3GPP TSG RAN WG2 Meeting #123 R2-230xxxx

Toulouse, France, 21th– 25th August, 2023

Agenda Item: 8.x.x

Source: ZTE Corporation (Rapporteur)

Title: Summary of [Post122][802][R18CEenh-UP] UP open issues (ZTE)

Document for: Discussion and Decision

# Introduction

This is the summary of post email discussion:

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| [Post122][802][R18CEenh-UP] UP open issues (ZTE)  Scope: If we should enable any fallback(s) and if so how to do this. Can identify impacts to both MAC procedure but also any implications on the signalling. Any other UP open issues for RACH procedure.  Intended outcome: Agreeable proposals  Deadline: Long, until next meeting (August 10 1000 UTC) |

In this document, we focus on the remaining user plan open issues for Msg1 repetition. The outcome of this discussion will be captured into MAC running CR after the proposals are agreed in RAN2#123.

Please companies provide your inputs before 4th Aug

Rapporteur will provide summary with proposals before 10th Aug.

# Contact information

Companies providing input to this email discussion are invited to leave contact information below.

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| Company | Name | Email Address |
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# Discussion

## Support of RACH fallback

In previous RAN2 meetings, companies discussed the support of RA fallback cases for Msg1-based repetitions and made below agreements:

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| RAN2#121bis-e Agreements:  RAN2 will not support the fallback from legacy RA to Msg1 repetition and vice versa; Other fall back scenarios are FFS  RAN2#122 Agreements  RAN2 to further discuss fallback from lower number of MSG1 repetition to higher number which is also FFS for now. We need to understand how to signal this and how this impacts MAC procedure. |

In short, for below fallback cases, RAN2 already concluded that Case1 is not supported in Rel-18, Case 2 can be prioritized because several companies showed interests in last RAN2 meeting.

* Case 1: Fallback from legacy 4-step RA to 4-step RA with Msg1 repetition; ----Not supported
* Case 2: Fallback from Msg1 repetition with lower number to Msg1 repetition with higher number; ----FFS, Supported by multiple companies
* Case 3: Fallback from 2-step RA to 4-step RA with Msg1 repetition; ----FFS, low priority (not much support)
* Case 4: Fallback from CFRA to CBRA with Msg1 repetition. ----FFS, low priority (not much support)

In this document, we will first further discuss the Case 2 and possible solutions if supported for this. For case 3 and case 4, we will discuss if there is support.

### Background

Before discussing RACH fallback for Msg1 repetitions, in this section, the existing RACH procedure specified in TS 38.321 is provided, so it is easy to understand the potential RRC or MAC impact if any RACH fallback scenario is supported.

By introducing RACH partitioning, the Rel-17 general RACH procedure is shown in below figure:



Figure 1 Rel-17 Random Access procedure

Highlights:

RACH partition (RACH resource set) is selected based on applicable features for this RACH procedure (e.g. RedCap, SDT, slice, Msg3 repetition, etc);

Once a RACH partition is selected, the RACH resources of this RACH partition can be used for this RACH procedure until RACH failure, the UE won’t select other RACH partition during the RACH procedure;

RACH resources of different RACH partitions can be configured with sharedROs or separateROs;

More than one RACH partitions associated with the same feature combinations per RA-type is not supported.

### Fallback options overview

So, there are two main options i.e. whether to support fallback or not. Then if we support fallback, then we need to discuss how to do this. So, the rapporteur would like to first discuss the following main options:

**Option 1: No fallback**

* In this option, there is no fallback between different Msg1 repetition numbers and this means each Msg1 repetition number can be treated as a separate feature
* This is aligned with the current agreements in RAN2

**Option 2: Allow fallback**

In this option, there may be 3 sub-options as below

***Option 2.1:*** *Each repetition number is treated as a separate RACH type*

* In this case Msg1 repetition is NOT considered as a feature;
* In this option, the fallback back can be supported within the RACH partition and the different Msg1 repetitions are treated as different RACH types (i.e. similar to 2-step and 4-step RACH today, where we allow fallback from 2-step to 4-step RACH);
* Requires big RRC spec change, e.g. to introduce multiple preamble index ranges (and/or RO mask indexes) within FeatureCombinationPreambles-r17, each one associated with a specific repetition number

***Option 2.2:*** *All repetitions are treated as a single feature, but within the feature, different repetition numbers are treated as different RACH type*

* In this case Msg1 repetition is considered as a feature;
* But, RACH resources for all repetitions are considered as RACH type within the same feature;
* In this option, the fallback can be supported within the RACH partition and the different Msg1 repetitions are treated as different RACH types within the same feature (i.e. similar to 2-step and 4-step RACH today, where we allow fallback from 2-step to 4-step RACH);
* Requires big RRC spec change, e.g. to introduce msg1-Repetition-r18 in FeatureCombination-r17, and to introduce multiple preamble index ranges (and/or RO mask indexes) within FeatureCombinationPreambles-r17, each one associated with a specific repetition number;

***Option 2.3:*** *Each repetition number is treated as a separate feature and we define fallback between features*

* In this case each Msg1 repetition number is considered as a separate feature;
* In this option we need to define fallback between different RACH partitions. This is currently not supported in MAC
* Less RRC spec change, but requires huge MAC spec impact, e.g. to allow switching between RACH partitions;

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| **Option 1** | **Option 2.1** |
| **Option 2.2** | **Option 2.3** |

Figure 2 Illustration of the 4 options

For above options, the supported RACH fallback cases are summarized in below table.

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|  | Supported RACH fallback cases | | |
| from lower repetition number to higher repetition number | from 2-step RACH to 4-step RACH with Msg1 repetition | from CFRA to 4-step CBRA with Msg1 repetition |
| Option 2.1 | Support | Support | This is different from other fallback cases, see details in 3.1.3 |
| Option 2.2 | Support | Not support  [Rapp’s note] Because this partition only has 4-step RACH resources and switching between partitions is not supported in this option. |
| Option 2.3 | Support | Can support but with complexity  [Rapp’s note] This means switching from 2-step in another partition to a partition associated with Msg1 repetition. Currently, UE will fallback to 4-step that within the same partition, so allowing switching directly to different partition needs additional specification efforts. |

**Open issues for each option:**

For option1 there are no real open issues, basically, the existing framework in RRC and MAC can simply be reused.

For option 2.1, there is no open issue and we can follow the same framework as switching between 2-step RACH and 4-step RACH.

For option 2.2, the following option issues need to be addressed:

When triggering RACH fallback, which parameters need to be initialized?

For the same feature combination (RedCap+Msg1 repetition), whether the network can configure more than one RACH partitions associated with different repetition numbers. For example, for below RACH configuration, whether RACH partition 2 can also be configured? If allowed, how to select between RACH partition1 and RACH partition 2?

Partition 1: RedCap + Msg1 repetition (number\_2 + number\_4 + number\_8);

Partition 2: RedCap + Msg1 repetition (number\_4);

For option 2.3, the following option issues need to be addressed:

When triggering RACH fallback, which parameters need to be initialized?

Whether fallback is only allowed between two RACH partitions that configured with the same feature combination except Msg1 repetition? For example, for below RACH Configuration, whether only fallback from Partition 1 to Partition 2 is allowed?

Partition 1: RedCap + Msg1 repetition number\_2;

Partition 2: RedCap + Msg1 repetition number\_4;

Partition 3: RedCap + Slice 1+ Msg1 repetition number\_4;

(Note, if fallback from Partition 1 to Partition 3 is supported, it means the UE needs to evaluate all applicable features upon each Msg1 retransmission)

If switching between partitions is supported, how to restrict other fallback cases which are considered as “not supported”? e.g. fallback from legacy RA to RACH with Msg3 repetition, fallback from Msg1 repetition with higher number to lower number; fallback from legacy 4-step RA to 4-step RA with Msg1 repetition.

**Q1. Do companies agree with the above options and do you have any other options in mind?**

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| Company | Agree/  Disagree | Comments |
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**Q2. Which option do companies prefer and why?**

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| Company | Option 1/  Option 2.1/2.2/2.3 | Comments |
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**Q3. For your preferred option, please explain how to address the open issues mentioned above.**

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| Company | Option | Comments on how to address the open issues for this option |
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If RACH fallback is supported, we also need to discuss the triggering conditions. For fallback from 2-step to 4-step, rapporteur thinks it makes sense to reuse the existing triggering condition: “when reaches MsgA-TransMax”, but for fallback from lower number to higher number, considering these are all 4-step RACH, so in which condition the UE can trigger fallback should be discussed. Following alternatives can be considered:

Alt 1: Based on DL RSRP evaluation upon each Msg1 retransmission;

Alt 2: UE autonomously selects higher repetition number upon Msg1 retransmission when the number of Msg1 retransmission reaches a configured value;

Alt 3: UE autonomously selects higher repetition number upon Msg1 retransmission when the UE reaches maximum transmission power;

other

**Q4. If fallback from repetition with lower number to higher number is supported, which option do companies prefer regarding the triggering condition?**

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| Company | Alt | Comments on how to address the open issues for this option |
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### Fallback from CFRA to 4-step CBRA with Msg1 repetition

Fallback from CFRA to 4-step CBRA with Msg1 repetition (Case 4) is different from other fallback cases because contention-free based RACH resources are configured independently, not within a RACH partition, in RAN2#122 meeting, companies discussed CFRA with Msg1 repetition and agreed that RAN2 intends to support CFRA for Msg 1 repetition for *ReconfigurationWithSync* case.

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| Agreements   1. RAN2 intends to support CFRA for msg1 repetition for ReconfigurationWithSync case, FFS for other cases. |

Therefore, for RA fallback Case 4, there are two sub cases:

* Case 4-1: fallback from legacy CFRA to 4-step CBRA with Msg1 repetition;
* Case 4-2: fallback from CFRA with Msg1 repetition to 4-step CBRA with Msg1 repetition.

As mentioned in previous sections, no matter different repetition numbers are modelled not as a feature or as one feature or separate features, the RACH resources for Msg1 repetition must be configured via RACH partition (i.e. *FeatureCombinationPreambles-r17*). Based on current MAC spec, once CFRA resources are provided, the legacy CBRA resources will be selected as the fallback resource pool. The only exceptional case is RedCap, for which a RACH partition may be selected as the fallback resource pool if there is only one RACH partition that associated with RedCap feature only.

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| TS 38.321  5.1.1b Selection of the set of Random Access resources for the Random Access procedure  …  1> if contention-free Random Access Resources have not been provided for this Random Access procedure and one or more of the features including RedCap and/or Slicing and/or SDT and/or MSG3 repetition is applicable for this Random Access procedure:  NOTE 2: The applicability of SDT is determined by MAC entity according to clause 5.27. The applicability of *NSAG-ID* is determined by upper layers when the Random Access procedure is initiated. The applicability of RedCap is also determined by upper layers when Random Access procedure is initiated and it is applicable to the Random Access procedures initiated by PDCCH orders and any Random Access procedure initiated by the MAC entity.  2> if none of the sets of Random Access resources are available for any feature applicable to the current Random Access procedure (as specified in clause 5.1.1c):  3> select the set(s) of Random Access resources that are not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.  2> else if there is one set of Random Access resources available which can be used for indicating all features triggering this Random Access procedure:  3> select this set of Random Access resources for this Random Access procedure.  2> else (i.e. there are one or more sets of Random Access resources available that are configured with indication(s) for a subset of all features triggering this Random Access procedure):  3> select a set of Random Access resources from the available set(s) of Random Access resources based on the priority order indicated by upper layers as specified in clause 5.1.1d for this Random Access Procedure.  1> else if contention-free Random Access Resources have been provided for this Random Access procedure and RedCap is applicable for the current Random Access procedure and there is one set of Random Access resources available that is only configured with RedCap indication:  2> select this set of Random Access resources for this Random Access procedure.  1> else:  2> select the set of Random Access resources that are not associated with any feature indication (as specified in clause 5.1.1c) for the current Random Access procedure. |

Technically, rapporteur thinks the motivation for supporting Case 4 is unclear, because:

* In current spec, except RedCap UE, the legacy RACH resources will be selected as CBRA fallback pool. If we change this principle, it means the UE can select a RACH partition that only associated with Msg1 repetition as the CBRA fallback pool. However, RACH partition selection is performed before triggering CFRA, after CFRA fails, it is possible the selected RACH partition pool is not applicable any more due to not fulfilment of the Msg1 repetition threshold. And it is possible the UE will not select the Msg1 repetition RACH partition because the UE does not fulfil the threshold when triggering CFRA.
* RAN2 already agreed to support CFRA with Msg1 repetition for *ReconfigurationWithSync* case, and this is applicable to RRC\_CONNECTED UEs, so the network is already possible to enhance Msg1 transmission by enabling CFRA with Msg1 repetition;
* CFRA is only applicable to RRC\_CONNECTED UEs, thus fallback from CFRA to legacy 4-step CBRA is sufficient.
* If “CE only BWP” is supported for Msg1 repetition, then once CFRA fails, the UE will autonomously select the RACH resource that associated with Msg1 repetition for CBRA.

In Rel-17 CE discussion, companies discussed similar issue and concluded that fallback from CFRA to CBRA with Msg3 repetition is not supported. For Msg1 repetition, do companies .

**Q5. Do companies agree that there is no need to support fallback from CFRA to CBRA with Msg1 repetition? (If answers No, please elaborate which case (4-1, 4-2) you want to support and how to support?)**

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| Company | Not support /  Support (Case4-1/ 4-2) | Comments |
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## CE only BWP

In Rel-17 CE discussion, RAN2 agreed to support CE only BWP for Msg3 repetition, so for RRC\_CONNECTED UEs, the network can configure a dedicated BWP that only with RACH resources for Msg3 repetition, in this case, the UE is not required to evaluate the DL RSRP during RACH initialization.

For Rel-18 Msg1 repetition, we also need to discuss whether the network can configure a dedicated BWP in which all RACH resources are associated with Msg1 repetition. Technically, this may be useful during handover procedure, e.g. network may want the UE to directly trigger Msg1 repetition if the target cell is not so good.

However, by considering we have multiple Msg1 repetition numbers, the solution specified for Rel-17 CE may not applicable for Rel-18 CE. For discussion, rapporteur provides the following options:

* Alt 1: CE only BWP for Msg1 repetition is supported in Rel-18
  + Alt 1.1: Network can configure a dedicated BWP in which all configured RACH resources are associated with a specific Msg1 repetition number, when RACH is triggered, the UE is not required to perform RSRP evaluation.
  + Alt 1.2: Network can configure a dedicated BWP in which all configured RACH resources are associated with Msg1 repetition but can be configured with more than one repetition numbers, when RACH is triggered, the UE selects the applicable repetition number and corresponding RACH resource based on the DL RSRP.
* Alt 2: CE only BWP for Msg1 repetition is NOT supported in Rel-18;

**Q6. Which option do you prefer regarding the support of “CE only BWP” for Msg1 repetition?**

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| Company | Preferred Alternative | Comments |
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## Power ramping

For Msg1 power ramping, RAN1 made the following agreement:

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| **RAN1#112 Agreement:**  For multiple PRACH transmissions with same Tx beam in one RACH attempt, transmission power ramping is not applied within one RACH attempt. |

Based on above agreement, the UE should use the same power for Msg1 repetitions within one RACH attempt, so the MAC spec can be updated accordingly, see below example:

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| 5.1.3 Random Access Preamble transmission  The MAC entity shall, for each Random Access Preamble:  1> if *PREAMBLE\_TRANSMISSION\_COUNTER* is greater than one; and  1> if the notification of suspending power ramping counter has not been received from lower layers; and  1> if LBT failure indication was not received from lower layers for the last Random Access Preamble transmission; and  1> if the current Random Access preamble is not part of a preamble transmission with Msg1 preamble repetition and SSB or CSI-RS selected is not changed from the selection in the last Random Access Preamble transmission:  2> increment *PREAMBLE\_POWER\_RAMPING\_COUNTER* by 1.  1> select the value of *DELTA\_PREAMBLE* according to clause 7.3;  1> set *PREAMBLE\_RECEIVED\_TARGET\_POWER* to *preambleReceivedTargetPower* + *DELTA\_PREAMBLE* + (*PREAMBLE\_POWER\_RAMPING\_COUNTER* – 1) × *PREAMBLE\_POWER\_RAMPING\_STEP* *+* *POWER\_OFFSET\_2STEP\_RA*; |

**Q7. Do companies agree with above spec change regarding the conclusion on power ramping (any wording suggestion is welcome)?**

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| Company | Yes or No | Comments |
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## RAR window

For the start of RAR window in case of Msg1 repetition, RAN1 made the following agreements:

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| **RAN1#112bis Agreement:**  The starting point of RAR window is after the last symbol of the last valid RO in the RO group corresponding to the multiple PRACH transmissions.  Note: Valid RO(s) refers to what is defined in existing specification, i.e., Section 8.1 in TS 38.213.  Note: The last valid RO is irrespective of whether the PRACH transmission on the last valid RO in the RO group is dropped or not.  **RAN1#112 Agreement:**  For multiple PRACH transmissions with same Tx beam, only one RAR window is supported for RAR monitoring for one RACH attempt. |

Based on above agreements, in case of Msg1 repetition, the RAR window starts after the last symbol of the last Msg1 repetition, so the MAC spec needs to be clarified, see below example:

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| 5.1.4 Random Access Response reception  Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap, the MAC entity shall:  1> if the contention-free Random Access Preamble for beam failure recovery request was transmitted by the MAC entity:  2> if the contention-free Random Access Preamble for beam failure recovery request was transmitted on a non-terrestrial network:  3> start the *ra-ResponseWindow* configured in *BeamFailureRecoveryConfig* at the PDCCH occasion as specified in TS 38.213 [6].  2> else:  3> if Msg1 repetition is not applicable:  4> start the *ra-ResponseWindow* configured in *BeamFailureRecoveryConfig* at the first PDCCH occasion as specified in TS 38.213 [6] from the end of the Random Access Preamble transmission.  3> if Msg1 repetition is applicable:  4> start the *ra-ResponseWindow* configured in *BeamFailureRecoveryConfig* at the first PDCCH occasion as specified in TS 38.213 [6] from the end of the last Random Access Preamble of the multiple preamble transmissions in one Msg1 repetition.  2> monitor for a PDCCH transmission on the search space indicated by *recoverySearchSpaceId* of the SpCell identified by the C-RNTI while *ra-ResponseWindow* is running. |

**Q8. Do companies agree with above spec change regarding the conclusion on RAR window (any wording suggestion is welcome)?**

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| Company | Yes or No | Comments |
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## RA-RNTI

For the calculation of RA-RNTI in case of Msg1 repetition, RAN1 made the following agreements:

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| **RAN1#113 Agreement:**  RA-RNTI is calculated based on the last valid RO in the RO group corresponding to the multiple PRACH transmissions.  Note 1: Valid RO(s) refers to what is defined in existing specification, i.e., Section 8.1 in TS 38.213.  Note 2: The last valid RO is irrespective of whether the PRACH transmission on the last valid RO in the RO group is dropped or not. |

Based on above agreements, in case of Msg1 repetition, the RA-RNTI is calculated based on the last valid RO no matter the PRACH transmission on the last valid RO in the RO group is dropped or not, so the MAC spec needs to be clarified, see below example:

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| 5.1.3 Random Access Preamble transmission The RA-RNTI associated with the PRACH occasion (i.e. the PRACH occasion associated with the transmitted Random Access Preamble when Msg1 repetition is not applicable, and the PRACH occasion associated with the last Random Access Preamble within one Msg1 repetition transmission, regardless of whether the last preamble is transmitted or not, when Msg1 repetition is applicable) in which the Random Access Preamble is transmitted, is computed as:  RA-RNTI = 1 + s\_id + 14 × t\_id + 14 × 80 × f\_id + 14 × 80 × 8 × ul\_carrier\_id |

**Q9. Do companies agree with above spec change regarding the conclusion on RA-RNTI calculation (any wording suggestion is welcome)?**

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| Company | Yes or No | Comments |
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## Other

Besides above questions, companies are welcome to provide your comments if other issues are identified.

Q10. Any other MAC open issues that need to be discussed in RAN2?

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| Company | Comments |
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# Conclusion

To be updated

# References

[1] RAN2#122 Chairman notes