3GPP TSG-RAN WG2 #116e Tdoc R2-21xxxxx

Electronic meeting, 2021-11-01 - 2021-11-12

Agenda Item: x.x.x.x

Source: Ericsson(Rapporteur)

Title: Report of [Post115-e][504][RACH Partitioning] Signalling Aspects (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This document reports on the RAN2 email discussion below:

* [Post115-e][504][RACH Partitioning] Signalling Aspects (Ericsson) Mattias, Henrik

Scope: Discuss signalling options/modelling related to RACH partitioning and whether we specify allowed feature combinations

Deadline: long email discussion

Email discussion deadline: October 21st, 0900 UTC

Companies are invited to provide company input on the questions below before the email discussion deadline.

# 2 Contact Persons

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Ericsson | Henrik Enbuske | henrik.enbuske@ericsson.com |
| ZTE | Eswar Vutukuri | eswar.vutukuri@zte.com.cn |
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# 3 General

RACH partitioning is being considered for several Rel-17 features to enable early identification of the feature on the network side (see table below):

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| **Feature** | **Reason for RACH indication** |
| RedCap [1] | To indicate reduced capabilities to the network in MSG1 so that the network can adapt subsequent transmissions |
| SDT [2] | To request a larger MSG3 size (or MSGA size in case of 2-step RA) |
| CovEnh [3] | To indicate need for coverage enhancement (esp. for request of MSG3 repetition) |
| Slicing [4] | To indicate high priority slice to the network and to achieve slice isolation also for RACH |

**Agreements** :

A history of agreements per WI can be found in Annex A

RA partitioning agreements RAN2115e:

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| Agreements:  1. Preamble partitioning is defined on a feature and/or feature combination basis. FFS on signalling. 2step RA and CE is excluded, if RAN1 decided to exclude  2. Preambles associated with a Rel-17 feature should never be chosen by legacy UEs in the case of RO sharing.  3. New feature and/ feature combination specific preambles can be defined in a) Separate time-frequency resources, not defined through legacy RRC signalling, b) Within the Contention free preamble resources (i.e. within the preambles not used for contention based) defined through legacy RRC signalling. FFS on c) Within the “not available” preambles defined at the end of a RO through the legacy totalNumberOfRA-Preambles  4. A common RRC CR capturing the signalling framework for RACH resource configuration across all the WIs should be used and this CR should be maintained as part of the common RACH agenda item. Each WI is expected to provide the necessary parameters to include in the signalling.  5. A common MAC CR capturing the changes to sections 5.1.1 and section 5.1.1a of the MAC spec can also be considered and if agreeable, this CR should also be maintained as part of the common RACH agenda item.  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. |

# 4 Discussion points

## 4.1 General

A PRACH configuration as defined in legacy consists of a set of contention-based preambles (CBPR) and contention-free preambles (CFPR) divided among multiple ROs. The CBPR are further split per SSB, RA-type, GroupA/B and are randomly chosen by a legacy UEs.

The CFPR are used by the UE only upon indication from the network, and thus the network may reserve a set of CFPR for Rel-17 UEs, i.e not assigning those preambles to legacy UEs.

There is a further set of preambles that are not used by any device; where less than the maximum 64 preambles each RO can support can be configured through the parameter totalNumberOfRA-Preambles.

With regards to the above, RAN2 agreed the following:

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| 3. New feature and/ feature combination specific preambles can be defined in a) Separate time-frequency resources, not defined through legacy RRC signalling, b) Within the Contention free preamble resources (i.e. within the preambles not used for contention based) defined through legacy RRC signalling. FFS on c) Within the “not available” preambles defined at the end of a RO through the legacy totalNumberOfRA-Preambles |

RAN2 left approach c) above as FFS, i.e. whether the preambles for a feature/feature combination can be defined in the end of an RO through the legacy totalNumberOfRA-Preambles.

**Q1:** Should RAN2 rule out option c?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | Yes | The preambles that are reserved (i.e. located after the totalNumberOfRA-Preambles) are also used for on demand SI for which a different RAR format will be used. So, defining new structure to reuse this preamble space is not preferable. Further if we define a new structure for this, then we also need to split these preambles per SSB (which will basically duplicate the existing structure for the rest of the preamble space and such scheme seems unnecessary as the option b would achieve same without needing such new design). |
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**Q2:**Two approaches have already been agreed, namely approach a) and approach b). Is it your understanding that this agreement means the **RAN2 specification should allow for use of approach a), use of approach b), and use of approach a) in combination with b)?**

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | Yes |  |
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## 4.2 Feature combination preambles and SSBs

Approach b) in the above agreement states:

*New feature and/ feature combination specific preambles can be defined within the Contention free preamble resources (i.e. within the preambles not used for contention based) defined through legacy RRC signalling.*

**Q3:** For approach b), do you agree 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)?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | Okay, but needs endorsement (e.g in RAN1) | We think this will simplify the overall design (since the best beam, which is selected after the feature combination selection would be guaranteed to have a RACH resource). However, perhaps such decision needs to be endorsed in each WI (probably even in RAN1?). So, if we do agree this, we need to inform RAN1 of this preference/agreement accordingly. |
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**Q4:** If the result of the question above is "yes", do you agree that a feature combination shall have the **same number** of preambles in all SSBs?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | Yes | Seems okay to have such design goal unless some bottleneck is identified. i.e. as much as possible, all beams should have equal probability of preamble collision. |
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## 4.3 Feature combination in a subset of RACH occasions

According to the current spec, it is possible that e.g. 2-step RA preambles are only present in a subset of the RACH occasions for a RACH configuration.

**Q5:** Do you agree that this behaviour should be used also for the Rel-17 RA partitioning feature? Namely that signalling should allow that a particular feature/feature combination can be mapped only to a subset of the RACH occasions of a RACH configuration?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | Yes |  |
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**Q6:** In legacy it is possible that e.g. 2-step RA preambles are mapped to either: all ROs, all odd ROs, all even ROs, or a particular RO. This is defined in Table 7.4-1 in 38.321.

If "yes" to the question above, should we reuse this legacy masking index approach for the Rel-17 RA partitioning feature?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | Yes |  |
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## 4.4 Location of feature combination indication

It must be clear for the UE which feature/feature combination a certain RA partition is for. The network therefore needs to send a feature combination indication to the UE. There could be different potential places for such an indication, for example in the RACH configuration or in a configuration of a RACH occasion, etc.

Please indicate where you think such feature combination should be indicated.

**Q6:** On which level in ASN.1 should the feature combination indication be indicated?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | ?? | In general, we think a new structure introduced under the BWP-UplinkCommon to configure the RACH partitions would be needed.  To minimize the impact on overall procedure, it would be good to limit the whole RACH procedure within the RACH resource pool selected. (i.e. per agreement 6c above at R2#115-e).  For the NW slicing, REDCAP, SDT, since these the feature selected will not change during the RACH procedure, it seems logical to configure them as single RACH-Resource pools for a given feature combination and assume that there is no change in the selected pool once the RACH procedure is initiated.  For the coverage enhancement, it is not clear whether the fallback between 4-step RACH and 4-step RACH with CE resource will be supported during a single RACH procedure (e.g. whether the CE 4-step RACH resource can be selected in the preamble retransmission, even if the normal 4-step RACH resource is selected in the initial preamble transmission – note that the switching in the other direction (i.e. from CE to non-CE seems not so critical since a UE in non-CE condition should also be able to work in CE conditions). If such switching is allowed, then we may need some discussion to handle this (i.e., either MAC has to handle reinitialization of RACH pool after each preamble for CE case or we need to define RACH resources with and without CE in each RACH pool etc).  May be some agreement on the CE case is needed for the above scenario hence.  So, to summarise, if RACH-Resource pool reinitialization is to be prevented in the MAC procedure, we have two options:  Option 1: switching between non-CE to CE is not allowed during a given RACH procedure  Option 2: Switching between non-CE to CE is allowed during the RACH procedure.  With option 1, it seems it is fairly straight forward and the ASN.1 may look something like below:  **Option 1 example (no fall back from non-CE to CE):**  BWP-UplinkCommon   * additional-RACH-ResourcesPoolList {containing a list of RACH resources for 2-step and 4-step RACH allowing one or more of the following features}   + allowedNSSAI – slice indication (note not binary)   + sdtIndication – true/false   + redcapIndication – true/false   + ceIndication – true/false   The details may look like below:  BWP-UplinkCommon ::= SEQUENCE {  ….  [[  additional-RACH-ResourcesPoolList SEQUENCE (SIZE (1..maxNrofRACHResourcePool)) OF Additional-RACH-ResourcesPool OPTIONAL, -- Need R  ]]  }  Additional-RACH-ResourcesPool::= SEQUENCE {  allowedNSSAI TBD  redcapIndication ENUMERATED {true} OPTIONAL -- Need R  sdtIndication ENUMERATED {true} OPTIONAL -- Need R  ceIndication ENUMERATED {true} OPTIONAL -- Need R  rach-ConfigCommon-Additional SetupRelease {  RACH-ConfigCommon-Additional } OPTIONAL, -- Need M  msgA-ConfigCommon-Additional SetupRelease {  MsgA-ConfigCommon-Additional } OPTIONAL -- Cond SpCellOnly2  }  RACH-ConfigCommon-Additional ::= SEQUENCE {  ro-configuration CHOICE {  shared-RO Shared-RO,  separate-RO-configuration Separate-RO-Configuration  }  //other parameters.  }  **Option 2 example (fallback allowed from non-CE to CE):**  BWP-UplinkCommon   * additional-RACH-ResourcesPoolList {containing a list of RACH resources for 2-step RA, 4-step RACH with CE and 4-step RACH without CE; allowing one or more of the following features}   + allowedNSSAI – slice indication   + sdtIndication – true/false   + redcapIndication – true/false   The details may look like below:  [[  additional-RACH-ResourcesPoolList SEQUENCE (SIZE (1..maxNrofRACHResourcePool)) OF Additional-RACH-ResourcesPool OPTIONAL, -- Need R  ]]  }  Additional-RACH-ResourcesPool::= SEQUENCE {    allowedNSSAI TBD  redcapIndication ENUMERATED {true} OPTIONAL -- Need R  sdtIndication ENUMERATED {true} OPTIONAL -- Need R  rach-ConfigCommon-Additional SetupRelease {  RACH-ConfigCommon-Additional} OPTIONAL, -- Need M  rach-ConfigCommon-CE-Additional SetupRelease {  RACH-ConfigCommon-Additional } OPTIONAL, -- Need M  msgA-ConfigCommon-Additional SetupRelease {  MsgA-ConfigCommon-Additional} OPTIONAL -- Cond SpCellOnly2  }  RACH-ConfigCommon-Additional ::= SEQUENCE {  ro-configuration CHOICE {  shared-RO Shared-RO,  separate-RO-configuration Separate-RO-Configuration  }  //other parameters.  } |
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## 4.5 How does the feature combination indication look like?

The network needs to indicate which feature or feature combination a certain RA partition belongs to. RAN2 should decide how that combination looks like. The rapporteur foresees at least two possible approaches:

**Approach A**: An IE contains one field for each of the features, i.e. one for RedCap, one for Small Data, one for Slicing, and one for Coverage enhancements. The network indicates a feature combination by setting the ENUMERATED {true} for those features that constitutes the feature combination.

In terms of ASN.1, this could look something like the following. Also, it is shown how this could be extended to add a potential Rel-18 feature in the future.

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| FeatureCombinationIndication ::= SEQUENCE {  redCap ENUMERATED {true} OPTIONAL,  smallData ENUMERATED {true} OPTIONAL,  slicing ENUMERATED {true} OPTIONAL,  covEnh ENUMERATED {true} OPTIONAL,  ...,  potentialRel-18Feature ENUMERATED {true} OPTIONAL  } |

**Approach B**: In this approach the ASN.1 defines all possible feature combinations, and the network chooses one of all possible feature combinations. In terms of ASN.1, this could look something like the following. Also, it is shown how this could be extended to add a potential Rel-18 feature in the future.

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| FeatureCombinationIndication ::= CHOICE {  redCap NULL,  smallData NULL,  slicing NULL,  covEnh NULL,  redCapAndSmallData NULL,  redCapAndSlicing NULL,  redCapAndCovEnh NULL,  smallDataAndSlicing NULL,  smallDataAndCovEnh NULL,  slicingAndCovEnh NULL,  redCapAndSmallDataAndSlicing NULL,  redCapAndSmallDataAndCovEnh NULL,  redCapAndSlicingAndCovEnh NULL,  smallDataAndSlicingAndCovEnh NULL,  redCapAndSmallDataAndSlicingAndCovEnh NULL,  ...,  potentialRel-18Feture  potentialRel-18FetureAndRedCap NULL,  potentialRel-18FetureAndSmallData NULL,  potentialRel-18FetureAndSlicing NULL,  potentialRel-18FetureAndCovEnh NULL,  potentialRel-18FetureAndRedCapAndSmallData NULL,  potentialRel-18FetureAndRedCapAndSlicing NULL,  potentialRel-18FetureAndRedCapAndCovEnh NULL,  potentialRel-18FetureAndSmallDataAndSlicing NULL,  potentialRel-18FetureAndSmallDataAndCovEnh NULL,  potentialRel-18FetureAndSlicingAndCovEnh NULL,  potentialRel-18FetureAndRedCapAndSmallDataAndSlicing NULL,  potentialRel-18FetureAndRedCapAndSmallDataAndCovEnh NULL,  potentialRel-18FetureAndRedCapAndSlicingAndCovEnh NULL,  potentialRel-18FetureAndSmallDataAndSlicingAndCovEnh NULL,  potentialRel-18FetureAndRedCapAndSmallDataAndSlicingAndCovEnh NULL,  } |

**Q7:** Do you prefer an Approach in line with A or B?

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| **Company** | **Answer (A/B)** | **Comments** |
| ZTE | A | We prefer something similar to option A. The details may depend on whether we allow fallbacks and if so, for which features and whether the fallbacks are handled entirely in MAC or we do some optimisation in RRC etc. Please see Q6.  One comment on option A is that for slicing, the indication cannot be enumerated {true} – i.e. since there could be multiple slices, the indication for slicing has to be per slice (i.e. the resource should be per slice in this case). For the rest the structure can be binary as noted. |
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## 4.6 Multiple RA partitions per feature-combination?

The agreement in RA partitioning results in that the network can provide specific RA partition that is specific to a feature/feature combination. It is open if there could be multiple RA partitions which map to the same feature.

**Q8:** Do you agree that RAN2 should define signalling allowing for **multiple** "RA partitions" which map to the **same** feature/feature combination? For example, should it be possible for the network to configure two RA partitions that both map to RedCap.

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| **Company** | **Answer (Yes/No)** | **Comments** |
| ZTE | No | There seems to be no clear motivation for this.  If we have this, then, we need some further discussion on how the UE has to select between different RA partitions (e.g. based some predefined rules in case multiple partitions satisfy a given feature combination, or whether this will be left to UE implementation?? Etc. seems not something that is essential for this release at least). |
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# 5 Summary & Conclusions

TBD

# 6 References & Contributions

1. R2-210xxx
2. [R2-2108253](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2107249.zip) RACH partitioning for Rel-17 features Ericsson discussion Rel-17
3. [R2-2107484](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2108786.zip) RRC and MAC related aspects of common RACH configuration ZTE Corporation, Sanechips discussion
4. [R2-2107009](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2108019.zip) Common aspects of RACH Samsung Electronics Co., Ltd discussion Rel-17
5. [R2-2107219](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2107219.zip) Unified RACH indication and partitioning Qualcomm Incorporated discussion Rel-17
6. [R2-2107058](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2107058.zip) Discussion on RACH Partitioning in Rel-17 vivo discussion NR\_SmallData\_INACTIVE-Core, NR\_cov\_enh, NR\_redcap-Core, NR\_slice-Core
7. [R2-2107244](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2107244.zip) RACH partitioning common design for Rel-17 features Beijing Xiaomi Software Tech discussion Rel-17
8. [R2-2107256](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2107256.zip) Discussion on PRACH partitioning OPPO discussion Rel-17
9. [R2-2107552](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2108714.zip) Common aspects of RACH partitioning Intel Corporation discussion Rel-17
10. [R2-2107575](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2004983.zip) Cross-WI RACH Design Apple discussion Rel-17
11. [R2-2107835](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2108085.zip) RACH indication and partitioning InterDigital, Europe, Ltd. discussion Rel-17
12. [R2-2108004](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2108199.zip) On RACH indication and partitioning CATT discussion Rel-17
13. [R2-2108138](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2107867.zip) General aspects of RACH indication and partitioning NEC discussion Rel-17
14. [R2-2108210](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2107440.zip) RACH indication and partitioning Huawei, HiSilicon discussion Rel-17
15. [R2-2108760](file:///C:/Users/panidx/OneDrive%20-%20InterDigital%20Communications,%20Inc/Documents/3GPP%20RAN/TSGR2_115-e/Docs/R2-2108760.zip) Discussion on RACH partitioning in Rel-17 LG electronics Inc. discussion Rel-17

# Annex A

Random access resource partitioning and configuration is discussed in RedCap, SDT, UL coverage enhancement and RAN slicing work items. Relevant agreements to date:

**RAN2#112e Agreements SDT:**

As a baseline, the RACH resource i.e. (RO + preamble combination) is different between SDT and non-SDT

- If ROs for SDT and non SDT are different, preamble partitioning between SDT and non SDT is not needed.

- If ROs for SDT and non SDT are same, preamble partitioning is needed

**RAN1#105e Agreements UL coverage enhancements:**

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

**RAN2 Agreements RAN Slicing:**

* RAN2 aims to support both RO partition and preambles partition.
* RAN2 confirm for a slice group, separated RO and/or separate preamble can be configured within the existing RACH-ConfigCommon and RACH-ConfigCommonTwoStepRA
* For RACH type selection, UE first selects between slice-specific and common RACH, then selects between 2-step and 4-step.
* The following fallback case is supported:
  + Fallback case 2: Fallback from 2-step slice specific RACH to 4-step common RACH, if 4-step slice specific RACH is not configured.
* The following fallback cases are not supported in this release:
  + Fallback case 1: Fallback from 4-step slice specific RACH to 4-step common RACH
  + Fallback case 3: Fallback from 2-step slice specific RACH to 2-step common RACH, if neither 4-step slice specific RACH nor 4-step common RACH is configured

**RAN2 Agreements RedCap:**

* (Working Assumption) For 4-step RACH, support the early indication of RedCap UEs at least in Msg1.
  + The early indication in Msg1 can be configured to be enabled/disabled
* (Working Assumption) For enabling/supporting that the RACH occasion (RO) associated with the best SSB falls within the RedCap UE bandwidth, support separate initial UL BWP for RedCap UEs (which is not expected to exceed the maximum RedCap UE bandwidth), and this separate initial UL BWP for RedCap includes ROs for RedCap UEs.
  + Note: these ROs can be dedicated for RedCap UEs or shared with non-RedCap UEs
* There is no need to support Rx branches specific early identification from RAN2 perceptive (final decision up to RAN1).
* At least for early identification there will be only one RedCap UE (no need to define separate RedCap UE types for FR1 and FR2)
* Support 2-step RACH for RedCap UEs as an optional feature
  + FFS details of early indication in MsgA, e.g.:
  + Separation of 2-step RACH resources or MsgA preambles
  + Separation of initial UL BWP
  + Using a new indication in MsgA PUSCH part
  + Note: Discussion on 4-step RACH for early indication should be prioritised