nokia’s comments, from view of gNB, it is capable to avoid collision by implementation, e.g. Alt 3. Just for example, avoid scheduling DL for other UEs (in RRC\_CONNECTED state) when it schedules a RRC\_IDLE UE to transmit Msg3 repetition in flexible symbols indicated in *tdd-UL-DL-ConfigurationCommon*.  We think the note suggested by Sharp is the final result of Alt.3. But it is unlikely to be captured in the spec. Not sure if we need it here. |
| CMCC | Share the similar view that Sharp’s notes are not necessary or could be captured in anywhere.  Alt 3 could work and we should be cautious about further optimizations. |

#### Second round

In this round of discussion, FL suggests focusing on **Proposal 7-v1 for Issue#7** discussed in GTW session.

**Proposal 7-v1 for Issue#7: Flexible symbol indicated by *tdd-UL-DL-ConfigurationCommon* and not overlapped with SSB symbols indicated by *ssb-PositionsInBurst* can be regarded as available symbols for Msg3 PUSCH repetition.**

First of all, there are two steps for Msg3 PUSCH repetition counting based on available slot.

* Step 1: How to determine available slot
* Step 2: Determine the actual transmission of a Msg3 repetition in an available slot.

All our discussion so far is only on Step 1. Whether step 2 is needed or if needed how to determine is to be discussed separately under Issue #8, which is not open for discussion before.

Regarding Step 1, we have the following agreements.

Agreement**:** Available slot for Msg3 PUSCH repetition depends on *TDD-UL-DL-Configcommon*.

* A slot is determined as available for Msg3 repetition only if the consecutive symbols allocated for Msg3 repetition in the slot are all available symbols.
  + UL symbols indicated by *TDD-UL-DL-Configcommon* are determined as available for Msg3 repetition.
  + FFS whether and how to use flexible symbols indicated by *TDD-UL-DL-Configcommon*.

**Agreement**

* The available slot of Msg3 PUSCH repetition is only determined by the *tdd-UL-DL-ConfigurationCommon* and *ssb-PositionsInBurst*, no other additional Rel-16 signals/signalings will be considered.
* If a symbol for Msg3 repetition in a slot overlaps with SSB transmission [FFS:N Gap symbols after SSB], the slot is determined as not available during the counting of repetitions. As there is no Msg3 repetition in the slot, no Msg3 repetition omission applies to the slot.

And, **Proposal 7-v1 for Issue#7** is to further clarify Step 1 to address the ‘whether’ part in the FFS points in the first agreements above.

So, the proposal is to discuss Step 1: whether the flexible symbol indicated by tdd-UL-DL-ConfigurationCommon is **available** symbol or not. It is not about Step 2: if it is available, whether a transmission on the available slot can be actually transmitted or not. Therefore, there is no need to consider ‘symbols indicated by pdcch-ConfigSIB1 in *MIB* for a CORESET for Type0-PDCCH CSS set’ in the proposal, as we agreed no additional signalings will be considered for available slot determination. The collision handling between Msg3 repetition and ‘symbols indicated by *pdcch-ConfigSIB1* in *MIB* for a CORESET for Type0-PDCCH CSS set’ in an available slot would be discussed in Issue #8, where legacy rules are also summarized.

We have already agreed if a symbol for Msg3 repetition in a slot overlaps with SSB transmission, the slot is determined as not available already. So, I suggest deleting SSB parts in the proposal, otherwise we may also need to discuss whether to add ‘N gap symbols after SSB’ also.

**Proposal 7-v1 for Issue#7: Flexible symbol indicated by *tdd-UL-DL-ConfigurationCommon* ~~and not overlapped with SSB symbols indicated by~~ *~~ssb-PositionsInBurst~~* can be regarded as available symbols for Msg3 PUSCH repetition.**

**Please provide your comment below only if you have strong concerns.**

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| **Company** | **Comments** |
| Intel | We suggest to add it back.  We have similar discussion in AI 8.8.1.1 and we should follow the conclusion/agreement made in AI 8.8.1.1. Flexible symbols not used for SSB transmission are the only condition to be considered for available symbols for Msg3 repeittion. We do not need to consider CORESET0 with type 0 CSS and Ngap. |
| Ericsson3 | We’re fine with FL proposal and also fine with the removed red text added back.  As FL clarified and most of the companies already commented, this is the just the 1st step of determining available slot for counting the number of msg3 repetitions, whether msg3 is actually transmitted can be determined in a 2nd step based on legacy rules applied for msg3 transmissions without repetition, and these legacy rules are not necessarily to be discussed here. |

### [Open] Issue #8 Transmission of Msg3 repetition on the available slots

It has been agreed the rules for the determination of ‘available slot’ for Msg3 repetition, i.e., Step 1 as the approach defined in AI 8.8.1.1. However whether/how to determine the rules for ‘actual transmission’, i.e., whether to drop a Msg3 repetition or not on the ‘available slot’ is still FFS.

Detailed companies views are summarized below.

* The UE determines whether to drop a Msg3 PUSCH repetition or not according to Rel-15/16 PUSCH dropping rules (FFS some exceptional cases), but the Msg3 PUSCH repetition is still counted in the K repetitions.
  + [1, Huawei, HiSilicon], and [17, Ericsson] propose some exceptional cases as follows. While [18, Sharp]? Prefer to follow legacy Rel-15/16 rules, including the rules related to SFI, UL signals and CI etc.
    - [1, Huawei, HiSilicon]: The actual transmission of Msg3 PUSCH repetition in an available slot cannot be canceled by *tdd-UL-DL-ConfigurationDedicated*.
      * FL Note: As summarized in Issue#10, there are two cancellation cases in Rel-16.

Case a): Downlink symbols indicated by *tdd-UL-DL-ConfigurationCommon*, or by *tdd-UL-DL-ConfigurationDedicated*.

Case b): Symbols configured for SSB transmission.

However, it has already been agreed that *tdd-UL-DL-ConfigurationCommon* and SSB transmission are used for available slot determination. In other words, *tdd-UL-DL-ConfigurationCommon* and SSB transmission would not be used for canceling Msg3 repetition in Rel-17 as there is no Msg3 repetition in the slot with DL symbols or SSB transmission that would overlap with Msg3 repetition. Then, the only canceling case (if reusing Rel-16 rules) is due to ‘downlink symbols indicated by *tdd-UL-DL-ConfigurationDedicated’.*

* + - [17, Ericsson]: RAN1 is to further discuss whether Msg3 repetition can be cancelled by dynamic cancellation indication, whether flexible symbols for Msg3 repetition can be dynamically changed to be downlink, and the collision rules when Msg3 repetition collides with other UL channels and signals.

#### First round

The legacy collision handling for Msg3 transmission is summarized in the Appendix. It includes,

* Collision handling due to TDD configuration/SSB/CORESET for Type0-PDCCH CSS set
* Collision handling due to SFI.
* Collision handling due to UL CI.

Note that, since *tdd-UL-DL-ConfigurationCommon* and SSB transmission are used for available slot determination, the only canceling case for Msg3 repetition is due to collision with ‘downlink symbols indicated by *tdd-UL-DL-ConfigurationDedicated’.*

* + If the canceling case is precluded for Msg3 repetition (i.e., Alt 2 in Issue#7 in Table 3.3-1), then there would be no any canceling cases for Msg3 repetition, meaning we don’t need to discuss how to use the flexible symbols indicated by TDD-UL-DL-Configcommon. Based on the discussion on Issue#7, it seems few companies support Alt 2. That is, companies would like to reuse legacy cancellation rules while solve the ambiguity issue due to cancellation either based on Alt 1 (introduce additional signaling) or Alt 3 (leave to gNB scheduling).

Among above collisions, FL wants to emphasize the collision due to SSB//CORESET for Type0-PDCCH CSS set, as there is some confusion among companies.

In current spec, the collision handling between Msg3 transmission and SSB/CORESET for Type0-PDCCH CSS set are summarized below. It’s clear that the SSB transmission can be configured on flexible symbols, while UL channels/signals cannot be transmitted on these symbols. For CORESET for Type0-PDCCH CSS, it can be configured on flexible symbols, while there is no restriction on whether UL channels/signals can be transmitted or not. It means, on these flexible symbols configured for CORESET for Type0-PDCCH CSS, gNB can either schedule PDCCH transmission or Msg3 transmission. In other words, Msg3 PUSCH transmission cannot be cancelled by flexible symbols indicated for CORESET for Type0-PDCCH CSS.

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| For operation on a single carrier in unpaired spectrum, for a set of symbols of a slot indicated to a UE by *ssb-PositionsInBurst* in *SIB1* or *ssb-PositionsInBurst* in *ServingCellConfigCommon*, for reception of SS/PBCH blocks, the UE does not transmit PUSCH, PUCCH, PRACH in the slot if a transmission would overlap with any symbol from the set of symbols and the UE does not transmit SRS in the set of symbols of the slot. The UE does not expect the set of symbols of the slot to be indicated as uplink by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*, when provided to the UE. |
| 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*. |

With above analysis, FL would like to check companies’ views on whether these legacy collision handling rules (including canceling due to collision) can be reused for transmission of Msg3 PUSCH repetition in an available slot.

**Proposal for Issue#8: The Rel-15/16 Msg3 PUSCH collision handling rules are reused for transmission of Msg3 PUSCH repetition in an available slot.**

* **FFS: Rel-17 Msg3 PUSCH collision rules are also applied if introduced in other WI(s)**

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| **Company** | **Comments** |
| NTT DOCOMO | We think collision with *tdd-UL-DL-ConfigurationDedicated* does not need to be composed of Rel-17 Msg3 PUSCH collision rules. The ambiguity about whether UE is in RRC connected mode or not requires difficulty for gNB scheduling. Since Msg3 is only within a slot in Rel-15/16, smart scheduling without ambiguity is a cinch. However, with repetition, it requires a lot of effort to avoid allocating resources over ambiguous slots. |
| Intel | It is not clear the motivation of proposal.  We share similar view as NTT DOCOMO that this has clear difference between RRC CONNECTED and RRC IDLE mode UE. For instance, dynamic SFI/CI can not apply for the cancellation of Msg3 PUSCH repetition given that RRC configuration is not available for initial access. |
| Ericsson3 | Fine.  And we do not see the need to introduce new rules on top of legacy rules applied for msg3 transmission without repetition, unless other WIs introduces new rules in Rel-17. |
| LG | We share the same view with NTT DOCOMO. |
| Sharp | We understand that this proposal is the same as Alt.3 in Issue#7. Therefore, we echo the comment in Issue#7 below.  Our concern is that this proposal will cause misalignment issue between UE and gNB. If RAN1 agrees that gNB can ensure no potential misalignment issue between UE and gNB by proper scheduling, we are fine with the proposal with adding the following note.  “The gNB has to ensure no other downlink transmissions would be scheduled on the flexible slots/symbols configured via *tdd-UL-DL-ConfigurationCommon* overlapping with Msg3 PUSCH repetition”. |

### [Open] Issue #9 whether to consider ‘N Gap symbols after SSB’ for available slot determination for Msg3 repetition

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| **Agreement**   * The available slot of Msg3 PUSCH repetition is only determined by the tdd-UL-DL-ConfigurationCommon and ssb-PositionsInBurst, no other additional Rel-16 signals/signalings will be considered.   + If a symbol for Msg3 repetition in a slot overlaps with SSB transmission [FFS:N Gap symbols after SSB], the slot is determined as not available during the counting of repetitions. As there is no Msg3 repetition in the slot, no Msg3 repetition omission applies to the slot. |

[14, Samsung] prefers to consider ‘N Gap symbols after SSB’ for available slot determination for Msg3 PUSCH, as reasoning summarized below.

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| One small detail is that whether the Ngap symbols after the SSB should be considered or not. This Ngap symbol is from the specification of RO validation and msgA PO validation, as showing in following text using msgA PO as illustration.  ==================================38.213. section 8.1A==================================  if a UE is not provided *tdd-UL-DL-ConfigurationCommon*, a PUSCH occasion is valid if the PUSCH occasion  - does not precede a SS/PBCH block in the PUSCH slot, and  - starts at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2 and, if *channelAccessMode* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where the UE does not transmit [15, TS 37.213].  - if a UE is provided *tdd-UL-DL-ConfigurationCommon*, a PUSCH occasion is valid if the PUSCH occasion  - is within UL symbols, or  - does not precede a SS/PBCH block in the PUSCH slot, and  - starts at least symbols after a last downlink symbol and at least symbols after a last SS/PBCH block symbol, where is provided in Table 8.1-2 and, if *channelAccessMode* = *semistatic* is provided, does not overlap with a set of consecutive symbols before the start of a next channel occupancy time where the UE does not transmit [15, TS 37.213].  ==================================38.213. section 8.1A==================================  The movtivation of having such Ngap symbol was back to R15 discussion, it’s to allow gNB switching from DL tx to UL rx, thus we can see the value of Ngap is not large. And it’s not targeting for TA change or UE switching. By this purpose, we think the N gap symbol should be considered here.  In addition, we can see the requirement of validation is that only overlapped with SSB symbols, it has to avoid the symbols preceding a SSB and only the symbols after the last SSB + Ngap will be considered as valid. So here the similar rule should be applied.  ***Proposal 13: If a symbol for Msg3 repetition in a slot precedes any SSB in a slot or overlaps with last SSB transmission plus Ngap symbols after the SSB, where is provided in Table 8.1-2 from TS38.213, the slot is determined as not available during the counting of repetitions.*** |

On the other hand, [18, Sharp] doesn’t see the motivation of considering ‘N Gap symbols after SSB’ for available slot determination.

#### First round

FL’s understanding is ‘N Gap symbols after SSB’ is not considered for collision handling for Msg3 PUSCH in current specification, while it is considered for RO validation and msgA PUSCH occasion validation.

**Companies are encouraged to provide your views below regarding whether to consider ‘N Gap symbols after SSB’ for available slot determination for Msg3 repetition. Note that, if no consensus can be made, the default behavior is it will not be used for available slot determination for Msg3 repetition.**

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| **Company** | **Comments** |
| LG | For the Msg3 PUSCH without repetition, the ‘N gap symbols after SSB’ didn’t have to be taken into account, since the Msg3 PUSCH can be directly scheduled by using RAR UL grant on the UL resources without colliding with any DL. On the other hand, for the Msg3 PUSCH repetition, considering the ‘N gap symbols after SSB’ can be a safety device to ensure that any collisions are avoided during the whole repetitions. |
| Intel | We do not think we need N Gap symbols after SSB. Existing collision handling for Msg3 without repetition as defined in R15/16 should be reused. |
| Sharp | The gNB can avoid such collision by K2 indication in TDRA. |
| Vivo | Understand the intention. However, if we assume the starting symbol *S* and length *L* still follows the legacy default TDRA table, and L may be not a small value for Msg3 repetition, the slot is anyway determined as not available if there is one SSB in the slot. If we understand correctly, it seems further considering NGap after SSB is not needed?  **Table 6.1.2.1.1-2: Default PUSCH time domain resource allocation A for normal CP**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Row index** | **PUSCH mapping type** |  | ***S*** | ***L*** | | 1 | Type A | *J* | 0 | 14 | | 2 | Type A | *J* | 0 | 12 | | 3 | Type A | *J* | 0 | 10 | | 4 | Type B | *J* | 2 | 10 | | 5 | Type B | *J* | 4 | 10 | | 6 | Type B | *J* | 4 | 8 | | 7 | Type B | *J* | 4 | 6 | | 8 | Type A | *j*+1 | 0 | 14 | | 9 | Type A | *j*+1 | 0 | 12 | | 10 | Type A | *j*+1 | 0 | 10 | | 11 | Type A | *j*+2 | 0 | 14 | | 12 | Type A | *j*+2 | 0 | 12 | | 13 | Type A | *j*+2 | 0 | 10 | | 14 | Type B | *j* | 8 | 6 | | 15 | Type A | *j*+3 | 0 | 14 | | 16 | Type A | *j*+3 | 0 | 10 | |
| Samsung | To LG and Intel and sharp, I can agree that legacy only one slot msg3 could be avoided by gNB configuration, but since this is multiple repetiion in multiple slots. It is then different, the collision is we are discussing for more slots. And in addition, K2 is slot level offset, while we are discussing the collision in one slot, so we don’t think k2 can help much.  To vivo, the table is default table, and we have SIB1 indicated table as well. So the S + L could be more flexible by gNB configuration. In addition, SSB could be in the front of a slot, there will be cases to handle such collision. |
| Xiaomi | For msg.3 transmission without repetition, it can be achieved by gNB’s scheduling to avoid the SSB and msg.3 in the same slot. Thus, there is no collision between msg.3 transmission and SSB reception.  Anyway, if there are SSBs in a slot, symbol#2~symbol#5 and symbol#8~symbol#11 in the slot will be occupied by SSBs when multiple SSBs in a SSB burst is applied and there is only 2 spare symbols after the SSB. According to the Ngap symbols definition to the determination of the invalid RO, the Ngap symbols equals to 2. So, there is no symbols left for msg.3 transmission.    From above, there is no need to take Ngap symbols after SSBs into consideration for the determination of available slots. And, when the allocated symbols collide with SSB, the slot is just taken as an unavailable slot. |
| Ericsson1 | We share similar view as the majority companies, this gap requirement is not necessary for available slot determination for Msg3.  Available slot determination is just the first step introduced in this work item with concerns on downlink heavy TDD configurations, existing rules for determining actual msg3 PUSCH transmissions are enough for handling collisions, dynamic/dedicated configurations. |
| FL | Based on the inputs from companies, it seems the majority doesn’t support to consider ‘N Gap symbols after SSB’ for available slot determination for Msg3 repetition. Technically speaking, either way could work.  In such situation, the consequence is that ‘N Gap symbols after SSB’ is not used for available slot determination for Msg3 repetition. @Samsung, Situation will not change, and this is the only output we can get. Hope this could be acceptable for you. |

**Proposal for Issue#9: ‘N Gap symbols after SSB’ is not used for available slot determination for Msg3 repetition.**

**Please provide your comment below only if you have strong concerns.**

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| **Company** | **Comments** |
| LG | We have same opinion with Samsung. We think the N gap symbols after SSB is needed since we are now considering repetitions over multiple slots. Nonetheless, since the majority view is not to consider the N gap, we can make an agreement with the proposal as a WA, and then we check later whether if there is any problem. It seems more constructive way for our progress. |
| FL | @LG Ok with the suggestion.  **Proposed working assumption for Issue#9: ‘N Gap symbols after SSB’ is not used for available slot determination for Msg3 repetition.** |

#### Second round

Based on the discussion, it is clear that no consensus could be made about whether to consider ‘N Gap symbols after SSB’ for available slot determination for Msg3 repetition. The argument from each side is clear. From FL perspective, it is just a matter of whether gNB can well handle the collision due to ‘N Gap symbols after SSB’ by implementation as legacy, and it could be arguable from each side. Here, FL would like to check again whether companies’ position would be changed. If not changed, the only way we can go with is the following conclusion.

**Proposed conclusion: No consensus on support of ‘N Gap symbols after SSB’ for available slot determination for Msg3 repetition.**

Companies are encouraged to provide your views below.

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| --- | --- |
| **Company** | **Comments** |
| NTT DOCOMO | N Gap symbols after SSB does not need to be considered for available slot determination for Msg3 repetition. |
| Nokia/NSB | Fine with the conclusion |
| Intel | We are fine with the conclusion. |
| Ericsson3 | Fine. |

## RV pattern

### [Closed] Issue#10: RV pattern for Msg3 repetition

In NR Rel-15/16, a UE shall use RV0 for Msg3 initial transmission, and use the 2-bit RV bit field in DCI format 0\_0 scrambled by TC-RNTI for RV indication. If Msg3 repetition is enabled, the following rules were agreed in RAN1#105-e.

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| Agreement: Use a fixed RV sequence [0 2 3 1] for repetition of Msg3 initial and re-transmission.   * The RV cycling for Msg3 initial transmission follows the rule specified in the first row in Table 6.1.2.1-2 in TS38.214. * The RV cycling for Msg3 re-transmission follows the rules specified in Table 6.1.2.1-2 in TS38.214. * FFS: The RV cycling for Msg3 is based on transmission occasions on available slot. |

Regarding the FFS point, all companies raising this issue propose that similar approach that defined for enhanced PUSCH repetition type A can be reused for Msg3 repetition. It is summarized as follows.

Each available slot identified by the UE is considered as a transmission occasion for Msg3 PUSCH repetition.

* RV is cycled across transmission occasions, irrespective of whether Msg3 PUSCH transmission in the transmission occasion is further omitted or not.
* Support: [4, ZTE], [6, CATT], [14, Samsung], [18, Sharp], [17, Ericsson], [22, LG]

**The issue is minor and the only concern is that whether Msg3 PUSCH transmission can be cancelled by any other transmission in the available slot, i,e, whether there would be further omission or not. FL suggests to further discuss this issue after more progress is made for Issue#8 and Issue#9.**

## Frequency hopping related issues.

### [Open] Issue#11: Support of intra-slot frequency hopping for Msg3 PUSCH with repetition

In Rel-15/16, intra-slot FH is supported for Msg3 transmission without repetition. If repetition is enabled for Msg3, it has been agreed to support inter-slot FH. Then, it needs to discuss whether intra-FH could be still supported.

This issue have been discussed in the past three RAN1 meetings without any consensus. In RAN1#105-e, the following conclusion was reached to encourage companies provide addition evaluations.

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| **Conclusion:**   * Companies are encouraged to perform additional evaluations regarding intra-slot frequency hopping for Msg 3 with repetition. Aim to conclude whether or not to support this feature in RAN1#106-e (note: if supported, the intention is to not configure intra- and inter-slot frequency hopping simultaneously) |

[1, Huawei, HiSilicon], [17, Ericsson], [20, NTT DOCOMO] and [22, LG] provide some evaluation results, and the observations are summarized as follows.

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| [1, Huawei, HiSilicon]:  For the inter-slot frequency hopping only with 1 symbol front-loaded DMRS and the intra-slot frequency hopping with 1 symbol front-loaded DMRS as well as 1 symbol additional DMRS, the performance of both is approximately the same. Inter-slot frequency hopping provides about 1 dB gain over intra-slot frequency hopping, when both are configured with 1 symbol front-loaded DMRS and 1 symbol additional DMRS.  [17, Ericsson]:  Initial link level results show 1 dB gain from inter-slot hopping over two frequencies compared to repetition with intra-slot FH.  [20, NTT DOCOMO]:  Intra-slot frequency hopping does not provide the gain in terms of coverage performance under the simulation assumptions made in coverage enhancements.  [22, LG]:  Inter-slot frequency hopping shows better performance than intra-slot frequency hopping when msg3 PUSCH repetition is applied. |

Companies’ views on the following two options are summarized below.

* **Option 1:** Support intra-slot frequency hopping for Msg3 with repetition.
* Intra-slot frequency hopping and inter-slot frequency hopping cannot be enabled simultaneously.
* When intra-slot frequency hopping is configured, the UE assumes the same starting RB and the same frequency offset for Msg3 PUSCH repetitions within a transmission.
  + [2, OPPO], [4, ZTE], [7, China Telecom],[8, Xiaomi],[10, Intel], [11, Apple], [12, Qualcomm] [13, Panasonic], argue that intra-slot FH could provide additional flexibility for UE multiplexing. An example is shown in Figure 2.5.1.
  + [2, OPPO], [4, ZTE], [7, China Telecom],[8, Xiaomi],[10, Intel], [13, Panasonic]: If both intra-slot and inter-slot FH is supported for Msg3 PUSCH repetition, one of the FH mechanisms can be configured by higher layers via SIB1. Further, FH flag in the RAR UL grant and DCI format 0\_0 can be used to enable FH.
  + [11, Apple]: FH is always enabled for a UE with Msg3 transmission with repetitions.The single bit for FH flag is repurposed to indicate the FH mode.
  + [12, Qualcomm]: Use the existing FH flag for indicating intra-slot FH, and reinterpret another bit filed for inter-slot FH.

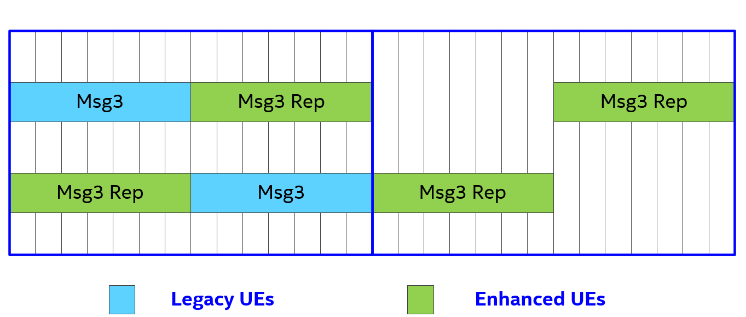


Figure 2.5.1 Multiplexing among two legacy UEs without Msg3 repetition and one Rel-17 UEs with Msg3 repetition

* **Option 2:** Support only intra-slot frequency hopping for Msg3 PUSCH without repetition and only inter-slot frequency hopping for Msg3 PUSCH with repetition.
  + [1, Huawei, HiSilicon], [6, CATT], [8, Xiaomi],[14, Samsung], [16, Nokia/NSB], [17, Ericsson], [23, WILUS]
  + [1, Huawei, HiSilicon]: If UE is indicated with Msg3 PUSCH with repetition, the frequency hopping flag information field in UL RAR grant is reused to indicate inter-slot frequency hopping.

Table 2.5-1 Summary of inter-slot FH for Msg3 repetition

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Support** | **Can live with** | **Have strong concern** | **Pros&Cons** |
| **Option 1** | Qualcomm, Panasonic, Intel, Xiaomi, ZTE, Apple, OPPO, [Vivo, Sharp, China Telecom, Spreadtrum], | DCM | Ericsson | **Pros:**   * Better multiplexing with legacy UEs.   **Cons:**   * 1 dB SNR loss in some cases * More spec efforts on determining the signaling design. |
| **Option 2** | CATT, Samsung, Ericsson, WILUS, Nokia/NSB, Huawei, Hisilicon, Xiaomi, | [OPPO], Apple, DCM | Intel | **Pros:**   * Less spec effort.   **Cons:**   * Less flexibility regarding multiplexing with legacy UEs. |

#### First round

**The proposal from the last meeting is copied below.**

*For frequency hopping for Msg3 repetition, down-select one of the two options below.*

* ***Option 1:*** *Support intra-slot frequency hopping for Msg3 with repetition.*
* *Intra-slot frequency hopping and inter-slot frequency hopping cannot be enabled simultaneously.*
* *When intra-slot frequency hopping is configured, the UE assumes the same starting RB and the same frequency offset for Msg3 PUSCH repetitions within a transmission.*
* ***Option 2:*** *Support only intra-slot frequency hopping for Msg3 PUSCH without repetition and only inter-slot frequency hopping for Msg3 PUSCH with repetition.*
* *If UE is indicated with Msg3 PUSCH with repetition, the frequency hopping flag information field in UL RAR grant or DCI format 0\_0 with CRC scrambled by TC-RNTI is reused to enable/disable inter-slot frequency hopping.*

This issue has been discussed from the first WI meeting. The pros and cons are quite well understood. If no consensus can be made on support of intra-slot frequency hopping for Msg3 with repetition, Option 2 would be the default behavior, though it would be not the preference for many companies. In addition, Option 2 could also avoid potential impact on RRC signaling.

**Proposed Conclusion for Issue#11: There is no consensus to additionally support intra-slot frequency hopping for Msg3 PUSCH repetition.**

**Companies are encouraged to provide your comments below.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | We support option2. Therefore, we are also fine with the proposed conclusion for Issue#11. |
| Intel | We think the motivation of introducing intra-slot frequency hopping is clear. We still believe it is beneficial to support intra-slot frequency hopping for Msg3 repetition. |
| Sharp | We prefer Option 1. |
| Panasonic | We prefer Option 1, but we can live with the proposed conclusion. |
| China Telecom | We prefer Option 1, we think the spec effort is indeed very small. But we can also live with the conclusion. |
| CATT | We prefer option 2. And hence we are fine with the proposed conclusion. |
| Samsung | Option 2. |
| Nokia/NSB | Prefer Option 2 and support the proposed conclusion. |
| OPPO | We prefer Option 1. |
| WILUS | We prefer Option 2. Please clarify that legacy mechanism can be reused for Rel-17 CE UE if a UE is scheduled Msg3 PUSCH without repetition. Thus, intra-slot FH is supported when a UE is scheduled Msg3 PUSCH without repetition. |
| ZTE | We prefer Option 1. |
| Ericsson1 | Support Option 2 according to evaluations we have so far for coverage enhancement of Msg3. |
| Huawei, HiSilicon | Prefer option 2. OK with the FL proposal. |
| FL | The situation hasn’t changed, and no consensus can be made. As a consequence, the proposed conclusion can be the only way to go.  I also added a note based on the comment from WILUS.  **Proposed Conclusion for Issue#11: There is no consensus to additionally support intra-slot frequency hopping for Msg3 PUSCH with repetition.**  **Note: intra-slot FH is supported when a UE is scheduled Msg3 PUSCH without repetition.** |
| LG | We are also fine with the FL’s new proposed conclusion. |
| Xiaomi | We prefer option 1. |
| Nokia/NSB | We are fine with the new proposed conclusion. |
| China Telecom | We still prefer option 1, but unfortunately that there is no consensus. We can live with the FL proposal. |
| CATT | Fine with the updated proposal. |
| Ericsson2 | Fine. |
| CMCC | Fine with the updated proposal. |
| FL | The following conclusion is reached in GTW session.  **Conclusion**  **There is no consensus to additionally support intra-slot frequency hopping for Msg3 PUSCH with repetition in Rel-17.**  **Note: intra-slot FH is supported when a UE is scheduled Msg3 PUSCH without repetition.** |

#### Second round

Based on the conclusion, intra-slot FH for Msg3 repetition would not be discussed and therefore supported in Rel-17. In such situation, the following proposal for enabling of inter-slot FH for Msg3 PUSCH with repetition seems straightforward.

**Proposal for Issue#11: If UE is indicated with Msg3 PUSCH with repetition, the frequency hopping flag information field in UL RAR grant or DCI format 0\_0 with CRC scrambled by TC-RNTI is reused to enable/disable inter-slot frequency hopping.**

**Companies are encouraged to provide your comments below.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| NTT DOCOMO | Support the proposal. |
| WILUS | We are fine with the proposal. |
| Nokia/NSB | Support |
| Panasonic | We are fine with the proposal. |
| Ericsson3 | Fine. |
| China Telecom | Support. |
| LG | Supportive. |

## Support of joint channel estimation for Msg3 repetition

Regarding applicability of PUSCH enhancements discussed in other agendas for Msg3 repetition, it has been agreed to support counting based on available slots and not support TBoMS. One remaining issue is whether to support joint channel estimation for Msg3 repetition.

### [Closed] Issue#12: Support of joint channel estimation for Msg3 repetition

Based on companies’ input, the support of joint channel estimation for Msg3 initial/re-transmission is summarized as follows.

* Support joint channel estimation for Msg3 repetition
  + Support: [2, OPPO], [13, Panasonic], [18, Sharp], [19, CMCC], [20, NTT DOCOMO],
    - [13, Panasonic], [18, Sharp]: Msg.3 repetition capable UE should always support joint channel estimation.

Some companies also provide evaluation results for joint channel estimation for Msg3 with the following observations.

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| [4, ZTE]: Cross-slot channel estimation among 4 Msg3 repetitions can provide about 1 dB gain.  [19, CMCC]: The joint channel estimation could bring additional 1.75dB coverage gain when 2 slot repetitions are considered.  [22, LG]: When DMRS bundling is enabled, inter-bundle frequency hopping can achieve much better performance than intra-slot frequency hopping or inter-slot frequency hopping. |

[12, Qualcomm]: If JCE is supported for Msg3 PUSCH repetitions with subject to power consistency and phase continuity requirements, only back-to-back PUSCH transmission is supported and the UE indicates its capability of supporting JCE during RACH procedure. UE is not expected to monitor Msg2 PDCCH between the repetitions of Msg3. gNB should be able to expect no UL beam switching among repetitions of Msg3.Support transmission of PTRS inside Msg3 repetitions.

[21, CATT] provides the following views as copied below.

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| In general, joint channel estimation on multiple slots requires gNB to operate channel estimation on consecutive slots. It makes sense to also take it into consideration for Msg3 PUSCH repetition in order to further enhance the coverage. The exactly same mechanisms for PUSCH can be reused for Msg3 PUSCH transmission with repetition type A. However, from UE’s view, the actual time domain window for Msg3 cannot be determined until a UE receives relative RRC configuration, e.g. window length L of the configured TDW. From gNB’s view, the actual time domain window cannot be determined when the maximum duration is unknown if RAN4 determines that multiple values of maximum duration are specified and need to be reported. Hence, we propose that joint channel estimation would be adopted only for the UEs in RRC\_CONNECTED state.  Proposal 1: Joint channel estimation can only apply to the UEs in RRC\_CONNECTED state.  Joint channel estimation cannot be applied to Msg3 PUSCH repetition during initial random access.  Joint channel estimation can be applied to Msg3 PUSCH repetition in RRC\_CONNECTED state. |

#### First round

As evaluated in SI phase, joint channel estimation could provide clear performance gain for PUSCH, PUCCH and Msg3 PUSCH. For PUSCH and PUCCH, good progress on the fundamental framework has been made in the last meeting. The main concern to apply joint channel estimation for Msg3 PUSCH repetition is because it may require additional capability reporting during initial access which would then causing further PRACH partitioning.

As suggested in [21, CATT], one possible way is to only support joint channel estimation for Msg3 PUSCH repetition in RRC\_CONNECTED state. In such case, the methods defined for normal PUSCH repetition type A in AI 8.8.1.3 could be reused, including the capability reporting and RRC signaling. According to TS 38.300, the cases that may trigger RACH procedure are summarized below, where the green highlighted cases could trigger CBRA procedure in RRC\_CONNECTED state.

* Case 1: Initial access from RRC\_IDLE;
* Case 2: RRC Connection Re-establishment procedure;
* Case 3: DL or UL data arrival during RRC\_CONNECTED when UL synchronisation status is "non-synchronised";
* Case 4: UL data arrival during RRC\_CONNECTED when there are no PUCCH resources for SR available;
* Case 5: SR failure;
* Case 6: Request by RRC upon synchronous reconfiguration (e.g. handover);
  + Note: This applies to both CBRA and CFRA
* Case 7: Transition from RRC\_INACTIVE;
* Case 8: To establish time alignment for a secondary TAG;
  + Note: This only applies to CFRA
* Case 9: Request for Other SI;
* Case 10: Beam failure recovery;
  + Note: This applies to both CBRA and CFRA
* Case 11: Consistent UL LBT failure on SpCell.

Based on above, FL suggests to discuss the following proposal.

**Proposed working assumption for Issue#12: Joint channel estimation is supported for Msg3 PUSCH repetition.**

* **It only applies to Msg3 PUSCH repetition in RRC\_CONNECTED state.**
* **The methods defined in AI 8.8.1.3 are reused, including the capability reporting and RRC signaling**

**Companies are encouraged to provide your comments below.**

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| **Company** | **Comments** |
| Intel | Even if the highlighted cases can be used for triggering CBRA procedure in RRC\_CONNECTED state, in this case, how can gNB know whether RACH procedure is from RRC\_IDLE/INACTIVE or RRC\_CONNECTED mode UEs? In other words, how can gNB know whether DMRS bundling is applied for Msg3 repetition.  Before we can agree the proposed working assumption, we need to answer the above question first. |
| Sharp | We understood the intention as restricting use cases to RACH resource dedicated for RRC\_CONNECTED UE (e.g., for BFR, handover, etc.). |
| vivo | Do not support this proposal.  For most cases, NW can not identify whether the preamble is from UE is RRC connected or from UE in idle/inactive. Hence, NW implementation is less likely to perform JCE for Msg3 repetitions. |
| Panasonic | Although we understand the intention, we share the similar question/concern from Intel and vivo. |
| CATT | We think JCE is beneficial if it can apply to Msg3 repetition, which is likely to be adopted only in RRC\_CONNECTED state. But if there is additional spec effort other than that in 8.8.1.3, or complicating the gNB implementation, we are fine to deprioritize this scenario. |
| Samsung | Not support.  Exactly like intel asked, even in connected mode, but before correctly decoded the msg3, gNB has no idea on who the UE is, so no point for this joint channel estimation. |
| Nokia/NSB | Agree with vivo, Intel and Samsung. Additionally, this can only be possible if Msg3 repetition capability is communicated to NW by UE after successful initial access. As per our understanding, an agreement on this has not been achieved yet. Suggest down-prioritization of this issue. |
| NTT DOCOMO | In our understanding, networks can only detect if UE is in RRC connected before Msg3, only when CFRA is applied. However, CFRA is out of scope in CovEnh. Accordingly, we should not confine JCE over Msg3 for UE in RRC\_CONNECTED state. |
| Xiaomi | Option 1 is more preferred by us. |
| ZTE | Agree the analysis from Intel for CBRA. Our understanding is PUSCH repetition could also be supported for CFRA case, while this could be discussed separately. |
| Ericsson1 | In CBRA, this is impossible as pointed out by other companies.  In CFRA, for PUSCH scheduled by RAR, we’re fine to support repetition though JCE specifically for this case may be not necessary as retransmission of this PUSCH scheduled by RAR can be further scheduled by DCI which is actually a normal PUSCH if repetition of the PUSCH scheduled by RAR is not enough. |
| Huawei, HiSilicon | Not support. Otherwise, the UE capable of Msg3 repetition has to be mandatorily support joint channel estimation. |
| FL | Based on the input, it seems the majority doesn’t support JCE for Msg3 repetition. In such case, FL would like to deprioritize this discussion. Therefore, the discussion on this issue is closed now. |

## Other issues

**Support of PUSCH repetition for CFRA PUSCH scheduled by RAR UL grant.**

[4, ZTE]: It was agreed in SI phase that enhancement to PUSCH scheduled by RAR UL grant will not consider the optimization specific for CFRA case. [4, ZTE] interprets that PUSCH repetition can be supported for CFRA while RAN1 will not do any optimization specific for CFRA. In most places of the current NR specifications, ‘a PUSCH scheduled by RAR UL grant’, which includes both Msg3 initial transmission and CFRA PUSCH, is widely used. That is, there is no differentiation of PHY layer handling for Msg3 PUSCH and CFRA PUSCH in most typical cases. Therefore, it is proposed that PUSCH repetition is supported for a PUSCH scheduled by RAR UL grant including CFRA PUSCH, while no optimization specific for CFRA PUSCH is considered.

[17, Ericsson]: Support indication that repetition of PUSCH scheduled by RAR for CFRA via UE specific signaling, e.g. in handover command.

**Support of qam64-LowSE MCS**

In [8, Xiaomi]: QAM64-LowSE MCS table provides lower coding rate, which is benefit for Msg.3 coverage enhancement with lower required SNR. So, QAM64-LowSE MCS table can be used for Msg.3 transmission in bad coverage. Therefore, it proposes to support the use of QAM64-LowSE MCS table for Msg.3 transmission with repetitions.

**Waveform indication for Msg3**

[11, Apple]: Specify a UE-specific procedure to enable/disable *transformprecoder* for Msg3 transmission, via:

* Alt1: explicit indication, e.g., repurpose some bits in RAR UL grant (for initial Msg3 transmission) or DCI format 0\_0 with CRC scrambled by TC-RNTI (for Msg3 retransmission) to indicate whether *transformprecoder* enabled or not
* Alt2: implicit indication, for example, *transformprecoder* is enabled if UE indicates to require coverage enhancement/recovery.

**Spatial domain transmission relation**

[12, Qualcomm]: Consider one of the following options on spatial domain transmission relation for Msg3 PUSCH transmission:

* Option 1: The UE transmits the Msg3 PUSCH repetitions within a transmission (initial transmission or re-transmission) using the same spatial domain transmission relation.
* Option 2: The UE may transmit the Msg3 PUSCH repetitions within a transmission (initial transmission or re-transmission) using the different spatial domain transmission relations.

[14, Samsung]: The repetitions for the msg3 PUSCH transmission that is scheduled by RAR use the same beam (spatial setting) as the one for the corresponding PRACH transmission. On the other hand, the UE can select the beam for msg3 re-transmissions.

**Support of additional C-RNTI and HARQ-ACK resource for MSG.4 PDSCH**

[24, vivo] observes that NW may decode MSG.3 PUSCH from multiple UEs, which have transmitted the same preamble on the same RO, if MSG.3 PUSCH repetition is introduced. It is beneficial to support contention resolution for multiple UEs simultaneously to reduce the access delay of CBRA procedure, if MSG.3 PUSCH repetition is supported. Therefore, it proposes additional (T)C-RNTI can be provided UE to support contention resolution for multiple UEs without initiating a new RACH attempt.

**Conditions of requesting Msg3 repetition**

In RAN1#105-e, it was agreed a UE can request Msg3 repetition when the RSRP of the downlink pathloss reference is lower than an RSRP threshold.

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| Agreement: A UE requests Msg3 PUSCH repetition at least when the RSRP of the downlink pathloss reference is lower than an RSRP threshold.   * FFS the determination of the RSRP threshold. |

Companies’ detailed views are summarized as follows.

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| [17, Ericsson]: Leave to RAN2 for decision.   * [17, Ericsson]:RAN2 is to discuss the details of how the procedure using the RSRP threshold shall work for determining whether Msg3 repetition shall be requested or not.   [13, Panasonic], [14, Samsung], [18, Sharp], [20, NTT DOCOMO]: RSRP threshold for triggering Msg.3 repetition should be configured (e.g., Msg3Reptition-RSRP-Threshold).  [12, Qualcomm]: The RSRP threshold depends on SS-RSRP and/or UE power class. FFS: whether RSRP thresholds are separate for NUL and SUL.  [16, Nokia/NSB]: A UE requests Msg3 PUSCH repetitions at least when the RSRP of the downlink pathloss reference belongs to the range {rsrp-ThresholdSSB, rsrp-ThresholdSSB + msg3-DeltaRepetitionRequest}, extremes included.   * A UE cannot request Msg3 PUSCH repetitions if the RSRP of the downlink pathloss reference is lower than rsrp-ThresholdSSB. * Note: A similar approach can be used in the SUL case, as a function of rsrp-ThresholdSSB-SUL.   [20, NTT DOCOMO]: Additionally, threshold of the number of Msg3 attempts should be supported as a condition to request Msg3 repetitions.  [22, LG]: The RSRP threshold is determined by the UE side considering on UE capability (e.g., UE maximum Tx power, UE Tx beam gain, number of UE Tx antenna.) |

FL notices that this issue is also under discussion in RAN2, as the determination of the RSRP threshold would impact the selection of RACH procedure defined in RAN2 (TS 38.321), with considering the conjunction with existing RSRP thresholds (e.g., SUL or 2-step RACH). Therefore, FL suggests discussing the issue in the email thread for RAN2 LS.

**UE capability reporting after initial access procedure**

If a UE requests Msg3 repetition, it implicitly means the UE reports its capability. However, gNB would not know how many of UEs in the cell is capable of Msg3 repetition. Many companies observe that allowing Rel-17 UEs report its capability of Msg3 repetition after initial access could be beneficial for gNB to optimize the PRACH configuration to reduce the collision probability.

* UE capability of supporting Msg3 PUSCH repetition is reported after initial access procedure
* Leave to RAN2 decision: [1, Huawei, HiSilicon]
* Support: [3, Spreadtrum Communications], [4, ZTE], [19, CMCC], [16, Nokia/NSB]
* Postpone the discussion: [12, Qualcomm],

FL suggests to leave the discussion in UE feature email thread.

**Early termination of Msg3 repetition**

In Rel-15/16 RACH procedure, a UE starts the *ra-ContentionResolutionTimer* and restart the *ra-ContentionResolutionTimer* at each HARQ retransmission in the first symbol after the end of the Msg3 transmission. The UE shall monitor PDCCH for Contention Resolution while the *ra-ContentionResolutionTimer* is running. If Msg3 repetition is enabled, then it needs to discuss whether to support early termination, i.e., whether the *ra-ContentionResolutionTimer* can start or re-start after each repetition.

In this meeting, [14, Samsung] proposes to support early termination while [2, OPPO] and [6, CATT] raise their concerns on the contrary.

# Appendix - A: Previous agreements

## RAN1#104-e

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| Agreements:   * For indication of the number of repetitions for Msg3 initial transmission, down-select one option from the options below.   + Option1: UL grant scheduling Msg3.     - FFS details.     - FFS fallbackRAR UL grant.     - Note: Optimization specific for fallbackRAR UL grant in 2-step RACH is not considered in Rel-17 CovEnh WI, if supported.   + Option2: DCI format 1\_0 with CRC scrambled by RA-RNTI     - FFS details.   + Option3: SIB1 only * Any modifications of RAR UL grant or DCI format 1\_0 with CRC scrambled by RA-RNTI for indicating Msg3 repetitions shall not impact the legacy UE interpretation of the RAR or DCI format 1\_0 with CRC scrambled by RA-RNTI respectively   Agreements:   * For indication of the number of repetitions for Msg3 re-transmission, down-select one option from the options below.   Option1: DCI format 0\_0 with CRC scrambled by TC-RNTI.  FFS details.  Any modifications of DCI format 0\_0 with CRC scrambled by TC-RNTI for indicating Msg3 repetitions shall not impact the legacy UE interpretation of the DCI format 0\_0 with CRC scrambled by TC-RNTI.  Option2: Can be determined based on the repetition number  for  Msg3 initial transmission  Agreements:  Support inter-slot frequency hopping for repetition of Msg3 initial and re-transmission.  FFS details, e.g., signaling etc.  **Agreements:**  For Msg3 PUSCH repetition,  the following options are considered, aiming for down-selection in RAN1#104b-e:   * Option 1-1: For gNB scheduled Msg3 PUSCH repetition without UE request, * A UE indicates to support of Msg3 PUSCH repetition via separate PRACH occasion or separate PRACH preamble in case of shared PRACH occasions. * For a UE supporting Msg3 PUSCH repetition, gNB decides whether to schedule Msg3 PUSCH repetition or not. If scheduled, gNB decides the number of repetitions. * FFS details if any. * Option 1-2: For gNB scheduled Msg3 PUSCH repetition without UE request, * gNB decides whether to schedule Msg3 PUSCH repetition or not. If scheduled, gNB decides the number of repetitions. * For UE does not support Msg3 PUSCH repetition, UE transmits Msg3 PUSCH without repetition * For UE does support Msg3 PUSCH repetition, UE transmits Msg3 PUSCH with repetition as indicated by gNB and UE uses, e.g., separate DMRS configuration or UCI multiplexing with Msg3 PUSCH (or other ways) * Note: e.g., this can be for differentiation between UEs not supporting Msg3 PUSCH repetition and Rel-17 CE UEs supporting Msg3 PUSCH repetition or between RACH procedure with Msg3 PUSCH repetition and Msg3 PUSCH without repetition, etc. * gNB blindly decodes Msg3 PUSCH with two different assumptions, w/ and w/o repetition. * FFS details if any. * Option 2-1: For UE triggered Msg3 PUSCH repetition with gNB indicating the number of repetitions, * A UE can trigger RACH procedure with Msg3 PUSCH repetition via separate PRACH occasion or separate PRACH preamble in case of shared PRACH occasions. * Whether a UE would trigger is based on some conditions, e.g., measured SS-RSRP threshold, which may or may not have spec impact. * If Msg3 PUSCH repetition is triggered by UE, gNB decides the number of repetitions for Msg3 PUSCH 3 (re)-transmission. * FFS details if any. * Option 2-2: For UE triggered Msg3 PUSCH repetition with gNB indicating the number of repetitions,   + gNB decides whether to schedule Msg3 PUSCH repetition or not. If scheduled, gNB decides the number of repetitions.   + If Msg3 PUSCH repetition is scheduled, UE transmits Msg3 PUSCH with or without repetition. If UE transmits Msg3 PUSCH repetition, the number of repetition follows the indication of gNB and UE uses e.g., separate DMRS configuration or UCI multiplexing with Msg3 PUSCH (or other ways) * Whether a UE would trigger is based on some conditions, e.g., measured SS-RSRP threshold, which may or may not have spec impact.   + FFS details if any. * Other options are not precluded. |

## RAN1#104b-e

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| Agreement: For Msg3 PUSCH repetition,  support the following modified Option 2-1.   * Option 2-1: For UE requested ~~triggered~~ Msg3 PUSCH repetition with gNB indicating the number of repetitions, * A UE can request ~~trigger RACH procedure with~~ Msg3 PUSCH repetition via separate PRACH resources (FFS details, e.g., separate PRACH occasion or separate PRACH preamble in case of shared PRACH occasions after SSB association, etc.). * Whether a UE would request ~~trigger~~ is based on some conditions, e.g., measured SS-RSRP threshold, which may or may not have spec impact. * If Msg3 PUSCH repetition is requested ~~triggered~~ by UE, gNB decides whether to schedule Msg3 PUSCH repetition or not. If scheduled, gNB decides the number of repetitions for Msg3 PUSCH 3 (re)-transmission. * FFS the UE capability of supporting Msg3 PUSCH repetition can be reported after initial access procedure as usual * FFS details if any.   Agreements: For the determination of RV for Msg3 PUSCH repetition,   * RV of the first repetition is determined in the same way as legacy.   + Use RV 0 for the first repetition of Msg3 PUSCH initial transmission.   + Use a dynamically indicated RV id via DCI 0\_0 with CRC scrambled by TC-RNTI for the first repetition of Msg3 PUSCH re-transmission. * FFS determination of the RV sequence.   Agreements: For indication of the number of repetitions for Msg3 initial transmission, Option 1 (i.e., using UL grant scheduling Msg3) is adopted.   * FFS additionally using MAC RAR for indication.   Agreements: For indication of the number of repetitions for Msg3 re-transmission, Option 1 (i.e., using DCI format 0\_0 with CRC scrambled by TC-RNTI) is adopted.  **Working assumption:**The number of repetitions is counted on the basis of available slots for Type A PUSCH repetitions for Msg3.   * FFS: the determination of available slots. |

## RAN1#105-e

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| Agreement: A UE requests Msg3 PUSCH repetition at least when the RSRP of the downlink pathloss reference is lower than an RSRP threshold.   * FFS the determination of the RSRP threshold.     Agreement:   * For requesting Msg3 PUSCH repetition, support the following:   + Use separate preamble with shared RO configured by the same PRACH configuration index with legacy UEs.     - FFS whether to introduce a PRACH mask to indicate a sub-set of ROs associated with a same SSB index within an SSB-RO mapping cycle for requesting Msg3 repetition for a UE.     - FFS definition of shared RO (e.g., whether the shared RO can be an RO with preamble(s) for 4-step RACH only or with preambles for both 4-step RACH and 2-step RACH).   + FFS whether or not to additionally support one (& only one) more option:     - E.g., option 2: Use separate RO configured by a separate PRACH configuration index from legacy UEs     - E.g., Option 3: Use separate RO, which include       * the separate RO configured by a separate RACH configuration index from legacy UE, and       * the remaining RO (if any) configured, by the same PRACH configuration index with legacy UEs, that cannot be used by legacy rules for PRACH transmission.     Working assumption:   * Using an information field from the existing information fields in RAR UL grant for indication of the number of repetition of Msg3 initial transmission   + Down-select only one from the following information fields in RAR UL grant for indication of the number of repetition of Msg3 initial transmission.     - TDRA information field with introducing a new TDRA table including the repetition factors.     - MCS information field     - TPC information field     - CSI request information field     - FDRA information field * The total size of RAR UL grant does not change. * Position of all fields in the bit sequence of the RAR UL grant does not change, regardless of whether they are repurposed or not. * FFS details, e.g., TDRA table selection, or whether/how to indicate which interpretation UE should use for the repurposed information field (legacy vs repurposed interpretation) etc.   Agreement: For repetition indication of Msg3 re-transmission, select one options from the following two options.   * Option 1: Use the same mechanism as supported for Msg3 initial transmission. * Option2: Use HARQ process number bit field in DCI format 0\_0 with CRC scrambled by TC-RNTI.   Agreement: Use a fixed RV sequence [0 2 3 1] for repetition of Msg3 initial and re-transmission.   * The RV cycling for Msg3 initial transmission follows the rule specified in the first row in Table 6.1.2.1-2 in TS38.214. * The RV cycling for Msg3 re-transmission follows the rules specified in Table 6.1.2.1-2 in TS38.214. * FFS: The RV cycling for Msg3 is based on transmission occasions on available slot.   **Conclusion:**   * Companies are encouraged to perform additional evaluations regarding intra-slot frequency hopping for Msg 3 with repetition. Aim to conclude whether or not to support this feature in RAN1#106-e (note: if supported, the intention is to not configure intra- and inter-slot frequency hopping simultaneously)   Agreement: Available slot for Msg3 PUSCH repetition doesn’t depend on dynamic SFI in DCI format 2-0.  Agreement**:** Available slots for Msg3 PUSCH repetition do not depend on *tdd-UL-DL-ConfigurationDedicated*.  Agreement: Available slot for Msg3 PUSCH repetition doesn’t depend on UL CI.  Agreement**:** Available slot for Msg3 PUSCH repetition depends on *TDD-UL-DL-Configcommon*.   * A slot is determined as available for Msg3 repetition only if the consecutive symbols allocated for Msg3 repetition in the slot are all available symbols.   + UL symbols indicated by *TDD-UL-DL-Configcommon* are determined as available for Msg3 repetition.   + FFS whether and how to use flexible symbols indicated by *TDD-UL-DL-Configcommon*. |

## RAN1#106-e

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| **Agreement**  Do NOT support fallback RAR UL grant in 2-step RACH for indicating Msg3 repetition.  **Agreement**  The separate preambles for requesting Msg3 repetition could be configured only in an RO configured with 4-step RACH preambles not for requesting Msg3 repetition.  **Working Assumption**  Down-select only one from the following methods for indication of the number of repetition of Msg3 initial transmission.   * Alt 1: If TDRA information field is chosen, introducing a new configurable TDRA table including the repetition factors.   + The new TDRA table is configured by SIB1, with selecting one of the two options below.     - Option 1: The new TDRA table includes separate new indication for K2, mapping type, SLIV and repetition factor.     - Option 2: The new TDRA table includes legacy indication for K2, mapping type and SLIV from legacy TDRA table, and new indication for repetition factor.   + If a new TDRA table is not configured, the legacy default TDRA table is used, and repetition factor K=1 is applied.     - ~~K=1.~~ * Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.   + X MSB bits of the MCS information field are used for repetition indication.     - FFS the value of X.     - FFS whether the X bits are directly used for indicating the repetition factor (i.e., the decimal value of X is equal to the repetition factor) or used for selecting one repetition factor from a predefined/SIB1 configured set. * Alt 3: If TPC information field is chosen, repurpose the TPC information field by selecting one of the two options below.   + Option 1: X LSB bits of the TPC information field are used for repetition indication.     - FFS the value of X.     - FFS whether the X bits are directly used for indicating the repetition factor (i.e., the decimal value of X is equal to the repetition factor) or used for selecting one repetition factor from a predefined/SIB1 configured set.   + Option 2: A predefined TPC command table with including repetition factor K is introduced.     - FFS details.   Agreements  Down-select one of the two options on how a UE should interpret the selected information field for indication of the number of repetitions.  Option 1:   * When a UE requests Msg3 repetition, the new TDRA table or repurposed information field is applied. gNB schedules Msg3 with or without repetition for the UE requesting Msg3 repetition.   + Repetition factor K=1 is included in the TDRA table or one entry/codepoint of the repurposed information field. * When the UE doesn’t request Msg3 repetition (including legacy UE), the legacy TDRA table or legacy information field is applied. gNB schedules Msg3 without repetition for the UE not requesting Msg3 repetition.   Option 2:   * When a UE requests Msg3 repetition, gNB schedules Msg3 with or without repetition by respectively using the new TDRA table or legacy TDRA table; or gNB schedules Msg3 with or without repetition by respectively using repurposed information field or legacy interpretation of information field. Whether the UE should apply the new or the legacy TDRA table, or apply repurposed or legacy interpretation of the information field, is indicated by gNB.   + FFS details, e.g. implicit or explicit indication or predefined.   + Repetition factor K=1 is NOT included in the TDRA table or one entry/codepoint of the repurposed information field. * When the UE doesn’t request Msg3 repetition (including legacy UE), gNB schedules Msg3 without repetition. The UE applies the legacy TDRA table, or the legacy interpretation of the information field.   **Agreement**   * Support at least repetition factor K = {2, 4} for Msg3 PUSCH repetition. * FFS whether to support other values, e.g., 8. * Note: K=1 is supported and how to support K=1 is FFS.   **Agreement**   * The available slot of Msg3 PUSCH repetition is only determined by the *tdd-UL-DL-ConfigurationCommon* and *ssb-PositionsInBurst*, no other additional Rel-16 signals/signalings will be considered. * If a symbol for Msg3 repetition in a slot overlaps with SSB transmission [FFS:N Gap symbols after SSB], the slot is determined as not available during the counting of repetitions. As there is no Msg3 repetition in the slot, no Msg3 repetition omission applies to the slot.   Agreements:  Do not support TBoMS for Msg3 in Rel-17 coverage enhancement WI. |

## RAN1#106bis-e

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| **Working Assumption**  **Down-select only one from the following methods for indication of the number of repetitions of Msg3 initial transmission.**   * **Alt 1: If TDRA information field is chosen, Option 2 is supported.**    + **The candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, [12], [16]}** * **Alt 2: If MCS information field is chosen, repurpose the MCS information field as follows.**   + **2 MSB bits of the MCS information field are used for selecting one repetition factor from a SIB1 configured set with 4 candidate values.**     - **The set of candidate values for repetition factor could be chosen from {[1], 2, 3, 4, 7, 8, [12], [16]}**   **Note: Whether ‘1’ is included depends on the outcome of interpretation of the selected information field.**  **Agreement**  **Include the following into the reply LS to** [**R1-2108712**](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106b-e\Docs\R1-2108712.zip)**(R2-2109195).**  **RAN1 thinks at least the number of preambles per SSB per RO for request of Msg3 repetition~~, i.e.,~~ *~~CB-PreamblesPerSSB~~*~~,~~ is needed. It’s up to RAN2 whether to indicate the start of preamble index for request of Msg3 repetition with shared RO.**  **Agreement**  **Include the following into the reply LS to** [**R1-2108712**](file:///C:\3gpp\Meetings\TSGR1\TSGR1_106b-e\Docs\R1-2108712.zip)**(R2-2109195).**   * **From RAN1 perspective, there is no need to separately configure the following legacy RACH parameters configured in *RACH-ConfigCommon* for requesting Msg3 PUSCH repetition with shared RO on a given UL carrier.** * ***prach-ConfigurationIndex*** * ***msg1-FDM*** * ***msg1-FrequencyStart*** * ***zeroCorrelationZoneConfig*** * ***totalNumberOfRA-Preambles*** * ***ssb-perRACH-OccasionAndCB-PreamblesPerSSB*** * ***FFS: rsrp-ThresholdSSB*** * ***rsrp-ThresholdSSB-SUL*** * ***prach-RootSequenceIndex*** * ***msg1-SubcarrierSpacing*** * ***restrictedSetConfig*** * ***msg3-transformPrecoder***   **Conclusion**  **There is no consensus to additionally support intra-slot frequency hopping for Msg3 PUSCH with repetition in Rel-17.**  **Note: intra-slot FH is supported when a UE is scheduled Msg3 PUSCH without repetition.** |

# Appendix - B: Legacy rules for use of flexible symbol for Msg3 transmission

FL’s understanding about Rel-15/16 rules for use of flexible symbol for Msg3 transmission is summarized below.

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| **If SFI is not configured,** the following symbols are available symbols for Msg3 transmission according to current specification.   * 1) Uplink symbols indicated by *tdd-UL-DL-ConfigurationCommon*, or by *tdd*-*UL-DL-ConfigurationDedicated* * 2) Flexible symbols indicated by *tdd-UL-DL-ConfigurationCommon* and *tdd*-*UL-DL-ConfigurationDedicated* if provided*.*   + If a UE is only provided by *tdd-UL-DL-ConfigurationCommon,* and a symbol is indicated as flexible symbol by *tdd-UL-DL-ConfigurationCommon,* it is a common understanding thatthe flexible symbol can be used for Msg3 transmission.   + If a UE is provided by both *tdd-UL-DL-ConfigurationCommon* and *tdd*-*UL-DL-ConfigurationDedicated,* and a symbol is indicated as flexible symbol byboth *tdd-UL-DL-ConfigurationCommon* and *tdd*-*UL-DL-ConfigurationDedicated,* the flexible symbol is available for Msg3 transmission.  |  | | --- | | 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 |   Meanwhile, the following symbols are not available for Msg3 transmission **if SFI is not configured.**   * 1) Downlink symbols indicated by *tdd-UL-DL-ConfigurationCommon*, or by *tdd*-*UL-DL-ConfigurationDedicated*  |  | | --- | | For a set of symbols of a slot that are indicated to a UE as downlink by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*, the UE does not transmit PUSCH, PUCCH, PRACH, or SRS when the PUSCH, PUCCH, PRACH, or SRS overlaps, even partially, with the set of symbols of the slot. |  * 2) Symbols configured for SSB transmission  |  | | --- | | For operation on a single carrier in unpaired spectrum, for a set of symbols of a slot indicated to a UE by *ssb-PositionsInBurst* in *SIB1* or *ssb-PositionsInBurst* in *ServingCellConfigCommon*, for reception of SS/PBCH blocks, the UE does not transmit PUSCH, PUCCH, PRACH in the slot if a transmission would overlap with any symbol from the set of symbols and the UE does not transmit SRS in the set of symbols of the slot. The UE does not expect the set of symbols of the slot to be indicated as uplink by *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated*, when provided to the UE. |  * Note that, a symbol for a CORESET for Type0-PDCCH CSS set indicated by *pdcch-ConfigSIB1* in *MIB* can be indicated as flexible symbol by *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* if provided, which can be used for Msg3 transmission. In other words, as long as it is a flexible symbol indicated by *tdd-UL-DL-ConfigurationCommon* and *tdd*-*UL-DL-ConfigurationDedicated* if provided*,* it can be used for Msg3 transmission.  |  | | --- | | 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*. | |
| **If dynamic SFI is configured,** the Rel-15/16 legacy UE behavior for collision handling of Msg3 transmission is summarized below.   * + If dynamic SFI is configured, a UE does not expect collision between Msg3 transmission and SFI indication.   + If dynamic SFI is configured and the DCI format 2\_0 is detected by UE, the flexible symbols indicated by the DCI format 2\_0 are available symbols for Msg3 transmission.   + If dynamic SFI is configured and while DCI format 2\_0 is not detected by UE, the flexible symbols indicated by *tdd-UL-DL-ConfigurationCommon*, and *tdd-UL-DL-ConfigurationDedicated* if provided are available symbols for Msg3 transmission.   The related specification texts are also copied below.   |  | | --- | | For a set of symbols of a slot, a UE does not expect to detect a DCI format 2\_0 with an SFI-index field value indicating the set of symbols in the slot as downlink and to detect a DCI format, a RAR UL grant, fallbackRAR UL grant, or successRAR indicating to the UE to transmit PUSCH, PUCCH, PRACH, or SRS in the set of symbols of the slot.  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 an SFI-index field value in DCI format 2\_0 indicates the set of symbols of the slot as flexible and the UE detects a DCI format, a RAR UL grant, fallbackRAR UL grant, or successRAR indicating to the UE to transmit PUSCH, PUCCH, PRACH, or SRS in the set of symbols of the slot the UE transmits the PUSCH, PUCCH, PRACH, or SRS in the set of symbols of the slot  - a UE does not expect to detect an SFI-index field value in DCI format 2\_0 indicating the set of symbols of the slot as downlink and also detect a DCI format, a RAR UL grant, fallbackRAR UL grant, or successRAR indicating to the UE to transmit SRS, PUSCH, PUCCH, or PRACH, in one or more symbols from the set of symbols of the slot  - ...  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 receives PDSCH or CSI-RS in the set of symbols of the slot if the UE receives a corresponding indication by a DCI format  - 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, a RAR UL grant, fallbackRAR UL grant, or successRAR | |

Regarding collision with UL CI, it was agreed that RACH related UL transmissions cannot be cancelled by UL CI in RAN1#98bis.

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| Agreements:   * SRS can be cancelled by UL CI * PUCCH cannot be cancelled by UL CI * RACH related UL transmissions cannot be cancelled by UL CI, including MSG 1/3 in case of 4-step RACH, MSG A in case of 2-step RACH. |

The related spec is:

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| An indication by a DCI format 2\_4 for a serving cell is applicable to a PUSCH transmission or an SRS transmission on the serving cell. If the PUSCH transmission or the SRS transmission is scheduled by a DCI format, the indication by the DCI format 2\_4 is applicable to the PUSCH transmission or SRS transmission only if the last symbol of the PDCCH reception providing the DCI format is earlier than the first symbol of the PDCCH reception providing the DCI format 2\_4. For the serving cell, the UE determines the first symbol of the symbols to be the first symbol that is after from the end of a PDCCH reception where the UE detects the DCI format 2\_4, where is obtained from for PUSCH processing capability 2 [6, TS 38.214] assuming where is provided by *delta\_Offset*, being the smallest SCS configuration between the SCS configuration of the PDCCH and the smallest SCS configuration provided in *scs-SpecificCarrierList* of *FrequencyInfoUL* or *FrequencyInfoUL-SIB*. The UE does not expect to cancel the PUSCH transmission or the SRS transmission before a corresponding symbol that is assuming that after a last symbol of a CORESET where the UE detects the DCI format 2\_4. |

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5. R1-2108993 Discussion on Type A PUSCH repetitions for Msg3 vivo
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