**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

|  |  |
| --- | --- |
| Company | Email |
| Huawei, HiSilicon | Chong Lou (louchong@huawei.com) |
| Samsung | anilag@samsung.com |
| Ericsson | Jonas.sedin@ericsson.com |
| Xiaomi | jiangxiaowei@xiaomi.com |
| InterDigital | Faris.alfarhan@interdigital.com |
| Lenovo | hchoi5@lenovo.com |
| Qualcomm | Linhai He (linhaihe@qti.qualcomm.com) |
| ZTE | LiuJing (liu.jing30@zte.com.cn) |
| Nokia | samuli.turtinen@nokia.com |
| LG Electronics | gyeongcheol.lee@lge.com |
| China Telecom | wangj08@chinatelecom.cn |
| OPPO | Haitao Li (lihaitao@oppo.com) |
| vivo | yitao.mo@vivo.com |
| CATT | wanghaocheng@catt.cn |

# 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)?**

|  |  |  |
| --- | --- | --- |
| **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. |
| Ericsson | Option 1 | Correct that RAN1 has not discussed early termination (source: RAN1 feature leads) and the feature would have multiple issues to be resolved in RAN2 and likely RAN1, so the notion of option 2 added flexibility is questionable. The gain is questionable with the small amount of repetitions that are added for msg3 repetitions. We could see the benefit of it if extensive amount of repetitions are added.  Restarting a timer for each repetition is for instance not done for other timers such as DRX. |
| Xiaomi | Option 1 | Share the same view as rapporteur, if RAN1 has no plan to introduce early stop, option 2 has no benefits. But since RAN1 has not made final decision, we suggest to send a LS to RAN1 to tell our decision and to see if RAN1 has concerns over this. |
| InterDigital | Option 1 | Since early termination of repetition is not indicated by R1, we can assume PDCCH monitoring starts after all repetitions are transmitted. |
| Lenovo | Option 1 | PUSCH early termination is treated with low priority in RAN1. To move forward RAN2 should make a decision on CR timer and not wait for RAN1 discussion. |
| Qualcomm | Option 1 | We support rapporteur’s proposal. In addition, benefits for early termination for Msg3 repetition (e.g. UE power saving) have not been fully justified. |
| ZTE | Option 1 | Based on the situation in RAN1, it is really hard to agree Option 2 in RAN2. |
| Nokia | Option 2 |  |
| LGE | option 3 or option 2 | RAN1 will finalize their Rel-17 work in November meeting. This means that anyway RAN2 can know the conclusion of early PUSCH termination at the next RAN2 meeting and RAN2 can make a conclusion easily based on more concrete RAN1 final decisions. So, we prefer option 3 for now, but if we should choose one of two options, we prefer option 2 as it is more aligned with the current MAC spec. |
| China Telecom | Option 1 | Agree with the rapporteur’s view. Since RAN1 has no plan to re-discuss PUSCH early termination again, we’re fine to go with the majority view. |
| OPPO | Option 1 | Support rapporteur’s proposal. |
| vivo | Disagree | Option 2 has no impact on the current MAC spec. Besides, it is capable of early termination if NW implements this behavior (e.g. it is possible NW by implementation performs early termination as no restriction will be specified by the spec without consensus RAN1 view), which in turn helps UE to complete RA procedure ASAP. |
| CATT | Option1 | It has been agreed in RAN1#106 meeting that at least repetition factor K = {1, 2, 4} for MSG3 PUSCH repetition can be applied for MSG3 repetition. And in RAN1#106bis meeting, RAN1 made the assumption that the candidate values for repetition factor can be chosen from{[1], 2, 3, 4, 7, 8, [12], [16]}. Therefore, the network can configure one proper repetition number for MSG3 PUSCH for the UE based on the channel estimation. Hence, it is high probability that the MSG3 early termination will not be applied. Therefore, option 1 is more reasonable. |

## 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:

|  |
| --- |
| *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?**

|  |  |  |
| --- | --- | --- |
| **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+.  [Rapp] Seems your answer is “Agree”?  I now highlight “not” in the question to avoid misleading. ; ) |
| Samsung | Disagree | We do not see need to configure separately in shared RO case  [Rapp] same comment as above. |
| Ericsson | Disagree (we noted the highlighted part) | We do not have any strong opinion here for shared RO, but if we allow for these parameters to be configured for CE, then I do not see why we need restrictions for shared or non-shared RO. We can check if anything is needed when we have CRs. |
| Xiaomi | Agree or separately configure preambleTransMax | These parameter are all related to msg1 transmission except preambleTransMax, which will impact the number of Msg3 retransmissions. For 2-step RA, preambleTransMax is configured separately for shared RO, because MsgA transmission failure rate is different from Msg1. For CE, the PUSCH channel is the bottleneck, the setting of preambleTransMax is based on the retransmission required on PUSCH channel. With same amount of msg3 transmissions required, increasing preambleTransMax would require less msg3 repetition configuration, but delay will increase as UE needs to retransmit from msg1. Decreasing preambleTransMax and increasing msg3 repetition, on the other hand, will reduce the delay, and consumes less RPACH resource. In light of this, network can by implementation to decide whether to configure separate preambleTransMax.  Thus, we slight suggest that preambleTransMax may be configured separately. But we are also ok to not support separate configuration of all the 3 parameters. |
| InterDigital | Disagree | Same view as Ericsson |
| Lenovo | Agree | This is aligned with RAN1 reply. |
| Qualcomm | Disagree (separate parameters are supported) | RAN1’s reply on the separate RO case clearly shows that RAN1 think it is beneficial to have separate msg1 Tx parameters for requesting Msg3 repetition.  For the shared RO case, we do not think the msg1 Tx parameters for the two types of RACH need to share the same set of parameters. A good example is RACH prioritization, i.e. a prioritized RACH sharing the same RO with another RACH with low priority can have a different power ramping step size from the latter. |
| ZTE | Agree | We prefer to align with RAN1 reply.  For Ericsson’s comment, we think for shared RO case, there is no separate *RACH-ConfigGeneric* IE configured for CE, so the same values are applied to non-CE and CE.  For QC’s comment, we think RAN1 did not say there is benefit to have separate msg1 Tx parameters in separate RO case, just because we will have separate *RACH-ConfigGeneric* configuration for separate RO, so naturally, those parameters can be separately configured. |
| Nokia | Agree |  |
| LGE | Agree  (no separate configuration) | Firstly, these three parameters are for Msg1, not Msg3.  In addition, if the UE uses a higher value of *preambleReceivedTargetPower* for Msg3 repetition than a legacy RACH in a shared RO, this can bad impact to legacy RACH performance because the preamble for legacy RACH may not be detected well compared to the preamble for Msg3 repetition at the gNB. This may result in increasing legacy RACH failure possibility.  For *powerRampingStep*, we think that this is only to increase preamble transmission power fast which is related to reduce latency until successful preamble transmission to the gNB, not increasing coverage of Msg3 transmission.  For *preambleTransMax*, we don’t find any gain and relationship between configuring separate *preambleTransMax* and increasing coverage of Msg3 transmission. |
| China Telecom | Disagree | Same view as Ericsson |
| OPPO | Agree(separate parameters are not supported) | We do not see need to configure separately in shared RO case |
| vivo | Agree | Even for separate ROs, we fail to see the benefit of introducing a separate configuration for the mentioned parameters. |
| CATT | Agree(no separate configuration) | We share the view with HW and think the benefits of separate configuration are not essential. But we can accept separate configuration if this is the majority view. |

In addition, RAN1 also mentions the following in their reply LS[1].

|  |
| --- |
| * 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?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree |  |
| Samsung | Agree |  |
| Ericsson | Agree | We agree, but please state somewhere that we do not preclude that **RIP WI** (badly needed acronym for the RACH Indication and Partitioning WI) can configure these separately along with CE. |
| Xiaomi | Agree |  |
| InterDigital | Agree |  |
| Lenovo | Agree |  |
| Qualcomm | Agree |  |
| ZTE | Agree |  |
| Nokia | Agree |  |
| LGE | Agree |  |
| China Telecom | Agree |  |
| OPPO | Agree |  |
| vivo | Agree | We should follow RAN1’s suggestion. |
| CATT | Agree |  |

Besides above parameters, in RAN1 reply LS, RAN1 also indicates:

|  |
| --- |
| * 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?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree | It is under discussion in RACH partitioning session |
| Samsung | Agree |  |
| Ericsson | Agree |  |
| Xiaomi | Agree |  |
| InterDigital | Agree |  |
| Lenovo | Agree |  |
| Qualcomm | Agree |  |
| ZTE | Agree |  |
| Nokia | Agree |  |
| LGE | Agree |  |
| China Telecom | Agree |  |
| OPPO | Agree |  |
| vivo | Agree |  |
| CATT | Agree |  |

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:

|  |
| --- |
| * 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)

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree | Already confirmed by RAN1 |
| Samsung | Agree |  |
| Ericsson | See comments | I think we can introduce it, but we should discuss what is the use of the threshold. I am not certain if RAN1 thought our selection details.  If we go for selecting that msg3 repetitions should be done before SSB selection, then I can see the use of the threshold as we would need a lower threshold compared with legacy 4-step to select an SSB.  If we go for selecting msg3 repetition at or during the SSB selection stage, then there are multiple options of how this one can be used (discussed in Q3.3). |
| Xiaomi | Agree | Since CE mode can endure much lower RSRP than non-CE mode, it would be much reasonable to have separate rsrp-ThresholdSSB for SSB selection for non-CE and CE mode. |
| InterDigital | Agree |  |
| Lenovo | Agree |  |
| Qualcomm | Agree |  |
| ZTE | Agree |  |
| Nokia | Agree |  |
| LGE | Agree |  |
| China Telecom | Agree |  |
| OPPO | Agree |  |
| vivo | Agree | It is suggested by RAN1. We should follow their advice. |
| CATT | Agree |  |

## 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**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or Disagree** | **Comments** |
| Huawei, HiSilicon | Agree |  |
| Samsung | Agree |  |
| Ericsson | Agree |  |
| Xiaomi | Agree |  |
| InterDigital | Agree |  |
| Lenovo | Agree |  |
| Qualcomm | Agree | We think this issue should be discussed in the common RACH session.  [Rapp] We only make decision from CE perspective, so the common RACH session can take it into account and make the final decision. |
| ZTE | Agree |  |
| Nokia | Agree |  |
| LGE | Agree |  |
| China Telecom | Agree |  |
| OPPO | Agree |  |
| vivo | Agree | This odelling is also aligned with SDT and RAN slicing. It helps to design a common procedure for RACH partitioning. |
| CATT | Agree |  |

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)

|  |  |  |
| --- | --- | --- |
| **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 |  |
| Ericsson | Comments | Agree with Huawei that it would be good to have unified procedure.  Having the msg3 type selection before or after the 2-step repetition evaluation should not really matter unless the rsrp thresholds are badly configured. |
| Xiaomi | Agree | Spec change is simpler. |
| InterDigital |  | This is natural with proper thresholds configured by the network. NW implementation will ensure that RA resources for 2-step RACH and Msg3 repetition cannot be selected simultaneously. |
| Lenovo | Agree |  |
| Qualcomm | - | This issue should be discussed in the common RACH session.  [Rapp] Agree the final decision should be made in the common RACH session, but guidance from other WIs can definitely be helpful. So let’s discuss its reasonableness from CE perspective, and the common RACH session can take it into account and make the final decision. |
| ZTE | Agree | Agree with Ericsson and InterDigital that network should set thresholds properly, so UE will not fulfil both 2-step RA and CE simultaneously, that is why we proposed the following principle in our paper R2-2109894, but based on online comments, seems companies are not happy to add it explicitly in spec.   * **Principle 2: If both 2-step RA configuration and 4-step RA configuration are signaled, the RSRP threshold used for requesting Msg3 repetition should be configured lower than *msgA-RSRP-Threshold-r16*.**   Regarding this question, we think from CE perspective, it is reasonable to only evaluate Msg3 repetition when 4-step RA is selected. Also based on the assumption that rsrp thresholds are properly configured. |
| Nokia | Agree |  |
| LGE |  | Agree with Huawei and Ericsson. We also prefer to have unified procedure and it would be good to discuss it in RACH partitioning session. |
| China Telecom | Agree |  |
| OPPO | Agree |  |
| vivo | No strong view |  |
| CATT | Comments | Agree with Huawei. It is better to have a unified procedure for all features and feature combinations. |

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?**

|  |  |  |
| --- | --- | --- |
| **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.  [Rapp] Rapp actually understand all options are aligned with principle b, principle b mainly says RACH resource selection should match the feature and/or feature combinations.  But Q3.3 is to ask company about the preferred UE behaviour in “RACH resource selection”.  In addition, seems Option 3 is same as Option 2? Maybe you can further clarify the difference between Option 2 and Option 3?  [LC] Option 2 is a bit misleading. My interpretation of “If none of SSB with SS-RSRP above the *rsrp-Threshold-Msg3Rep*, UE requests Msg3 PUSCH repetition,..” is the UE first perform SSB selection, followed by feature selection. In the current framework, the UE determines the RA type/UL carrier based on “downlink pathloss reference is above/below one threshold”, so there is no “SSB selection/comparison” indeed. But if the intention is just ask the order between “SSB selection” and “feature selection”, Then Option 2 and 3 are identical. |
| Samsung | See comments | Our preference is that Msg3 repetition criterion is checked at every RA attempt during the RA procedure. |
| Ericsson | Option 3, but with comments | I think if msg3 repetition would have been introduced in isolation, we would have been fine with Option 1, but along with RIP I think Option 3 would be the better choice.  Alternatively we could state that we multiple options for RIP WI to chose from  For determination at SSB-stage, I would think that the UE first compares SSB to legacy rsrp-ThresholdSSB, and if none are found then the UE can select msg3 repetitions, where any SSB selection is selected if the rsrp is below *rsrp-Threshold-Msg3Rep*(if configured) and a specific SSB is selected when the rsrp is above the threshold. |
| Xiaomi | Option 3 | Option 1 defeats the need of introducing seprate *rsrp-ThresholdSSB* for msg3 repetition. If SSB is selected based on *rsrp-ThresholdSSB* for msg3 repetition, which is lower than legacy rsrp-ThresholdSSB, UE may select a SSB whose RSRP is lower than legacy rsrp-ThresholdSSB but higher than legacy rsrp-ThresholdSSB for msg3. Then if the criterion for msg3 repetition is not satisfied, UE ends up with a wrong SSB.  [ZTE] UE will not end up with a wrong SSB, the UE will still select the best SSB, the results are the same. |
| InterDigital | Option 3 | The new SSB threshold for msg3 repetition only comes into play if RA resource for msg3 repetition is selected at RA initiation. |
| Qualcomm | Option 3 | We should keep the general principle that RSRP based UL carrier selection and RA type selection should always be performed before SSB (RO) selection. |
| ZTE | Option 1 | The intention of option 1 is to avoid UE to compare two rsrp-ThresholdSSB thresholds. So for CE capable UEs, at the step of initialization of RACH procedure, UE will use CE specific rsrp-ThresholdSSB instead (similar to BFR operation), but this does not obey the principle that “UL carrier and RA type selection are performed before SSB(RO) selection”.  Based on the comments from above companies, we see the key point is how to use the *rsrp-Threshold-Msg3Rep* (used to determine the necessity of Msg3 repetition). HW suggests to compare it with “downlink pathloss reference”, while Option1&2 intend to compare it with “SSB RSRPs”.  So maybe we need to discuss this first, and if “*downlink pathloss reference*” should be used, we also agree that Option 3 is reasonable. |
| Nokia | Option 3 |  |
| LGE | Option 3 | Considering the discussions in RACH partitioning session, we think the option 3 would be aligned with the baseline made in the RACH partitioning session. |
| China Telecom | Option 3 | Share same view with Qualcomm |
| OPPO | Option 3 | Msg3 repetition evaluation should be done during RACH initialization, while SSB selection is performed for each preamble attempt. |
| vivo | Option 2, Option 3 with comments | For option 1, if the UE has not decided Msg3 repetition requesting, how can the UE know it should use the specific SSB selection threshold rather than the legacy one? It might degrade the SSB selection performance.  We are okay with the intention of Option 3, but the UE should be allowed to evaluate the condition of Msg3 repetition before SSB selection during each RA attempt. |
| CATT | Option 3 | We think MSG3 repetition evaluation should be performed before SSB selection. |

## CFRA and CBRA

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

|  |  |
| --- | --- |
| 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?**

|  |  |  |
| --- | --- | --- |
| **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.  [Rapp] Agree, let’s use the term “PUSCH scheduled by RAR” instead. |
| Ericsson | Agree | We think it is fine to ask RAN1, but we want to point out that the intention is not to introduce anything new in RAR, but rather use the same principle for scheduling msg3 (PUSCH scheduled by RAR) as for CBRA (using either TDRA or repurposing MCS fields), but where the UE is told in advance whether the scheduling of PUSCH scheduled by RAR should be interpreted as if repetitions are to be scheduled or not.  We think that this can for instance enable more reliable handover executions. |
| Xiaomi | Disagree | For CFRA, the UL grant in RAR has no limitation on grant size and MCS since it does not impact PUSCH coverage. Reusing the modified UL grant version for msg3 serves no purpose. |
| InterDigital | Disagree | CFRA is in connected mode, and in such case link adaptation can be already in place. PUSCH coverage enhancement for the grant after successful RA completion is a separate issue. |
| Qualcomm | Disagree | We do not see a need for supporting Msg3 repetition indication in RAR of CFRA. |
| ZTE | Agree | We think the feasibility of this scenario is within RAN1’s scope.  From RAN2 point of view, we actually think supporting this can be helpful in handover case (as Ericsson indicated). |
| Nokia |  | This is up to RAN1, if they already discussed, no need for us to ask. Companies can anyway bring papers to RAN1. |
| LGE | Disagree | CFRA has no Msg3 transmission and the preamble for CFRA would not be associated with requesting Msg3 repetition to the network. This means that even if the UE does not request Msg3 repetition, the UE has to interpret the existing field in RAR differently to understand Msg3 repetition command from the network. We think it is a different issue and have doubt whether it is valid use case. |
| China Telecom | Agree | We don’t see strong need to support Msg3 repetition indication in RAR of CFRA, but we’re fine to ask RAN1. |
| OPPO | Disagree | Share the same view as Xiaomi |
| vivo | Disagree | Currently, CFRA is only used for BFR and HO. We think the link radio quality should be good after BFR and HO. We don’t see the motivation to support Msg3 repetition for CFRA. |
| CATT | Disagree | We think for CFRA, the network can do the accurate channel estimation. So benefits for repetition of PUSCH scheduled by RAR of CFRA are marginal. |

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:

|  |
| --- |
| *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?**

|  |  |  |
| --- | --- | --- |
| **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.  [Rapp] Your understanding of “switch” is correct, this question is to ask whether UE can switch from CE to non-CE (or vice versa) upon every Msg1 retransmission.  For BWP switching in RRC\_CONNECTED, Rapp also thinks it can be discussed after we conclude the basic scenario (i.e. initial access). |
| Samsung | Disagree | Our preference is that UE can determine CE or non CE during each RA preamble transmission |
| Ericsson | Comments | Our understanding is that one of the main purposes of enabling CE selection during SSB selection would be to enable this. Our worry with this is that with the RIP WI, there are multiple features signalled in the same preamble configurations, which means that if UE constantly compares the thresholds with each RACH attempt, then UE might jump in and out of preamble configurations that are indicating multiple features. |
| Xiaomi | No | Not allowing the switch from CE mode to non-CE mode during Msg1 retransmission may less be an issue, since only PUSCH resources will be wasted. But not allowing the switch from non-CE mode to CE mode will be an issue, as the RA procedure may fail. We do not see any issue of switching between CE mode and non-CE mode. Please note that UE can switch from BFR CBRA to BFR CFRA at every Msg1 retransmission. |
| InterDigital | Agree | Switching between RA types after each preamble transmissions can complicate the RA procedure. In some case the UE already has a Msg3 built in the HARQ buffer and switching to a different RA type may require TB rebuilding if the Msg3 TBS is different. |
| Lenovo | Agree | We should not complicate the RACH procedure unnecessarily. In which scenarios does a switch from CE to non-CE or vice versa upon Msg1 retransmission make sense? Does it happen often or is it a corner case? |
| Qualcomm | Disagree | We think it is useful to support the case where UE is allowed to evaluate the criteria for CE after a few failed attempts of 4-step RACH. But we think this scenario probably should be discussed in the common RACH session, given the agreement made in the common RACH session at the last RAN2 meeting. |
| ZTE | Agree | We actually have concern on the complexity if “switch” is supported. As mentioned by other companies, that UE will need to jump among different RACH resource pools and select different RO/preamble for Msg1 retransmission. |
| Nokia | Agree |  |
| LGE | Agree | We also don’t want complicated RA procedure.  If the UE selects the feature at the initialization step, the UE does not change the feature during RA procedure. It would be the simple way to define unified RACH procedure in RACH partitioning session. |
| China Telecom | Agree | We think the case of the channel quality varies during a very short time is not very common. Thus it’s better to keep the RA procedure simple. |
| OPPO | Agree | Share the same view as InterDigital |
| vivo | Disagree | For UE power saving, the UE should be allowed to evaluate the condition of Msg3 repetition before SSB selection during each RA attempt (e.g the radio link quality becomes good considering the T300 can be set to 2s). NW should guarantee that MAC PDU rebuilding is not needed after switching (i.e. the TBS allocated for CE preamble group should be the same for that for the legacy preamble group). |
| CATT | Disagree | We agree it is beneficial that UE can switch from CE (i.e. requesting Msg3 Repetition) to non-CE (i.e. not requesting Msg3 repetition). But considering there are other features, the whole procedure will be quite complex. For simplicity, we think we can follow the agreements made in common RA session. |

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?**

|  |  |  |
| --- | --- | --- |
| **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.  [Rapp] Rapp would like to clarify this scenario is not referring to “*fallbackRAR*” which is already excluded by RAN1.  In legacy RACH, UE can fall back to 4-step RA when the UE reaches *msgA-TransMax* in 2-step RA. We think the decision made in common RACH procedure does not intend to change this legacy design.  The intention of this question is to ask whether companies agree UE does not need to compare Msg3 repetition threshold upon every MsgA retransmission.  [LC] I am not saying fallback RAR, but fallback to 4-step RA when the UE reaches the limit. As I see you explicitly use “unless..”, it seems the proposal implies that in this “fallback case (not fallback RAR)”, the UE can re-evaluate CE again. Our concerns is it might not be allowed as CE selection is at the initialization phase and there are some parameters already running for the non-CE RACH, which might be also common to the subsequent RA procedure, and hence should not be initialized again for a CE RACH attempt. Hope it clarifies. |
| Samsung | Agree |  |
| Ericsson | Proposal not needed? | We are not sure if there are any specific concerns why we would check msg3 repetition configuration in 2-step or examples where this is a problem. In rel-16, once the UE has selected 2-step, it goes on to a specific section where 2-step RA is performed using 2-step RA specific resources and to our knowledge it does not check any 4-step configurations.  Maybe the proponents can clarify. |
| Xiaomi | Disagree | RAN1 has already agreed not to support msg3 repetition for 2-step fallback to 4-step case. It means that when 2-step RA is triggered, it has no relation with msg3 repetition at all. Thus, P9 is totally unneeded. |
| InterDigital | No proposal needed | RAN1 already agreed to not support msg3 repetition for 2-step nor for msg3 after fallback to 4-step. |
| Lenovo | Agree |  |
| Qualcomm | Agree | Share the same view as Interdigital. |
| ZTE | Agree | Regarding HW’s comments, we think if UE already fallbacks to 4-step RA due to *msgA-TransMax*, then UE should be allowed to trigger CE for better performance. |
| Nokia | Disagree | Should only evaluate at initiation of the RA procedure. |
| LGE | Disagree | We don’t think feature change during RA procedure is needed. If the UE selects the feature at the initialization step, the UE does not change the feature during RA procedure. It would be the simple way to define unified RACH procedure in RACH partitioning session. |
| China Telecom | Agree | Share the same view as Interdigital. |
| OPPO | Disagree | Share the same view as Xiaomi |
| vivo | Disagree | During the initialization of RA procedure, the UE anyway should initialize (which can only be performed at the very beginning of the whole RA procedure) all the RA related parameters as the UE doesn’t know which type of RA (e.g. 2-step RA or 4-step RA with Msg3 repetition) will be triggered. Then if P9 is used, indeed, it might help to save the UE memory (releasing the parameters for 2-step RA), however, the UE needs to re-initialize the 2-step RA related again, which has a significant impact on specification work and make UE implementation more complicated. |
| CATT | Agree | We agree with InterDigital. |

## Other

Any other issue that needs discussion?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | We would like to confirm further optimization on cell selection for CE is not considered in Rel-17. |
| vivo | In addition, we would like to confirm any optimization on carrier selection/BWP operation for RA procedure is not considered in Rel-17 CE. |
|  |  |
|  |  |
|  |  |

# 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