**3GPP TSG-RAN2 Meeting #117-e R2-211xxxx**

**e-Meeting, 17 – 26 Jan, 2022**

**Source: email discussion Rapporteur (ZTE Corporation)**

**Title: [Post116-e][515][RACH partitioning] MAC Procedure aspects (ZTE)**

**Agenda item:** **8.18.2**

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

# Introduction

This document contains summary of email discussion to related to MAC procedure aspects for common RACH partitioning:

* [Post116-e][515][RACH partitioning] MAC Procedure aspects (ZTE)

 - General procedure for feature set selection

 - General procedure for initialisation of RACH variables

- Overall RACH procedure in MAC

- Running CR

- Deadline: Long

**Discussion summary**

* TBD

# Discussion

## Selection of RA resource partition

The following agreements were made for the configuration of the RACH resource partitions:

**Agreements:**

1. No new feature and/ feature combination specific preambles are defined within the “not available” preambles defined at the end of a RO through the legacy totalNumberOfRA-Preambles
2. Specification allows for use of Separate time-frequency resources, not defined through legacy RRC signalling, within Contention free preamble defined through legacy RRC signaling and the combination of these (i.e. using the reserved preamble at the end of SSBs like 2-step RACH)
3. RAN2 baseline is that preambles for a particular feature combination shall be present in all SSBs (e.g., a feature combination cannot only have preambles in SSB0 but not SSB1)

4 As a baseline, a feature combination shall have the same number of preambles in all SSBs

5 Signalling should allow that a particular feature/feature combination can be mapped only to a subset of the RACH occasions of a RACH configuration.

6 The legacy masking index approach is reused in Rel-17 RA partitioning

7 RAN2 adopts Approach A as baseline (an IE contains one field for each of the features) for indicating which feature/feature combination a partition applies to. Details are FFS, e.g. details around slicing. FFS how to encode and design the signaling in a future compatible way (i.e. naming)

8 As a baseline, multiple "RA partitions" for one RA type which map to the same feature/feature combination is not supported on a given BWP. FFS if there is any special use case that requires multiple RA partition configuration.

Based on the above, the general RACH resource configuration will look something like below:



Figure 1: Assumed RACH resource structure

Thus, based on the above structure, for the initiated RACH procedure, the MAC entity should determine which feature(s) are applicable to the RACH procedure. It seems that prior to the RACH being triggered, the applicability of REDCAP, Slice and SDT will be already known to the MAC entity. For CE, this is not clear. There are two options:

Option 1: CE will also be considered as part of the feature combination for each RACH partition and the use of CE will be determined in MAC and the RACH partition selection is performed considering CE to be similar to other features

Option 2: CE will be considered as a type of RA resource within each RACH partition and the use of CE will be determined after the selection of RACH partition (i.e. CE will not be considered during RACH partition selection and is only used in case the CE resource is configured within the RACH partition selected)

Option 3: Other option (pelase explain).

So, the first question is how to handle CE in the overall framework above.

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| **Q1: For handling the CE, which option is preferred?**Option 1: CE will also be considered as part of the feature combination for each RACH partition and the use of CE will be determined before the RACH partition selection is performedOption 2: CE will be considered as a type of RA resource within each RACH partition and the use of CE will be determined after the selection of RACH partition (i.e. CE will not be considered during RACH partition selection and is only used in case the CE resource is configured within the RACH partition selected)Option 3: Other option (pelase explain).  |
| Company | Preferred option Option 1/2/3 | Comments (why?) |
| Qualcomm | Option 1 | If selection of RACH partition is up to UE implementation, then the question seems irrelevant because that decision will be up to UE implementation. If selection of RACH partition is based on some redefined rules, then we prefer Option 1 for the following two reasons:* We think UE can evaluate whether it meets the RSRP threshold for CE before it selects a RACH partition. This evaluation is not difficult to perform regardless of whether the RSRP threshold is configured per RACH paritition or the same for all partitions. It would simplify UE behavior if CE is considered one of the RACH features.
* Option 2 may require extra tie breaking rule in selecting RACH partition. For example, suppose there are two RACH partitions. Partition A and Partition B have the same set of features, except that Partition B also supports CE. Then if Option 2 is applied, UE can’t determine whether it should select Partition A or Partition B. But there would be no ambiguity if Option 1 is applied.
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| Apple | Option 1 | When RAN2 agreed the feature/feature combination specific RACH partitioning, the features refer to the SDT, Slicing, RedCap and CE. Therefore, the CE feature should be treated in the same way as other features.  |
| ZTE | Option 2 | In our view, CE should be like RACH-type. This is because, Msg1 based CE is only applicable if 4-step RA-type is selected and may be only used when the CE resource is configured for msg1 (note that network may also rely just on msg3 based CE indication instead). So, we think CE can be treated as a RA-type within each RACH partition. This simplifies the overall procedure (i.e. CE resource can be selected after selecting RACH partition and if the CE type RA resource for msg1 based CE indication) exists on the selected RA partition. @QC: In the example given QC, it seems the expectation is that there could be two partitions satisfying feature A and feature B (with and without CE resource). However, we don’t think such use case is really needed. i.e. for a given feature combination (i.e. A+B), only one RACH partition should exist. Within this RACH partition, there can be CE and non-CE resources. So, this is how option B works.  |
| Huawei, HiSilicon | Option 1 | It is the simplest approach to treat CE in the same way as other features, both from RRC signalling and MAC procedure perspective. The UE should check whether it meets the conditions for CE (and other features) and select a RACH partition based on this. |
| Intel | Option 1 | CE is decided at the point where a RACH partition needs to be selected like any other feature. This will provide the simplest procedure.  This is also aligned to the agreements from the CE session as follow:  1. From CE perspective, carrier selection and BWP selection are performed ahead of CE selection during RACH procedure.
2. From CE perspective, UE compares the RSRP of DL path-loss reference with the Msg3 repetition threshold [rsrp-Threshold-Msg3Rep] during the RACH initialization procedure and decides whether to use CE or non-CE RA.
3. From CE perspective, if CE RA is selected, then the decision doesn’t change during the entire RACH procedure (i.e. until RACH failure).
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| NEC | Option 1 | We think it is simpler approach to take into account the CE like other features, with same assumption as what Intel summarize. |
| Xiaomi | Option1 | We prefer to treat CE in the same way as other features in order to provide a unified and simpler solution for RACH partitioning. |
| LGE | Option 1 | Option 1 would be beneficial for the UE requiring CE-based RA resource selection because the UE will always a select a RA resource partition supporting CE, if any, while simplifying the overall RA resource selection procedure. The UE may check downlink RSRP for CE before the selection of RACH partition.Option 2 is not preferred because of following two reasons:* When the RACH paritition of feature combination with CE is not supported, CE would be always deprioritized. For example, when RA procedure is triggered with Feature 1 and meets the condition for CE operation, the UE always selects RACH partition without CE if there is no partition for CE with Feature 1. Given that CE operation is to improve the reliability of Msg3, it is not reasonable to depritize CE operation in all feature combinations in order to ensure the success of RA procedure.
* For other cases, the result of the RACH partition selection procedure for both options will be same. If Option 2 is taken, whether the CE is applied for RA procedure is determined after the RACH partition selection. Therefore, RA procedure for option 2 would be complicated for Rel-17 feature selection, since it causes the additional step without any benefit.
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Then, we need some general understanding on how the RACH resource partitions are used. As already agreed, each RACH partition will contain an IE indicating which feature/feature combination a partition applies to.

Hence, for each RACH partition configured, the understanding could be that the RACH partition will be considered as available for a triggered RACH procedure in case all the following conditions are satisfied:

1. if REDCAP indication is configured for the partition, then the RACH partition is only applicable to the RACH procedure triggered for REDCAP UE where Msg1 identification is required. Otherwise, if REDCAP indication is not configured, then the RACH partition is applicable to non-REDCAP UE and REDCAP UE where Msg1 identification is not required. (FFS how to determine whether Msg1 identification is required or not)
2. if slice info is configured for the partition,then the RACH partition is only applicable to the RACH procedure triggered for the slice. Otherwise, if the slice info is not configured, then the RACH partition is applicable to all slices.
3. if SDT indication is configured, then the RACH partition is only applicable to the RACH procedure triggered for SDT. Otherwise, if SDT indication is not configured, then the RACH partition is applicable to the RACH procedure not triggered for SDT.
4. if CE indication is configured, then the RACH partition is only applicable to the RACH procedure where CE is required. Otherwise, if CE indication is not configured, then the RACH partition is applicable to the RACH procedure where CE is not required. (if CE is considered as part of feature combination)

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| **Q2: Do companies agree with the general understanding below:** for each RACH partition configured, the RACH partition will be considered as available for a triggered RACH procedure in case all the following conditions are satisfied:1. if REDCAP indication is configured for the partition, then the RACH partition is only applicable to the RACH procedure triggered for REDCAP UE where Msg1 identification is required. Otherwise, if REDCAP indication is not configured, then the RACH partition is applicable to non-REDCAP UE and REDCAP UE where Msg1 identification is not required. (FFS how to determine whether Msg1 identification is required or not)
2. if slice info is configured for the partition,then the RACH partition is only applicable to the RACH procedure triggered for the slice. Otherwise, if the slice info is not configured, then the RACH partition is applicable to all slices.
3. if SDT indication is configured, then the RACH partition is only applicable to the RACH procedure triggered for SDT. Otherwise, if SDT indication is not configured, then the RACH partition is applicable to the RACH procedure not triggered for SDT.
4. if CE indication is configured, then the RACH partition is only applicable to the RACH procedure where CE is required. Otherwise, if CE indication is not configured, then the RACH partition is applicable to the RACH procedure where CE is not required. (if CE is considered as part of feature combination)

If there are any specific comments or other understanding on how each feature is mapped to the partition, please explain in the comments section |
| Company | Agree with general understanding?Y/N/comments | Comments (why?) |
| Qualcomm | Yes |  |
| Apple | See comments | The question is for the feature specific RACH partition, not for the feature combination specific case. If only we only consider the feature specific RACH partition, we agree with the general understanding. But for the feature combination specific RACH partition, NW may configure more than one feature indication per RACH partition, and further clarification is needed.  |
| ZTE | Y in general | In general these look fine to us. **For bullet point a)** We should clarify whether REDCAP UE is allowed to select partition that donot indicate REDCAP indication (in which case, msg3 based REDCAP indication is assumed to be used in the cell – this understanding needs to be confirmed first). If this assumption is valid, then the bullet point a) could be revised as follows: a) if REDCAP indication is configured for the partition, then the RACH partition is only available to REDCAP UE. Otherwise (i.e. if no REDCAP indication is configured for a given partition), then, this RACH partition is available to both REDCAP UEs (which use msg3 based identification) and non-REDCAP UEs. Since the network knows that some REDCAP UEs may use non-RECAP partition assuming msg3 based identification, the network can configure the partitions in such a way that either msg1 based or msg3 based identification is possible in the network as required. **For bullet point d)**If CE indication is configured for a partition, it seems that there should also be a partition with the same feature set combination but without CE indication. Otherwise, the CE indication for the given feature set combination doesn’t sense. With this assumption then, we think bullet d) is okay.  |
| Huawei, HiSilicon | More or less | It depends on how one defines a "RACH partition". The figure above suggests that a partition is always applicable to only one feature combination and, for example, legacy RACH configuration is treated as one partition. Our understanding is:1. Multiple RACH configurations for Rel-17 can be proivded.
2. Each RACH configuration can be used by one or more features and/or feature combinations (if multiple features/feature combinations are configured in the RACH configuration, RO mask is used).

Then, based on this, a single RACH configuration can be configured with a list of features/feature combinations, e.g.1. Feature #1: Redcap
2. Feature #2: SDT
3. Feature combination #3: SDT+Redcap

If the understanding of RACH partition is the resources for each of bullets 1/2/3 in the example above, then we are OK. We aslo agree with ZTE’s comments for bullet a). For ZTE’s comments on bullet d), although we tend to agree with those, we think we can simply rely on sensible network configuration and there is no need to limit in specifications. |
| Intel | See comments | We are fine with the understanding for a), c) and d). However, we are not clear of the understanding for b)For b), if a RACH partition is configured for a particular slice, we would assume that network wants the UE to use the specific RACH partition for the particular slice. Hence the UE should use the specific RACH partition for that particular slice. It is thus unclear to us what the ‘Otherwise, if the slice info is not configured, then the RACH partition is applicable to all slices’. If a specific RACH partition is configured for a slice in the BWP, the UE should attempt to use the specific RACH partition for that slice and not other RACH partition. With the current wording, this seems that UE can choose other RACH partition not dedicated for the slice. Maybe a rephrase on b) as follow will help:if slice info is configured for the partition,then the RACH partition is only applicable to the RACH procedure triggered for the slice indicated in the slice info. Otherwise, if the slice info is not configured for a RACH partition, then the RACH partition is applicable to all slices which are not included in any slice info configured in any RACH partitions. |
| NEC | Yes basically  | For a), we agree with ZTE’s comment on RedCap with Msg3-based indentification (not Msg1-based). If Msg1-based identification is not used (i.e. not requested by NW), RedCap UE is allowed to select RACH partition without linking to RedCap. For b), Intel’s clarification is same as our understanding. |
| Xiaomi | See comments | We share the same view with Apple that the general understandings are only applicable for feature-specific RACH partition. For the case of feature combination, it needs further discussion. For example, if Redcap UE initiates a RACH process triggered by SDT+Redcap, but there is only a RACH partition with SDT indication but without Redcap indication, if we follow above understanding, it seems Redcap UE can not use this RACH partitions which will lead SDT can not be supported. |
|  |  | If it is for feature-specific RACH partitions case, we agree with ZTE’s clarification on a) to cover the case of Redcap UE with msg3-basd early indication. For the Intel’s modification on b), we generally agree one slice may only use the specific RACH partition configured for it, but think it is also up to the decision on whether slice can use the RACH partitions configured for other slices or non-slice. |
| LGE  | Yes |

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| - In MAC perspective, a RedCap UE uses Msg1 early identification whenever transmitting preamble for CBRA, as long as the Msg1 early identification is configured for RedCap by NW.- For RedCap, Msg1 early identification is enabled/disabled implicitly by the presence of dedicate RACH configuration for Msg1 early identification. |

We can assume this as a baseline for common RACH procedure, except the cases asked in Q3. For b), we also share view with Intel. Regading ZTE’s comments on a), in RAN2#116 meeting, RedCap WI has agreed that the RedCap UE uses Msg1 early indication when there is dedicated RACH configuration for Msg1 early indication.:Since this agreements is made to handle the reduced radio capabilities (e.g., BW) in Msg2/3 transmission for RedCap UEs, whether RedCap UE may not indicate in Msg1 level should be carefully reviewed. |

Then, we also agreed that not all feature combinations will need to be supported by the network:

**Agreements**

1 RAN2 assumes that the network may not provide all possible permutation. FFS whether the selection in case of missing combination is specified or left to UE implementation

2 For slicing, unified partitioning framework should take priority

This means that we need to discuss what the UE behaviour shall be if only a subset of features are supported.

The main options to consider here are:

If only a subset of features have a matching RACH partition, and the triggered RACH doesn’t fit with any of the configured RACH partitions, then:

**Option 1:** it is up to UE implementation to select the RACH partition that matches UE’s preference based on implementation

* The consequence of this is that if there is no suitable Rel-17 RACH partition satisfying the triggered RACH feature combination, then the UE may choose any other RACH partition (this may even include other Rel-17 RACH partition that suits a subset of the features that triggered the RACH). How the UE chooses this subset is not specified (and left to UE implementation)

**Option 2:** the UE selects legacy RACH resource

* The consequence of this is that if there is no suitable Rel-17 RACH partition satisfying the triggered RACH feature combination, then UE will not select any other Rel-17 partition (even if that partition may indicate a subset of features that triggered the RACH procedure)

**Option 3:** we specify a set of rules based on which the UE shall select another RACH partition

* The consequence of this is that we need to specify clear priority rules that the UE shall follow in determining a fallback subset (if the feature set combination is not available)

Option 3: Would obviously need some further discussion. These can be discussed further down.

So, the first question is which of the broader options do companies prefer and why?

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| **Q3:** If only a subset of features have a matching RACH partition, and the triggered RACH doesn’t fit with any of the configured RACH partitions, then which option do companies prefer and why?:**Option 1:** it is up to UE implementation to select the RACH partition that matches UE’s preference based on implementation* The consequence of this is that if there is no suitable Rel-17 RACH partition satisfying the triggered RACH feature combination, then the UE may choose any other RACH partition (this may include other Rel-17 RACH partition that suits a subset of the features that triggered the RACH). How the UE chooses this subset is not specified (and left to UE implementation)

**Option 2:** the UE selects legacy RACH resource* The consequence of this is that if there is no suitable Rel-17 RACH partition satisfying the triggered RACH feature combination, then UE will not select any other Rel-17 partition (even if that partition may indicate a subset of features that triggered the RACH procedure)

**Option 3:** we specify a set of rules based on which the UE shall select another RACH partition* The consequence of this is that we need to specify clear priority rules that the UE shall follow in determining a fallback subset (if the feature set combination is not available)
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| Company | Preferred option Option 1/2/3/(Anything else?) | Comments (why?) |
| Qualcomm | Option 3 | We prefer Option 3 because the other two options have the following drawbacks:* Option 1 can lead to different (unpredictable) RACH performance by different UE implementations. In addition, Option 1 can make it difficult for network to estimate RACH load of different feature sets. That may lead to inefficient allocation of RACH resources;
* Option 2 is unnecessarily restrictive and may result in inefficient use of RACH resources. For example, suppose network configures one RACH partition for RedCap and another for legacy. If a RedCap UE triggers RACH and it also satisfies the criteria for SDT, then with Option 2 this RedCap UE has to use legacy partition instead of RedCap partition. That’s clearly not efficient.
 |
| Apple | Option 1/3 | We are fine with Option 1 or Option 3. For Option 1, we can trust the reasonable UE implementation. Option 2 will degrade the intial access performance in some cases, e.g. when UE is in coverage enahcnement area, and NW doesnot provide the CE only RACH partition but provides CE+Slicing RACH partition. |
| ZTE | Option 2 is needed when there is no RACH resource available for the triggered feature combinationOption 3 may be needed in case multiple RACH resources are available | We alredy agreed that the network is not obliged to configure RACH partitions for all features. So, if none of the RACH partitions is available for the triggered RACH procedure, then obviously, the UE has to select legacy RACH partition. So, option 2 is the baseline in this case. Then the question is whether option 3 is needed on top of option 2. We think option 3 comes in to picture only when there is one or more available RACH partitions (satisfying only a subset of the triggered features). For example: **RACH procedure is triggered for REDCAP (R) and Slice 1(Sl-1):** * RACH partion 1: R+Sl-2
* RACH partition 2: R+Sl-3
* RACH partition 3: R
* RACH partition 4: Sl-1

Then, RACH partitions 1 and 2 are obviously not available because they are for slice 2 and slice 3 and the current RACH procedure is triggered for slice 1. RACH partition 3 is still available because it supports only a subset of features (i.e. REDCAP only). RACH partition 4 is also available because it supports only a subset of features (i.e Slice 1 only). We then need some predefined rule to determine whether partition 3 or 4 will be selected. For instance if we define some rule like REDCAP>Slice>SDT>CE then in the above example we would select RACH partition 3. If no such priority rule is defined (of if neither partitions 3 or 4 exist), then option 2 becomes the default option and legacy RACH resource will be selected. So, it seems both option 2 and option 3 may need to be supported in the end. So, we have to have some discussion on priorities.  |
| Huawei, HiSilicon | Option 3 | We agree with Qualcomm Option 2 does not work properly. E.g. it could lead to Redcap UE selecting legacy RACH and not being able to access the network. Hence, it should be excluded. Option 1 would lead to unpredictable UE behviour which makes it hard to properly dimension and plan RACH configuration. Hence, option 3 is preferred. |
| Intel | Option 2 is needed for the case none of the RACH partitions satisfied the UEOption 3 is only needed in the case there are more than one RACH partitions that support subset of features | Option 2 is still needed for the case the UE is in a legacy cell or in a cell that do not support any of the featuresOption 3 allows some form of network control on the selection of the RACH partition if no RACH partition matches the UE’s feature combination and there are more than 1 RACH partition that matches the subset of UE’s feature combination. This will also provide a consistent and predictable UE behaviour across different UEs.  |
| NEC | Option 2 for single feature case,Option 3 for feature combination case | It seems good to consider a single feature case and feature combination case separately. For single feature case, Option 2 should be applied.For feature combination case, if a part feature(s) of FC is not suppored in any RACH partition, then some rules need to be specified. At leaset for RedCap, the RedCap UE shall select the RACH partition configured with RedCap indication, except for the case where Msg3-based identification is applied. Option 1 (up to UE implementation) may be a part of the Option 3. |
| Xiaomi | All options can be considered.Option2 is the baseline solution. Option3 is preferred to guarantee higher priority feature can be supported .Option1 can also be considered in case of multiple RACH partitions meet criteria. | As we agreed in last meeting, NW may not provide RACH partitions for all possible permutation. Based on this, there are some cases stated as follows:Case1: The features triggered RACH is not any subset of features indicated in a RACH partition or there are none of R17 RACH partitions.Case2: The features indicated in a RACH partition is a subset of the features triggered RACH. For example, a RACH is triggered by SDT+Redcap and there is a RACH partition for SDT and a RACH partitions for Redcap.Case3: The features triggered RACH is a subset of features indicated in a RACH partition. For example, a RACH is triggered by SDT+Redcap, there has no partition for SDT+Redcap but have RACH partitions for SDT+Redcap+CE and SDT+Redcap+slice1.For case1, we think option2 should be supported as baseline to guarantee UE can get access.For case2, option3 is preferred to achieve the consensus control across different UE and guarantee the higher priority feature can be supported in the selected RACH partition.For case3, as there are multiple RACH partitions can support all features triggered the RACH process, from our view, either option3 and option1 is okay to determine a RACH partition among these. |
| LGE | Option 1 | Regarding option 2, it is not reasonable to limit the UE operation to exclude other features even though a subset of feature are applicable.Regarding option 3, it is not future proof and the spec description would be complicated whenever the additional RACH paritioning feature is added.UE implementation would be sufficient to select the appropriate RACH partition with partial use of feature/feature combination, since the purpose of each feature is clear.  |

Then, the next question, is to discuss the details of option 3, should this be preferred by the majority of companies.

Firstly, if we want to specify a set of rules, there may be multiple sub-options:

**Option a:** Priority rules are static and will be defined in the specs (e.g. the available RACH partition with slice info will be prioritized etc)

**Option b:** Priority rules are configurable (e.g. can be configured in SI)

**Option c:** Others (please explain)

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| **Q 4: If we agree to specify the priority rules, which option is preferred and why?****Option a/b/c** |
| Company | Preferred option (option a/b/c/d/) | Comments (why?) |
| Qualcomm | Option a | We expect this priority rule to be fairly static. Hence we do not see a need to signal it in SI, which introduces unnecessary overhead in SIB1. |
| Apple | Option a/b |  |
| ZTE | a | If majority companies prefer to fully specify the priority rules, then we think option a is sufficient.  |
| Huawei, HiSilicon | option b | Option b is most future proof as RACH partitioning may be used for more features in future. Hard-coded rule would have to be rediscussed and updated each time we add a new feature relying on RACH indication. Furthermore, there may be different preferences from operators on how to set the prioritization rule. The additional overhead seems to be fairly low. |
| Intel | Prefer Option b | As mentioned, by allowing Option 3, it provides some form of network control. Each network may have different priority for each feature and this can only be achieved if the priority of each feature or feature combination is configurable. However, we are also fine to go with Option a. |
| NEC | Option a | Related to our comment to Q3, how to handle the RACH partition by RedCap UE should be specified at least. We are open for further discussion on Option b (then, decide whether Option a is sufficient or b is also necessary) |
| Xiaomi | Prefer option a  | In our understanding, the RACH partitions selection priority is only related to the feature priority which is static. We are open for the discussion on the necessary of option b if it is majority view. |
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If we choose to specify the detailed priority rules (i.e. fallback options), then we need to further discuss how to specify this.

For instance this may be based on some static priority rules (e.g. the available RACH partition with slice info will be prioritized etc etc). i.e. this means if both RACH partition with and without slice info are configured and be considered as available, then the UE should prioritize the RACH partition with slice info configured etc.

Since it is not straightforward to describe all such possible priories, we can start with some open discussion and companies can explain their views on how the priority and order can be specified

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| Q 5: If there is no RACH partition that maps to all triggered features and if we want to define specific rules for fallback to a subset, how should UE determine the alternative Rel-17 partition to be selected (for a subset of features)? |
| Company | Comments (e.g. companies can explain how the priority order would look – etc) |
| Qualcomm | In our paper R2-2109452 ([2]), we have described the following steps for UE to apply to select a RACH partition, assuming there is a priority list among different RACH features predefined in the spec:1. Start with all configured RACH partitions, and the RACH feature which has the highest priority;
2. Determine if the RACH feature selected for this step is one of the triggers for the RACH procedure or UE is eligible to use. If it is not, select the next RACH feature in the priority list and check again. Otherwise, among the RACH partitions selected at the start of this step, select those that include the selected RACH feature and then perform Step 3;
3. Among the RACH partitions selected for this step, select those partitions that UE meets the criteria of all its included RACH features. In addition, select the next RACH feature on the list. Then repeat Step 2. If UE does not meet criteria of any partitions selected for this step, or all RACH features in the priority list has been evaluated, UE stops this proccedure.
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| Apple | The fallback priority list provides the feature priotiy in the order for the RACH paritition selection, e.g. CE is the 1st priority, RedCap is the 2nd priority…and so on. If there is no RACH partition mapped to all triggered features, UE will follow the fallback priority list to select the feature specific RACH partition.* UE selects the RACH partition mapped to the feature with the 1st priority, and if not, UE selects the RACH partition mapped to the feature with 2nd priority…
* If no RACH partition is selected finally, UE will perform legacy RACH procedure.
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| ZTE | Firstly, for SDT, before the resume procedure is triggered for RA-SDT, RRC will anyway check with MAC that there are RA-SDT specific RACH resources available. Thus, it can be ensured that the RACH partition for SDT will be available in this case. If RACH partition for SDT doesn’t exist, then RA-SDT will not be triggered by RRC. So, we don’t need to further consider SDT in priority rules. Then, we think that CE should be considered as a RACH type instead of as a RACH partition as mentioned above. So, CE also doesn’t need to be considered then in priority selection. This leaves us with REDCAP and slice indication. We think then we can specify slice indication has higher priority than REDCAP. This works because the network can always rely on msg3 based REDCAP indication. Hence, the UE can prioritise the slice resources. Since the network knows that it has to rely on msg3 based REDCAP indication in some fallback scenarios where slice indication takes precedence, it can always tailor the RACH partitions accordingly (i.e. either to provide explicit partitions with REDCAP indication and slice combinations where this is seen as important and then to rely on the msg3 based REDCAP indication where this is not seen as important). **So, with this approach, we think the only priority rule to specify is that Slice indication has higher priority than REDCAP.**  |
| Huawei, HiSilicon | The partition selection rule could look like the one proposed by QCM. However, as we mentioned above, it would be simplest to make the feature priorities configurable by the network, which has the benefit of not having to discuss the priority order of different features. For example, the priority between the slice and Redcap as proposed by ZTE may not be preferred by some networks. The network may be configured to rely on msg1 based Redcap indication only. In such a case, the Redcap UE should always use Redcap partition and, e.g., “resign” from slice indication in case there is no Redcap+slice partition. |
| Intel | The gNB can provide priority for each of the feature. One option is that the UE will select the RACH partition corresponding to the feature combination that has the highest aggregated priority. For example, UE requires Slicing, RedCap and CE and there are 2 RACH partitions for feature combinations {Slicing + RedCap} and {Slicing + CE}. If slicing has priority 1, RedCap has priority 2 and CE has priority 3, the UE will select {Slicing + CE} as it provides an aggregated priority of 4 while {Slicing+RedCap} provides an aggregated priority of 3. In the case there is only 1 RACH partition that matches the subset of UE’s feature combination, the UE should just pick that RACH partition.  |
| NEC | Firstly, RedCap should be taken as the first priority, except for the case where Msg3-based identification is applied (i.e. no RACH partition for RedCap).For SDT, we do not think this is high priority than others, as the UE can send a data even without SDT via normal resume procedure. For CE, if this is seen as necessary for a UE, then it should have high(er) priority as the (data) transmission may be failed without CE function. For Slice, this may depend on the purpose or intention of the Slice-based RACH. If the network wants to filter (e.g. reject to Msg3 other than specific slice(s)) then it should have high(er) priority. Otherwise (e.g. for successful rate is controlled via Slice-based RACH), it may not need to be considered as high priority. With these observations, we assume the following priority order: RedCap (top) > CE, Slice > SDT.  |
| Xiaomi  | We share the same view with Apple if the RACH partition selection considers all R17 feature priorities not only the features triggered RACH process, and the feature priorities can be discussed later.However, in the procedure raised by Apple, if UE performs RACH partition selection only based on the priority of features triggered RACH process, there may exists multiple RACH partitions at the end of selection procedure. For example, a RACH is triggered by SDT+Redcap, there has no partition for SDT+Redcap but have RACH partitions for SDT+Redcap+CE and SDT+Redcap+slice1, in this case, UE behaviour needs further specified to choose only one RACH partition. |
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## Initialization of RACH variables

Once the RACH partition is selected, the RACH variables can be initialised based on the selected partition. We can check if companies share this view.

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| **Q 6: Do companies agree that once the RACH resource partition for a given feature set combination is determined, RACH procedure related variables in sections 5.1.1 and 5.1.1a can be initialized based on the values signalled within the selected RACH partition?** |
| Company | Yes/No | Comments (why?) |
| Qualcomm | Yes |  |
| Apple | Yes |  |
| ZTE | Yes | Once the RA partition is selected, the MAC entity should know all the corresponding RA parameters for the partition and should proceed to initialise the RA variables in section 5.1.1 and 5.1.1a using the configured variables.  |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes |  |
| NEC | Yes |  |
| Xiaomi | Yes |  |
| LGE | Yes |  |

Then, one further question is whether all the RACH parameters within a RACH partition are common to all features that use the corresponding RACH partition. This aspect is mentioned in [2] for instance (see P1). In general, it is possible for the network to configure the RACH parameters within a given RACH partition to take into account all features that are mapped to the specific RACH partition. For instance, if a given slice requires specific power control or other RACH prioritisation related parameters, the network can configure the corresponding parameters in this RACH partition accordingly. It seems that other features which may also use this partition will also use these parameters, but since this is under control and can be tailored to each partition, it seems there is sufficient flexibility to allow the RACH variables to be specific to the partition (i.e. not specific to the feature within the partition). So, the following question is asked.

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| **Q 7: Do companies agree that all features that are mapped to a given RACH partition use the same set of RACH parameters (signalled within this partition) – in other words the RACH parameters are per RACH partition rather than per feature within the partition?** |
| Company | Yes/No | Comments (why?) |
| Qualcomm | See comment | We do not fully understand the rapporteur’s question. The following comments are based on our best guess on what the rapporteur is asking.It seems that the second part of the question asks whether RACH parameters should be configured per RACH partition (e.g. two-step RACH in different RACH partitions can be configured with different values) or per feature globally (e.g. two-step RACH in all RACH partitions share the same values for two-step RACH parameters). In our view, the configuration should be per RACH partition, because different RACH features, when jointly configured, may require different values for the same parameter. For example, suppose Partition A includes only legacy RACH and Partition B includes slice-specific 4-step RACH. Then Partition B may be configured with, say, different *preambleTransMax* or *powerRampingStep* to meet the special requirement of the slice. Regarding the first part of the question, we first observe that all RACH parameters are unique in a RACH partition, for the following reasons. Since each feature included in a RACH partition is always unique, then one may conclude that RACH parameters specific to a feature (e.g. *msgA-RSRP-Threshold* is specific to only two-step RACH) is also unique within that partition. If there are RACH parameters used by all RACH features, then those parameters have to be associated with either RACH resources or PHY-layer transmission procedures, not RACH features. Since the mapping between RACH resources and RACH partition is one-to-one, then those parameters are also unique/specific to a RACH partition.  |
| Apple | Yes | RACH parameters should be provided per RACH partition. In our understanding, the RACH configuraiton of one RACH partition has 3 cases: a) 4-step RACH only, b) 2-step RACH only, and c) 2-step RACH +4-step RACH.  |
| ZTE | Yes | Although it is possible to configure feature specific RA parameters within the RA partition that uses multiple features, we think such flexibility is not really needed. If a RA partition is applicable to a high priority feature, then even if some low priority features are mapped to this partition, they can also use the high priority RA parameters applicable to this partition. If this is not desirable, then the network always has the choice to change the feature set mapping to a different partition. So, we don’t think that additional complexity should be introduced by further dividing the RA parameters per feature within the partition. Of course within the RACH partition, the RACH parameters are per RACH type (same as legacy – i.e. for 2-step and 4-step RACH the parameters will be different).  |
| Huawei, HiSilicon | See comment | This again depends on how RACH partition is defined. If we define it as a combinaiton of certain ROs and preambles dedicated to a specific feature combination, then we agree with the proposal. I.e. it should be possible to configure feature or feature combination specific parameters. If not configured, then the UE may use the parameters configured in legacy RACH config. For example if we take an example as above where we have a RACH configuration which is shared by multiple feature combinations:1.Feature #1: Redcap2.Feature #2: SDT3.Feature combination #3: SDT+RedcapThen, it should be possible to configure, e.g. different power control parameters for RACH in these three RACH partitions (even though they use the same RACH configuration / set of ROs). |
| Intel | See comments | We agree that most of the RACH parameters are common to all features for a RA type within a RACH partition. But there are some RACH parameters related to shared RO (e.g. cb-PreamblesPerSSB-PerSharedRO, groupBconfigured, SharedRO-MaskIndex etc.) which have to be feature/feature combination specific.  |
| NEC | Yes |  |
| Xiaomi | See comments | We share the same view with Intel that most parameter are common for all feature within a RAHC partition. But some parameters like sharedRO configuration can be specific for each feature or each feature combination sharing the same RO configuration. |
| LGE | Yes | For common RACH procedure, it would be simpler to define RACH-related parameters in each partition. When the RACH parameters are defined for each feature, there would be collision cases since multiple features define the feature-specific RACH parameter (e.g., *rsrp-ThresholdSSB* can be separatedly defined in CE and RA-SDT procedure.). Since there are limited TUs for common RACH discussion, additional complexity should be avoided.If RACH parameters are signalled in each RACH partition, it looks straightforward to use the parameter signalled within each RACH partition.  |

## Carrier/BWP selection

Currently, in sections 5.1.1, UE performs the carrier and BWP selection based on the thresholds configured in the RACH configuration. We can check if the same procedure can be reused for the common RACH procedure.

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| **Q 8: Do companies agree that carrier selection and BWP selection can be performed based on the RACH parameters signalled in the selected RACH partition?** |
| Company | Yes/No | Comments (please explain any changes needed?) |
| Qualcomm | No | We think carrier and BWP selection should be performed before the selection of RACH partitions. Therefore, the thresholds for their selections should be configured separately from the configuration of RACH partitions. |
| Apple | No | Carrier selection and BWP selection should be performed before RACH partition selection.  |
| ZTE | Yes | **For Carrier selection:**There is a bit of a chicken-and-egg situation here since the carrier selection happens based on the RSRP threshold configured and this will be configured per RACH partition (i.e. per feature as agreed for some of the features already). If as carrier selection has to happen before RACH partition selection, then we need to clarify which RSRP threshold is then used for the carrier selection and how this threshold is configured. It should be noted that since carrier selection thresholds are configured per partition anyway, the network can ensure that once the given partition is selected it can always be ensured that the correct carrier is selected by the UE. i.e. there will be no case where the carrier selection will result in a scenario where the feature combination specific RA resources donot exist. So, we think we can stick with the existing mechanism where the modelling in MAC assumes carrier selection to be performed after selecting RACH partition. **For BWP selection:**Similar to the carrier selection above, we can also leave it up to the network implementation to ensure that on the selected BWP, the feature specific RACH resources exist. Note that for now the only question here is for REDCAP. So, if the REDCAP UE selects the REDCAP BWP, then all RACH resources on this partition implicitly support REDCAP indication. So, then REDCAP indication can always be provided anyway. In otherwords on the REDCAP BWP, all RACH partitions are REDCAP partitions. For other features, we can leave it up to network implementation.  |
| Huawei, HiSilicon | Tend to agree for carrier selectionUnclear what is meant by “BWP selection based on parameters signaled in RACH partition” | On one hand, we have already agreed that: “Carrier selection (between NUL/SUL) should happen ahead of the initial RACH resource selection (i.e. feature combination is not considered in carrier selection).” On the other hand, we tend to agree with ZTE’s evaluation for carrier selection aspect. Some features indeed rely on feature specific threshold and in order to use these, we need to know the feature first. So, for carrier selection, we tend to think that carrier is chosen after selecting the applicable feature combination.When it comes to BWP selection, the BWP selection rules are specified in section 5.15 in MAC specifications and the rules can be summarized as follows:1. If RACH is configured on the active BWP -> use active BWP.
2. If there is no RACH on the active BWP -> switch to initial BWP.

In general, this principle should be reused, but we need to discuss what happens in case there is RACH on the UE's active BWP, but not corresponding to its selected feature combination and a similar approach as in Q3 can be considered. |
| Intel | No with comments | In general, carrier selection and BWP selection should be performed before RACH partition selection. However, there is one exception case: if a separate BWP is configured for REDCAP, the BWP selection should also consider this in selecting the BWP |
| NEC | Yes for carrier section,  | For the single feature, the carrier selection can be done before selecting the RACH partition. The network should ensure the corresponding feature is available when the RSRP threshold for this feature is configured. On the other hand, for feature combinations, this may not be the case as ZTE commented. We think that even for the single feature case, the UE can select RACH partition(s) for that single feature and then use parameters for carrier selection. So, the RACH partition(s) can be selected firstly and then carrier can be selected based on the parameters for the selected RACH partition(s). Regarding the BWP selection, we would like to discuss and confirm how carrier selection works and then further BWP selection is considered, as BWP selection in this context seems only for RedCap. |
| Xiaomi  | No | We have already agreed that: “Carrier selection (between NUL/SUL) should happen ahead of the initial RACH resource selection (i.e. feature combination is not considered in carrier selection).” |
| LGE | No | The carrier selection should be performed before selecting RACH partition. This principle is also aligned with the current baseline agreed in RAN2#115:

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| 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).  |

Since there is no selected RACH partition before the carrier selection, the RACH parameters within the selected RACH partition cannot be used.Regarding the BWP selection, it is also performed regardless of the RACH partition, as specified in 5.15 (Bandwidth Part (BWP) operation). The additional description in 5.1.1 is not needed. |

## RACH type selection

After carrier and BWP are selected, UE performs the RA-type selection and initialise RA-type specific variables (see section 5.1.1a of the MAC spec). We can check whether this procedure can also be replicated (again based on the RACH parameters signalled in the selected RACH partition).

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| **Q 9: Do companies agree that the RA-type selection can happen like today (i.e. after the carrier and BWP selection) based on the RACH parameters signalled in the selected RACH partition?** |
| Company | Yes/No | Comments (please explain any changes needed to the current procedure?) |
| Qualcomm | No | In our view, RA-type selection should be a part of selection of RACH partitions, because the priority between 4-step or 2-step RACH may be depend on which other R17 feature(s) it is configured with. For example, slice-specific 4-step RACH may be prioritized over common 2-step RACH. |
| Apple | Yes | After RACH partition is selected, UE will perform the RACH type selection if both 4-step RACH and 2-step RACH are provided in the RACH configuration of the selected RACH partition.  |
| ZTE | Yes | For this, we are not sure how it will work if RACH type has to be selected before the RACH partition since the 2-step and 4-step RACH resources are configured per RACH partition! |
| Huawei, HiSilicon | Yes | Agree with ZTE. |
| Intel | Yes | RA type selection will be performed based on the RA types supported for a RACH partition. |
| NEC | Yes |  |
| Xiaomi | Yes |  |
| LGE | Yes | If the question is asking whether RA type should be selected within the selected RACH features/partition, our answer is yes.Considering all of the features define the RACH partitioning for CBRA cases, the legacy RA type selection procedure is based on whether the RA resource for 2-step RA/4-step RA is configured in the BWP. Similarly, the RA type can be determined based on whether the RA resource for selected RACH feature/partition is configured in the BWP. In this sense,* If the BWP is only configured with 2-step RA type Random Access resources for selected RACH features/partition, select *2-step RA*
* If the BWP is only configured with 4-step RA type Random Access resources for selected RACH features/partition, select *4-step RA*
* If the BWP is configured with both 2-step and 4-step RA type Random Access Resources for selected RACH features/partition, the RA type is selected based on the RSRP of the downlink pathloss reference (comparing with *msgA-RSRP-Threshold* for selected RACH features/partition)
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## RNTI collision problem

In [1], [3] the RNTI collision issue for RACH partitioning is discussed. In [1] it is proposed to solve this issue by using a custom offset signalled through RRC and associated with each PRACH configuration to solve this problem. On the otherhand in [3], it is proposed to use a separate search space for RAR/MSGB monitoring. It should be noted that for some work items (e.g. SDT), separate search space has already been agreed to be configured. So, it seems we need to support this option anyway and it seems it may be possible then to extend this to all RACH partitions too. So, companies are asked to answer the following question.

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| **Q 10: To solve the RNTI collision issue, which option do companies prefer?****Option 1: Do nothing (i.e. leave to network implementation)****Option 2: A custom offset, signalled through RRC and associated to each PRACH configuration, is added in the formula for RA-RNTI and/or MSGB-RNTI. The legacy PRACH configuration it is assumed to have offset = 0 (see [1])****Option 3: the network should be able to (optionally) configure a specific search space for RAR/MSGB monitoring per RACH resource partition (see [3] – as was already agreed anyway for some features – e.g. SDT)**  |
| Company | Option 1/2/3 | Comments (why?) |
| Qualcomm | Option 1 | Although there can be more RACH configurations in R17, network still has several options to handle possible RNTI collision, as discussed in the past. If a super-majority of companies (e.g. more than 2/3) want to introduce enhancements to handle RNTI collision, we are fine with option 2, or option 2 together with Option 3.  |
| Apple | Option 2 | The RA-RNTI/MsgB-RNTI used for R15/R16 and R17 can be overlapped due to the multiple PRACH configurations for the same RACH type in one cell. The RNTI offset should be introduced to avoid the overlapping between between legacy and R17 usage and to avoid the impact to legacy UE. |
| ZTE | Option 3 (option 1 is also okay) | We think option 3 is anyway needed (since some features already agreed feature specific search space). We think the search space then can be made to be feature combination specific (and apply a given search space per RA-partition). With this, option 3 seems necessary and is also sufficient.  |
| Huawei, HiSilicon | Option 3 | With the introduction of feature and feature combination specific RA configurations, it will be extremely hard, if not impossible, to resolve RNTI collision issue by network implementation (e.g. it may be impossible for the network to configure ROs of different features and feature combinations at different time), so option 1 can be infeasible. When it comes to option 2, considering the remaining RNTI space is very limited already after introducing MSGB-RNTI, it seems impossible to have respective offset for all features and feature combinations while still avoiding collisions. Having a an option to configure a dedicated search space is the simplest approach to us and as mentioned by the rapporteur, some WIs already agreed to support that. It should be noted that even though multiple search spaces would have to be provided, UE is only required to monitor one of them during an ongoing RA procedure, so this approach would not impose new requirements on the UE.  |
| Intel | Options 1, 3 and preamble partitioning | The simplest is to go with Option 1 for this release and leave it to network implementation to control the number of RACH partitioning on top of ensuring no RNTI collision. In addition, as mentioned by the rapporteur, Option 3 is already agreed for SDT and if generalised for use with other feature/feature combination can further help in relieving RNTI collision problem (e.g. by adding “SDT specific SS set configuration (Type 1A-PDCCH CSS) can easily be reused for slicing, and CE if needed. For example, case (1) when SDT is not used/configured, but only used for slicing and CE, or case (2) when any combination of SDT, slicing and/or CE is used.”). If Option 3 is agreed, it would still be good for RAN2 to check with RAN1 whether generalising Option 3 to other features/feature combinations, other than just for SDT is feasible in their view. |
| NEC | Option 3, otherwise Option 1 (if majority support this) | We see some pros/cons for each option. For Option 1, there may be no big concern in Rel-17, if not so many feature or feature combinations are applied in a cell. However, this may not be future proof considering potential increase of number of feature or feature combinations. For Option 2, there are already some fragmentations and thus it is not easy to configure an appropriate offset from network point of view. For Option 3, given SDT is using this option for subsequent transmission, i.e. separate CSS can be configured for SDT, it is wroth considering to apply the similar to other features. Note that in any case, RAN2 needs to ask RAN1 about this option. |
| Xiaomi | Option 3 | Firstly, RA-RNTI collision has been agreed to be addressed in RAN slicing WI, but as there are not too many RACH partitions for slices, it can be resolved by network implementation (e.g. network configure RO in different time). However, as the possibility of RA-RNTI collision increases with the number of feature/feature combinations requiring RACH partitions increasing, it seems impossible to be totally resolved by network implementation. Thus option1 is improper, we can not do nothing and totally hand over to NW implementation.For option 2 and 3, we share the same view with Huawei, as the RA-RNTI space is limited especially after MSGB-RNTI is introduced, option2 seems impossible to avoid all collisions for so many feature combinations. Thus, we prefer to adopt option 3 to provide a flexible solution and be align with some features (e.g. SDT) agreements.  |
| LGE | Option 1 | Since the network may handle RA-RNTI collision problem (e.g., by configuring the ROs in different time or resolving using contention resolution in Msg4), network implementation is preferred considering the limited RNTI space.Note that the Option 3 has not been agreed for RAR/MsgB in RA-SDT. In SDT, separated search space has been agreed for monitoring the PDCCH addressed to the C-RNTI after successful completion of the RACH procedure during RA-SDT |

# Conclusion and proposals

TBD

# References

1. R2-2110560 RNTI collision problem for Rel-17 features Ericsson discussion
2. R2-2109452 Selection and fallback between RACH partitions Qualcomm Incorporated discussion
3. R2-2110598 MAC aspects for RACH partitioning Huawei, HiSilicon discussion
4. R2-2110578 User plane aspects of RACH partitioning ZTE Corporation, Sanechips discussion Rel-17
5. R2-2109532 RA Procedure Aspects Samsung Electronics Co., Ltd discussion Rel-17 NR\_cov\_enh-Core
6. R2-2109542 Considerations on the common aspects of RACH procedure Beijing Xiaomi Software Tech discussion Rel-17
7. R2-2109882 RACH resource/configuration selection and fallback mechanism Intel Corporation discussion Rel-17
8. R2-2110260 Discussion on RACH indication and partitioning CMCC discussion Rel-17
9. R2-2110665 Overview of RACH resource selection NEC discussion Rel-17
10. R2-2110813 Selection of RACH partition Nokia, Nokia Shanghai Bell discussion Rel-17
11. R2-2110917 RACH indication and partitioning InterDigital discussion Rel-17
12. R2-2110927 Discussion on RACH Partitioning in RA Procedure Aspect vivo discussion Rel-17
13. R2-2111164 Discussion on common RA procedure for RACH partitioning features LG Electronics Inc. discussion

# Annex (contact details for email discussions)

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| --- | --- | --- |
| Company | Contact name | Contact email |
| Apple | Fangli XU | fangli\_xu@apple.com |
| ZTE | Eswar Vutukuri | eswar.vutukuri@zte.com.cn |
| Intel Corporation | Seau Sian Lim | seau.s.lim@intel.com |
| NEC | Hisashi Futaki | hisashi.futaki@nec.com  |
| Xiaomi | Xiaofei Liu | liuxiaofei@xiaomi.com |
| LGE | Hanseul Hong | hanseul.hong@lge.com |
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