**3GPP TSG-RAN WG2 Meeting #116-e (draft) R2-2111346**

**Online, 1st – 12th November, 2021**

**Agenda Item: 8.19.2**

**Source: ZTE Corporation**

**Title: [AT116-e][112][CovEnh] Coverage enhancements aspects (ZTE)**

**Document for: Discussion and decision**

# Introduction

This document summarizes the following offline discussion.

* [AT116-e][112][CovEnh] Coverage enhancements aspects (ZTE)

Initial scope: Continue the discussion on proposals in [R2-2109894](file:///C:\Data\3GPP\Extracts\R2-2109894%20Consideration%20on%20Msg3%20repetition%20in%20CE.docx) and on CFRA/CBRA issues raised in other contributions, also taking into account the outcome of the session on RACH partitioning (when/if available), where applicable. For any proposal that might not require to be checked in the common session on RACH partitioning, also attempt email agreements.

Initial intended outcome: Summary of the offline discussion with e.g.:

* + - List of proposals for agreement (if any)
    - List of proposals that require online discussions
    - List of proposals that should not be pursued (if any)

Initial deadline (for companies' feedback): Friday 2021-11-05 0900 UTC

Initial deadline (for rapporteur's summary in R2-2111346): Friday 2021-11-05 1200 UTC

Proposals marked "for agreement" in R2-2111346 not challenged until Monday 2021-11-08 1000 UTC will be declared as agreed via email by the session chair (for the rest the discussion will further continue offline until the CB session in Week2).

Status: Ongoing

# Contact from companies

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| --- | --- |
| Company | Email |
| Huawei, HiSilicon | Chong Lou (louchong@huawei.com) |
| Samsung | anilag@samsung.com |
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# Background

Following agreements were made after Wednesday online discussion:

Agreements:

1. Confirm Msg3 repetition is supported on both NUL and SUL, and network can configure different RSRP thresholds for requesting Msg3 repetition on NUL and SUL.
2. Group B preambles with Msg3 repetition is supported, it is up to network to decide whether to configure Group B together with Msg3 repetition.
3. If Group B preambles with Msg3 repetition is configured, network can configure separate parameters for requesting Msg3 repetition, including ra-Msg3SizeGroupA, messagePowerOffsetGroupB and numberOfRA-PreamblesGroupA (ASN.1 details can be discussed in session on RACH partitioning)

In this offline, we continue discussing other remaining issues.

# Discussion

## Contention Resolution timer

RAN2 discussed the processing of *ra-ContentionResolutionTimer* in Msg3 repetition last meeting, but no consensus was reached, based on company contributions, following options were proposed for starting and restarting the *ra-ContentionResolutionTimer* in Msg3 repetition:

* Option 1: *ra-ContentionResolutionTimer* is started or restarted in the first symbol after all Msg3 repetitions [3][6][10][12];
* Option 2: *ra-ContentionResolutionTimer* is started or restarted in the first symbol after each Msg3 repetition [2][5][11][13];
* Option 3: Wait for RAN1 [4][14].

Based on company views, there is no clear majority. Technically, Option 2 is beneficial if PUSCH early termination can be supported, and proponent of Option 2 think it aligns with current MAC spec (i.e. consider Msg3 repetition as Msg3 re-transmission). But, some company argued that Option 2 will cause more power consumption and the UE may not be able to maintain power and phase continuity during Msg3 repetitions.

From RAN1 perspective, RAN1 has discussed the support of PUSCH early termination for several meetings but no conclusion was made. As far as we know, RAN1 has no plan to re-discuss this issue again. To move forward, rapporteur would suggest to adopt Option 1 (e.g. not support PUSCH early termination)

**Q1. Do companies agree with Option 1 (consider RAN1 has no conclusion to support PUSCH early termination)?**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Option 2, but no strong view | Option 2 is more aligned with the current MAC and gives more flexibility to NW. Since CR timer is only started upon CE RA, which is not frequent as normal scheduling, so the power consumption benefit of Option 1 is marginal. But we are also fine to follow majority. |
| Samsung | Option 2 | Also ok with Option 1, if that’s the Majority view. |
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## Separate RACH parameters

In Msg3 repetition, can network configure a separate set of RACH parameters (*preambleReceivedTargetPower, powerRampingStep, preambleTransMax*), RAN1’s answer from reply LS[1] is given below:

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| *Answer to Question 3: RAN1 has no consensus on optionally configuring a separate set of RACH parameters for preambleReceivedTargetPower, powerRampingStep, preambleTransMax for requesting Msg3 repetition with shared RO. If separate RO is supported for requesting Msg3 PUSCH repetition (not supported yet and no consensus in RAN1), RAN1 thinks a separate set of RACH parameters can be configured.* |

Basically, for separate RO, it is natural that network can configure separate set of RACH parameters for requesting Msg3 repetition, but for shared RO, there is no consensus in RAN1.

Companies are invited to show your views on this. It is expected that the eventual signalling of these parameters will be decided finally in the common RACH session. However, companies can still answer this question from CE perspective.

**Q2.1. From CE perspective, in shared RO case, do companies agree separate set of RACH parameters (*preambleReceivedTargetPower, powerRampingStep, preambleTransMax*) for requesting Msg3 repetition is not supported?**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Disagree | For shared RO, unfortunately we fail to understand the benefit of separate RACH parameters. It seems relevant to Msg1 enhancement indeed, and hence more suitable to discuss in R18 UL+. |
| Samsung | Disagree | We do not see need to configure separately in shared RO case |
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In addition, RAN1 also mentions the following in their reply LS[1].

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| * 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* * *rsrp-ThresholdSSB-SUL* * *prach-RootSequenceIndex* * *msg1-SubcarrierSpacing* * *restrictedSetConfig* * *msg3-transformPrecoder* |

Rapporteur thinks the parameters listed above look straightforward, companies are asked to show your views, and whether we can confirm this understanding in RAN2. Similar to above, the final details of these parameters are expected to be decided in the common RACH session. However, companies can still express their views from CE perspective.

**Q2.2. From CE perspective, in shared RO case, do companies agree there is no need to separately configure above parameters in RACH-ConfigCommon for requesting Msg3 repetition?**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree |  |
| Samsung | Agree |  |
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Besides above parameters, in RAN1 reply LS, RAN1 also indicates:

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

Regarding the first sentence, rapporteur thinks the configuration of number of preambles for requesting Msg3 repetition should be discussed in the common RACH session.

While for the second sentence, in [8], the following two proposals are given:

**Proposal 1: Introduce the start of preamble index in the shared RO configuration for CE specific RACH configuration.**

**Proposal 2: If R17 RACH partitioning is configured the shared RO, the start of preamble index is introduced for each R17 feature/feature specific RACH configuration.**

Rapporteur thinks network should inform UE the start of preamble index for CE, but as noted above, final signalling details are expected to be discussed in the common RACH session because a unified framework should be defined for multiple features or feature combinations. So, the following question is provided again to gather the company views from CE perspective.

**Q2.3. From CE perspective, in shared RO case, do companies agree how to configure the number of preambles per SSB per RO, and how to indicate the start of preamble index for requesting Msg3 repetition should be discussed in the common RACH session?**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree | It is under discussion in RACH partitioning session |
| Samsung | Agree |  |
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Regarding *rsrp-ThresholdSSB*, In RAN1 reply LS [1], RAN1 indicates that it can be beneficial to configure a separate *rsrp-ThresholdSSB* for requesting Msg3 repetition:

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| * 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. |

Different from the RSRP threshold used to determine the necessity of Msg3 repetition, rsrp-ThresholdSSB is used to select SSB and associated RACH resources. For Msg3 repetition capable UEs, if network can configure a separate rsrp-ThresholdSSB for Msg3 repetition, then UE has more chance to select “good” beams to trigger Msg3 repetition. An example is given in [7], as shown below.



**Q2.4. In shared RO case, do companies agree separate *rsrp-ThresholdSSB* can be configured for requesting Msg3 repetition?**

(Note: details of how to use the new *rsrp-ThresholdSSB* will be discussed in Q3.3)

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree | Already confirmed by RAN1 |
| Samsung | Agree |  |
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## Msg3 repetition evaluation in RACH procedure

In this section, we mainly discuss the steps of RACH procedure, and when UE selects Msg3 repetition resources. In Rel-16, the RACH procedure involves the following steps in that order:

• RACH triggering;

• Carrier selection (NUL or SUL);

• RA-Type selection(2-step RA or 4-step RA) and RA specific variables are initialized;

• SSB selection and RACH resource selection based on selected SSB;

• Msg1/MsgA transmission/retransmission.

In Rel-17, for RedCap UEs, separate initial UL BWP may be configured, so RedCap UEs will select the separate initial UL BWP if signalled in system information. Since RedCap UE may also support coverage enhancement, so for RedCap+CE UEs, BWP selection will be performed after carrier selection.

Based on company contributions, seems most companies agree that carrier selection and BWP selection should be performed ahead of Msg3 repetition evaluation. Although the common RACH session will also discuss the overall procedure considering other features, it seems from CE perspective, the carrier selection and BWP selection can happen ahead of msg3 repetition evaluation based on company contributions. So, we can check this.

**Q3.1. From CE perspective, do companies agree carrier selection and BWP selection (for RedCap capable UEs) should be preformed ahead of Msg3 repetition evaluation?**

**Note the overall procedure designed in the common RACH session can take this into account if this is agreeable**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree |  |
| Samsung | Agree |  |
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Then for RA-type selection, RAN1 and RAN2 have agreed Msg3 repetition is only applicable to 4-step RA, so it makes sense to first determine the RA-type, and then performs CE/non-CE selection once 4-step RA is selected. However, during online discussion, one company commented this can be discussed and determined in the common RACH session.

From rapporteur point of view, I see no harm to discuss this in CE session, and it will be helpful if CE session can provide some guidance to the common RACH session. (Also considering we know more knowledge of the applicable scenarios of Msg3 repetition)

So rapporteur would suggest to have some initial discussion during this CE offline, and ask the common RACH session for confirmation.

**Q3.2. From CE perspective, do companies agree RA-type selection should be performed ahead of Msg3 repetition evaluation? (I.e. UE first selects RA-type as in legacy behaviour, then evaluates Msg3 repetition criteria only if 4-step RA is selected)**

(If disagree, please describe your preferred UE behaviour in your comments)

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Comments | Both options result in the same. Regardless of which option to go, we prefer to have a unified procedure for all the features, which would make the MAC spec easier. |
| Samsung | Agree |  |
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Regarding SSB selection and Msg3 repetition evaluation, so far, following options are proposed:

(To facilitate the discussion, let’s assume the threshold configured for Msg3 repetition criterion is *rsrp-Threshold-Msg3Rep*):

* Option 1: UE first selects SSB based on Msg3 repetition specific *rsrp-ThresholdSSB* (if Q2.4 is agreed), and then determines whether Msg3 repetition is needed or not based on *rsrp-Threshold-Msg3Rep*. [7]
* Option 2: If none of SSB with SS-RSRP above the *rsrp-Threshold-Msg3Rep*, UE requests Msg3 PUSCH repetition, and further selects SSB based on Msg3 repetition specific *rsrp-ThresholdSSB* (if Q2.4 is agreed). [2]
* Option 3: UE first determines whether Msg3 repetition is needed or not based on *rsrp-Threshold-Msg3Rep* at the initialization phase of RA, and further selects SSB based on Msg3 repetition specific *rsrp-ThresholdSSB* (if Q2.4 is agreed). [2]
* Other?

In fact, rapporteur think there is no big difference between Option 1 and Option 2, but this will impact MAC CR, so companies are invited to show your views, and other solutions are not precluded.

Same statement as to previous question, we can discuss this in CE session, and ask RACH partitioning session for confirmation.

**Q3.3. From CE perspective, which option do you prefer for performing SSB selection and Msg3 repetition evaluation?**

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| **Company** | **Option x** | **Comments** |
| Huawei, HiSilicon | Option 3 | Option 3 is aligned with the current framework and the baseline from the RACH partitioning session as below:  As a baseline, the RA procedure design for Rel-17 should adhere to the following general principles:  a: Carrier selection (between NUL/SUL) should happen ahead of the initial RACH resource selection (i.e. feature combination is not considered in carrier selection).  b: Initial RACH resource should be selected based on the selected carrier for the selected feature combination (i.e., selected slice, SDT or not, REDCAP or not etc). Only the RACH resource matching the feature and/or feature combination of current RACH procedure will be considered as available in the RACH resource selection. |
| Samsung | See comments | Our preference is that Msg3 repetition criterion is checked at every RA attempt during the RA procedure. |
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## CFRA and CBRA

Based on companies contributions, two companies have provided proposals for CFRA scenario, see below:

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| Huawei[13] | Proposal 8: When the 4-step CFRA SSB are available for the selected BWP, one of the following three options can be adopted to proceed with Msg3 repetition RACH:   * Option 1: UEs perform the determination of Msg3 repetition before SSB selection but shall follow 4-step CFRA procedure if 4-step CFRA SSB is available during SSB selection. * Option 2: UEs first perform the determination of Msg3 repetition. If the criterion for Msg3 repetition is met, UEs shall follow 4-step CBRA procedure and by pass the 4-step CFRA SSB selection. * Option 3: UEs first evaluate whether 4-step CFRA SSB is available. If any, UEs shall perform 4-step CFRA. Otherwise, UEs proceed to perform the determination of Msg3 repetition. |
| Ericsson[12] | Proposal 10 CFRA for Msg3 (PUSCH scheduled by RAR) can be enabled by the network signalling how the UE shall interpret Msg2 in the CFRA configuration. |

In general, one company assumes CFRA cannot be performed together with Msg3 repetition (PUSCH scheduled by RAR), while the other company suggests to allow network to enable the Msg3 repetition signalling in RAR of CFRA. In [12], it further explains that for CFRA, since the dedicated preamble is preconfigured by network, network knows the UE after receiving Msg1, so it is feasible for network to indicate Msg3 repetition numbers in RAR, hence the performance of PUSCH transmission scheduled by RAR can be improved.

In fact, RAN1 has discussed this issue before, and thought it can be considered as long as no extra specification effort is needed. From rapporteur point of view, this is more RAN1 related issue, so Rapporteur would suggest to ask RAN1 if they have identified any problem in supporting this scenario.

**Q4.1. Do companies agree to ask RAN1 whether they have concern in supporting Msg3 repetition indication in RAR of CFRA?**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree, but | From our understanding, we fail to see the valid use case of CFRA to support “Msg3 rep”. Note that RAR grant in this case is not defined as Msg3 across all the spec. Normally CFRA can be only triggered in good channel condition, which is contradictory with Msg3 rep. But we are okay to ask RAN1 or wait for one more meeting to see if any progress on this in the coming RAN1 meeting. |
| Samsung | See comments | There is no Msg3 in case of CFRA. |
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Follow-up questions (e.g. P8 from [13]) can be discussed after we receive the feedback from RAN1.

## Consideration on Msg1 retransmission

Based on company contributions, several companies propose to discuss whether UE needs to re-evaluate Msg3 repetition criteria upon Msg1 restransmission, which means whether UE can switch from CE specific RACH to non-CE RACH (or vice versa) upon Msg1 retransmission.

First, the following general principles were agreed in the common RACH session last meeting:

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| *RAN2#115e Agreements from common RACH session*  6. As a baseline, the RA procedure design for Rel-17 should adhere to the following general principles:  a: Carrier selection (between NUL/SUL) should happen ahead of the initial RACH resource selection (i.e. feature combination is not considered in carrier selection).  b: Initial RACH resource should be selected based on the selected carrier for the selected feature combination (i.e., selected slice, SDT or not, REDCAP or not etc). Only the RACH resource matching the feature and/or feature combination of current RACH procedure will be considered as available in the RACH resource selection.  c: As a general rule, all RACH retransmissions (if any are needed, until RACH failure happens) shall be performed over the same RACH resources (and same carrier – NUL/SUL) as the one selected for initial RACH resource. However, we can discuss fallback on a case by case basis if there is a strong motivation and discuss them together in this AI. |

According to principle c, unless strong motivation is found, the selected RACH resource (pool) is not expected to be changed until RACH failure. If we follow this principle, it means the UE cannot switch from CE RACH to non-CE RACH upon Msg1 retransmission. This is similar to carrier selection and RA-type selection.

Although the common RACH session will also discuss the overall procedure considering other features, companies are encouraged to show your views from CE perspective.

**Q5.1. From CE perspective, do companies agree UE cannot switch from CE (i.e. requesting Msg3 Repetition) to non-CE (i.e. not requesting Msg3 repetition), or vice versa upon Msg1 retransmission?**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Comments | We would like to first clarify what does “switch” mean. If it means the UE switch from CE to non-CE or vice versa for every time Msg1 retx, it is agreeable. But we should also consider whether to allow “switch” for BWP selection in the case when only normal RA resources is configured on the active BWP. This can be discussed at a later phase by taking common session into account. |
| Samsung | Disagree | Our preference is that UE can determine CE or non CE during each RA preamble transmission |
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Besides the switching between CE and non-CE RACH, in [7], it is proposed to discuss the CE evaluation in 2-step RA. The motivation is to clarify that once 2-step RA is selected, then the UE does not need to evaluate the Msg3 repetition criteria upon each MsgA transmission. If the UE reaches the *msgA-TransMax*, and the UE falls back to 4-step RA, then the UE can evaluate whether to trigger 4-step RA with/wo CE.

To avoid misleading, the original P9 from [7] is updated as below:

**Proposal 9: Once 2-step RA is triggered, the UE ignores the Msg3 repetition configuration unless max MsgA retransmission is reached. (i.e. UE cannot change the RA type unless max MsgA retransmission is reached)**

As noted above, although the common RACH session will also discuss the overall procedure considering other features, companies are encouraged to show your views from CE perspective.

**Q5.2. From CE perspective, do companies agree with above Proposal 9?**

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| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Disagree | We have concerns on “fallback to 4-step”. If feature selection is determined at the initialization phase, it means that the UE cannot select the feature again even for “fallback” as some parameters are shared between 2-step and “fallback” 4-step. |
| Samsung | Agree |  |
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## Other

Any other issue that needs discussion?

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| **Company** | **Comments** |
| Huawei, HiSilicon | We would like to confirm further optimization on cell selection for CE is not considered in Rel-17. |
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# Conclusions

*TBD.*

# References

1. R2-2111210 Reply LS on Msg3 repetition in coverage enhancement (R1-2110585; contact: ZTE) RAN1 LS in Rel-17 NR\_cov\_enh-Core To:RAN2
2. R2-2109443 Further Discussion on RAN2 Impacts of Msg3 Repetition vivo discussion Rel-17 NR\_cov\_enh-Core
3. R2-2109456 RAN2 aspects of coverage enhancements Qualcomm Incorporated discussion Rel-17 NR\_cov\_enh-Core
4. R2-2109503 Discussion on CE’s impact on the start of ra-ContentionResolutionTimer OPPO discussion Rel-17 NR\_cov\_enh-Core
5. R2-2109530 MAC Aspects of UL Coverage Enhancements Samsung Electronics Co., Ltd discussion Rel-17 NR\_cov\_enh-Core
6. R2-2109877 RAN2 aspects of Msg3 PUSCH repetition Intel Corporation discussion Rel-17 NR\_cov\_enh-Core
7. R2-2109894 Consideration on Msg3 repetition in CE ZTE Corporation, Sanechips discussion Rel-17 NR\_cov\_enh-Core
8. R2-2110038 RAN2 impact of coverage enhancements Apple discussion Rel-17 NR\_cov\_enh-Core
9. R2-2110192 Considerations on requesting Msg3 repetition NEC Corporation discussion Rel-17 NR\_cov\_enh-Core
10. R2-2110440 Analysis on Type A PUSCH repetitions for Msg3 CATT discussion Rel-17 NR\_cov\_enh-Core
11. R2-2110814 RAN2 aspects for Coverage Enhancement Nokia, Nokia Shanghai Bell discussion Rel-17 NR\_cov\_enh-Core
12. R2-2110833 On Type A PUSCH repetitions for Msg3 Ericsson discussion Rel-17 NR\_cov\_enh
13. R2-2111026 Further discussions on RAN2 support of Msg3 PUSCH repetition Huawei, HiSilicon discussion Rel-17 NR\_cov\_enh-Core
14. R2-2111160 Discussion on Msg3 PUSCH repetion LG Electronics Inc. discussion Rel-17 NR\_cov\_enh-Core