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 |
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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). |
| OPPO | Yes | We basically agree with ZTE. If network want to use some of the preamble located after the totalNumberOfRA-Preambles, network can simply configure proper totalNumberOfRA-Preambles, then some of the preambles will be squeezed to be part of the reserved preamble for further partition. |
| Huawei, HiSilicon | Yes | We think it is sufficient to follow similar principles as used for 2-step RA, which is already covered by bullets a) and b) in the agreement. |
| Intel | Yes | We think that the preamble partitioning should be done in the similar way as 2-step RACH where further partitioning is taken from CFPR as in b) |
| Samsung | Yes | Agree with ZTE |
| Apple | Yes | We support to follow the similar way as the 2-step RACH for the RACH/preamble partitioning. |
| Ericsson | Yes |  |
| NEC | Yes | We also agree with comments above. The approach a) an b) would be sufficient. |
| Qualcomm | Yes | Agree with ZTE |
| vivo | Yes | We share the same view with Huawei. |
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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 |  |
| OPPO | a) and b), but not sure about a)+b) | The new ROs in approach a) is purely for Rel17 usage. So there is no preambles for CBRA for legacy 2-step or 4-step RACH procedure. So what does a)+b) mean? |
| Huawei, HiSilicon | Yes | Some feature/feature combinations may be configured using approach a) while others may use approach b), so a combination of a) and b) should be possible. |
| Intel | Yes |  |
| Samsung | Yes | Different approach can be followed for different feature/feature combination |
| Apple | Yes |  |
| Ericsson | Yes | Our understanding of a)+b) is what Huawei suggests, i.e. it would be possible that the network configures: one feature combinations to be mapped to a "separate time-frequency resources" (e.g. RACH configuration), while another feature combination is mapped to some preambles within contention free preamble resources.  This of course also means that the network could map a certain feature combination to a certain range of preambles in a separate (non-legacy) RACH-configuration. |
| NEC | Yes |  |
| Qualcomm | Yes | We are fine with what HW/Ericsson has suggested.  To avoid misunderstanding, maybe the proposal can also explicitly capture that no single RACH partition can be configured using both (a) and (b) . |
| vivo | Yes | Again, we share the same view with Huawei. |
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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. |
| OPPO | Yes | We think RAN2 can make decision on this. Maybe ZTE can explain what is the RAN1 aspect here. |
| Huawei, HiSilicon | Yes, for CBRA | For CBRA, we can use parameters similar to ssb-perRACH-OccasionAndCB-PreamblesPerSSB, msgA-SSB-PerRACH-OccasionAndCB-PreamblesPerSSB, msgA-CB-PreamblesPerSSB-PerSharedRO.  If a feature indication is allowed using CFRA, then this of course does not hold for such case. |
| Intel | Yes |  |
| Samsung | Yes | Same as in legacy |
| Apple | Yes |  |
| Ericsson | Yes | The focus for this question was of course only the CBRA-preambles. |
| NEC | Yes but | as ZTE points out, maybe we can wait for conclusion in each related WI. For instance, if preambles for a feature (A) is not necessarily present in all SSBs, then the same way can be applied for the feature combination including that feature (A). Although we guess the answer could be Yes in the end, no need to decide right now. |
| Qualcomm | Yes but | There might be use case where a feature is configured on only a subset of SSBs (e.g. coverage enhancement is supported only on beams with poor channel conditions). But for simplicity, maybe in this release we can require the same feature is configured on all SSBs. |
| vivo | Yes | The discussed RA resource for specific feature/feature combination is generally intended for initial access / RRC resumption. In this sense, it seems a spontaneous logic to support all SSB indicated in SIB1 for seamless access, considering the mobility characteristic of IDLE/INACTIVE UE cannot be aware at the NW side. |
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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. |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes, for CBRA | Same reply as for Q3. |
| Intel | Yes |  |
| Samsung | Yes |  |
| Apple | Yes |  |
| Ericsson | Yes | For simplicity this seems the preferred approach. |
| NEC | Yes | This sounds reasonable. |
| Qualcomm | Yes | For simplicity |
| vivo | Yes | We should follow the legacy NR design. |
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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 |  |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes | A specific subset of ROs can be configured to a specific feature or a feature combination using a separate RO mask index value. Such approach would decrease configuration overhead in SIB1 and would decrease the RNTI collision issue as compared to always having to specify separate RACH configurations per feature/feature combination. |
| Intel | Yes |  |
| Samsung | Yes | For RO sharing case |
| Apple | Yes |  |
| Ericsson | Yes | This is possible in legacy (for 2-step) hence we think it should be possible also for Rel-17. |
| NEC | Yes |  |
| Qualcomm | Yes |  |
| vivo | Yes | From RAN2 perspective, we are fine with this design. However, RAN1 is also discussing this issue in SDT/CovEnh session. For safety’s sake, we should anyway confirm with RAN1. |
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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 |  |
| OPPO | No | Such legacy approach could be sufficient for the case that the total ROs in same slot is 1,2 or 4. But for the case of 8, the total choice is 8+1+1+1=11 while logically there could be up to 256 combinations. Considering even in Rel17 the number of features or feature combinations is not small as indicated in table of section 4.5, we think more flexibility of mapping solution is needed e.g. a bitmap. |
| Huawei, HiSilicon | Yes | We think the values allowed by the legacy masking index are sufficient. |
| Intel | Yes |  |
| Samsung | Yes | For RO sharing case |
| Apple | Yes |  |
| Ericsson | Yes | We see the point by OPPO, but for now we assume that the existing masking-approach is sufficient. |
| NEC | Yes | Legacy approach could be reused. According to discussions in #115e, we understand that the number of combinations logically supported by the spec is already a lot. However, they are not necessarily fully/optimally supported at the same time.. |
| Qualcomm | Yes |  |
| vivo | Yes | Same comments to Q5. |
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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.  } |
| OPPO | See comment | Not very sure about the meaning of configuration per RO. For shared case, we expect some new parameters for partition will be added in either RACH-ConfigCommon or MsgA-ConfigCommon-r16. For separated RO cases, a new structure in the same level is needed.  As for the issue raised by ZTE i.e. how to treat non-CE to CE case we prefer a simple solution i.e. without any change of the feature or feature combination indication during RACH procedure. In case RACH procedure fails for non-CE and the condition for CE is met while RACH trigger is still holding, UE can trigger another CE specific RACH. |
| Huawei, HiSilicon |  | The feature combination can be indicated per RACH configuration. In case ROs of a RACH configuration are shared by multiple feature combinations, RO mask index should be configured per feature combination to indicate which ROs can be used by a specific feature combination. |
| Intel | See comments | Each of PRACH configuration/resources in the list may be shared with one or more features and/or feature combinations.  To indicate features and/or feature combinations sharing the PRACH configuration/resources, the feature combination indication can be added either at the *BWP-UplinkCommon* as in Signalling#1 or can be added in the *RACH-ConfigCommon* (for 4-step RACH) and in the *RACH-ConfigCommonTwoStepRA-r16* in *MsgA-ConfigCommon-r16*(for 2-step RACH) in Signalling#2 as follow:    Approach 1: Add the feature/feature combination indication in *FeatureCombinationRACH-Resource-r17* (in red)  BWP-UplinkCommon ::=                SEQUENCE {      genericParameters                   BWP,      rach-ConfigCommon     SetupRelease { RACH-ConfigCommon }          OPTIONAL,   -- Need M      pusch-ConfigCommon          SetupRelease { PUSCH-ConfigCommon }         OPTIONAL,   -- Need M      pucch-ConfigCommon          SetupRelease { PUCCH-ConfigCommon } OPTIONAL,   -- Need M      ...,      [[      rach-ConfigCommonIAB-r16    SetupRelease { RACH-ConfigCommon }          OPTIONAL,   -- Need M      useInterlacePUCCH-PUSCH-r16 ENUMERATED {enabled}                        OPTIONAL,   -- Need R      msgA-ConfigCommon-r16       SetupRelease { MsgA-ConfigCommon-r16 }      OPTIONAL    -- Cond SpCellOnly2      ]],  [[  -- Providing a pool of separate RO (e.g. using PRACH-COnfigurationIndex)  featureCombinationRACH-ResourcesList-r17 SEQUENCE (SIZE(1…maxFeatureCombList) OF FeatureCombinationRACH-Resource-r17  OPTIONAL   -- Need M  ]]  }    FeatureCombinationRACH-Resource-r17 ::= SEQUENCE {      featureCombinationList-r17              SEQUENCE (SIZE{1..maxFeatureCombList}) OF  {  redCap-r17 ENUMERATED{true} OPTIONAL,  sdt-r17  ENUMERATED{true} OPTIONAL,  slicing-r17 FFS                           OPTIONAL,  covEnh-r17  ENUMERATED{true} OPTIONAL,  …  },      rach-ConfigCommon-r17          SetupRelease { RACH-ConfigCommon }       OPTIONAL,   -- Need M      msgA-ConfigCommon-r17          SetupRelease { MsgA-ConfigCommon-r16 }   OPTIONAL    -- Need M  }  **Signalling#1**    Approach 2: Add the feature/feature combination indication in *RACH-ConfigCommon* (for 4-step RACH) and in the *RACH-ConfigCommonTwoStepRA-r16* in *MsgA-ConfigCommon-r16*(for 2-step RACH) as illustrated below:  BWP-UplinkCommon ::=                SEQUENCE {      genericParameters                   BWP,      rach-ConfigCommon     SetupRelease { RACH-ConfigCommon }          OPTIONAL,   -- Need M      pusch-ConfigCommon          SetupRelease { PUSCH-ConfigCommon }         OPTIONAL,   -- Need M      pucch-ConfigCommon          SetupRelease { PUCCH-ConfigCommon } OPTIONAL,   -- Need M      ...,      [[      rach-ConfigCommonIAB-r16    SetupRelease { RACH-ConfigCommon }          OPTIONAL,   -- Need M      useInterlacePUCCH-PUSCH-r16 ENUMERATED {enabled}                        OPTIONAL,   -- Need R      msgA-ConfigCommon-r16       SetupRelease { MsgA-ConfigCommon-r16 }      OPTIONAL    -- Cond SpCellOnly2      ]],  [[  -- Providing a pool of separate RO (e.g. using PRACH-COnfigurationIndex)  featureCombinationRACH-ResourcesList-r17 SEQUENCE (SIZE(1…maxFeatureCombList) OF FeatureCombinationRACH-Resource-r17  OPTIONAL   -- Need M  ]]  }    FeatureCombinationRACH-Resource-r17 ::= SEQUENCE {      rach-ConfigCommon-r17              SetupRelease { RACH-ConfigCommon }       OPTIONAL,   -- Need M      msgA-ConfigCommon-r17          SetupRelease { MsgA-ConfigCommon-r16 }   OPTIONAL    -- Need M  }      An example for 4-step RACH is as follow:  RACH-ConfigCommon ::=               SEQUENCE {      rach-ConfigGeneric                RACH-ConfigGeneric,  totalNumberOfRA-Preambles         INTEGER (1..63)                    OPTIONAL,   -- Need S    <<Omitted>>      ...,      [[      ra-PrioritizationForAccessIdentity-r16  SEQUENCE {          ra-Prioritization-r16                   RA-Prioritization,          ra-PrioritizationForAI-r16              BIT STRING (SIZE (2))      }                                                   OPTIONAL,   -- Cond InitialBWP-Only      prach-RootSequenceIndex-r16             CHOICE {          l571                                    INTEGER (0..569),          l1151                                   INTEGER (0..1149)      }   OPTIONAL   -- Need R      ]],  [[  featureCombinationSupportedSharedRO-List SEQUENCE (SIZE(1…maxfeatureCombList) OF FeatureCombinationSupportedSharedRO OPTIONAL    -- Need M  ]]  }    FeatureCombinationSupportedSharedRO ::= SEQUENCE {      featureCombination-r17              SEQUENCE {  redCap-r17 ENUMERATED{true} OPTIONAL,  sdt-r17  ENUMERATED{true} OPTIONAL,  slicing-r17 FFS                           OPTIONAL,  covEnh-r17  ENUMERATED{true} OPTIONAL,  …  },  -- Other parameters….  }    **Signalling#2**    Both signalling can be made to work. But we have a slight preference for Signalling#2. |
| Samsung |  | List of 2 step/4 step RACH configurations are signalled. Feature combination indication is per RACH configuration. |
| Apple |  | We share the same view as Samsung.  For R17 RACH configuration, the list of RACH configuration should be introduced, and the feature/feature combination indication is provided per RACH configuration. One example is provided as follow: |
| Ericsson |  | Tend to agree with Huawei in general.  In the agreement 3 (see above for question 1), there are two options already agreed, for those:  Option a): A FeatureCombination is associated to a PRACH configuration (a pair of rach-ConfigCommon + msgA-ConfigCommon), the legacy PRACH is assumed to have all features deactivated.  Option b) the desired end result is that it is possible to associate a certain range of preambles in some ROs (i.e. "all", "odd", "even" or a specific RO) to a feature combination. To achieve this, a new IE should be created, which indicates a feature combination, that can be associated with a mask and a range of CB preambles. Similarily to 2-step RACH, if multiple feature combinations result mapped to the same RO, they will be allocated to different ranges of preambles.  The figure below provides an example, once RAN2 gets a common understanding of what we are trying to achieve (i.e. a common understanding on the level of an image like this), ASN.1 can be produced. |
| NEC |  | We assume the feature combination indication is included in RACH-ConfigCommon (or maybe new IE under BWP-UplinkCommon). |
| Qualcomm | See comment | Agree with Samsung and Apple. |
| vivo |  | In our understanding, a Rel-17 PRACH occasion configuration list should be introduced within BWP-UplinkCommon, which is used to configure the new RO configurations for Rel-17. Then a Rel-17 feature combination list is also needed to indicate which feature can be supported, the association between this feature and PRACH occasion configuration, and the other specific parameters for RA procedure (e.g. CB-PreamblesPerSSB). A brief illustration can be given as follows, |
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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.

|  |
| --- |
| 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.

|  |
| --- |
| 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?

|  |  |  |
| --- | --- | --- |
| **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. |
| OPPO | A | As indicated in Q6 we don’t believe switch between feature combination indications e.g. non-CE to CE is necessary. |
| Huawei, HiSilicon | A | Approach A is a lot clearer. Allowed feature combinations can be specified elsewhere and do not have to be specified by ASN.1. |
| Intel | A | This will allow network to provide all the different combinations for Rel-17 in a compact way in terms of readability point of view. If any feature combinations are to be restricted, it can be done in the field description. |
| Samsung | A |  |
| Apple | A | We support A like structure since it can be used indicate all the possible combination.  But for slicing, we have the same comments as ZTE. We need to support multiple-slice case. |
| Ericsson | A |  |
| NEC | A | This can be baseline. |
| Qualcomm | A | We also agree with ZTE’s comment on slicing. |
| vivo | A | It is far more reader-friendly. |
|  |  |  |

## 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.

|  |  |  |
| --- | --- | --- |
| **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). |
| OPPO | see comment | There are actually two alternatives to configure RA partition for one specific feature or feature combination:  Alt1:only one RA partition in one RO. Then the preambles are further split between 2-step/4-step in 2nd level and further split between group A and group B in 3rd level  Alt2: the total reserved preambles in one RO is split between 2-step/4-step in 2nd level and further split between group A and group B in 3rd level. Then eventually in 4th level relevant feature or feature combination will be assigned with one RA partition. For majority of the feature or feature combination at least two RA partitions are needed.  We think both are feasible but prefer alt2. Alt2 basically follows legacy style in the same level. One of the issue in Alt1 is that preambles for 2-step RACH will be scattered among feature or feature combinations, which make the mapping between PRACH resource and PUSCH occasion difficult for UE. |
| Huawei, HiSilicon | No | We do not see the benefit of this while it would require RAN2 to discuss and specify how the RA partition is selected by the UE. |
| Intel | See comments | This question is a bit dependent on the location of the feature combination indication. It should be possible for the same feature/feature combination to be mapped to a RA partition of a 2-step RACH and 4-step RACH. However, a feature/feature combination should map to only 1 RA partition of a RA type. |
|  |  |  |
| Samsung | No | One partition per feature combination is sufficient |
| Apple | See comments | We are fine with the proposal in general.  But for the slicing feature, we should allow the multiple RA partitions for different slices. |
| Ericsson | Yes, unless there are any show-stoppers | We do not want to introduce artificial limitations to avoid this.  If we go with the legacy masking-approach, there is a limitation as indicated by OPPO for question 6, namely that we can only do: all ROs, odd ROs, even ROs, or one specific RO. It is not possible to select more than one RO unless "all" or "odd" or "even" ROs are selected.  If "all ROs" and "odd ROs" and "even ROs" of a RACH configuration is too many resources for one feature combination, and if one specific RO is too little, if can we allow several RA partitions to map to the same feature combination, and then we get back some flexibility without having to do a new masking-approach. |
| NEC | No | This looks over-spec for Rel-17. |
| Qualcomm | No |  |
| vivo | No | Generally, multiple RA partitions should be provided only if the usage scenarios are different. For example, in NR, for a UE and for a given RA procedure trigger, at most two RA partitions (i.e. CBRA resources and CFRA resources) can be provided, as one partition is used for CBRA access while the other is used for CFRA access.  For Rel-17, one feature/feature partition can be explicated identified by one RA partition. We cannot observe what additional chrematistics should be associated. |
|  |  |  |

# 5 Summary & Conclusions

TBD

# 6 References & Contributions

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# 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