**3GPP TSG RAN2 #116-e R2-21xxxxx**

**Online, 1 – 12 November 2021**

**Agenda Item:**  **8.8.1 Organizational**

**Source: Huawei (email rapporteur)**

**Title:** **Report of [Post115-e][245][Slicing] Running NR RRC CR for RAN slicing (Huawei)**

**Document for: Discussion and Decision**

### 1 Introduction

This is the email report of [Post115-e][245][Slicing] Running NR RRC CR for RAN slicing (Huawei):

* [Post115-e][245][Slicing] Running NR RRC CR for RAN slicing (Huawei)

 Scope: Create running NR RRC CR for RAN slicing based on agreements

 Intended outcome: Running CR

 Deadline: October 21th, 0900 UTC

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### 2 Discussion

#### 2.1 Overall procedures

For slice based cell reselection/RACH, the overall procedures are shown in the figure below.



Figure 1: basic signalling flow for slice based cell reselection and slice based RACH

For option 4, the agreements are are below. Some FFSes are to be solved by RAN2 and other WGs.

Agreements

* 2 Following is taken as the baseline for Solution Option 4:

The “slice info” (for a single slice or slice group) agreed to be provided to the UE in the last RAN2 meeting using both broadcast and dedicated signaling are provided for the serving as well as neighboring frequencies. The following steps are used for slice based cell (re)selection in AS:

Step 0: NAS layer at UE provides slice information to AS layer at UE, including slice priorities.

Step 1: AS sorts slices in priority order starting with highest priority slice.

Step 2: Select slices in priority order starting with the highest priority slice.

Step 3: For the selected slice assign priority to frequencies received from network.

Step 4: Starting with the highest priority frequency, perform measurements (same as legacy).

Step 5: If the highest ranked cell is suitable (as defined in 38.304) and supports the selected slice in step 2 then camp on the cell and exit this sequence of operation; FFS: How the UE determines whether the highest ranked cell supports the selected slice.

Step 6: If there are remaining frequencies then go back to step 4.

Step 7: FFS: If the end of the slice list has not been reached go back to step 2.

Step 8: Perform legacy cell reselection.

* 1: Solution Option 4 is selected for further work i.e., resolve the FFSs, send any required LSs and consequently start to draft specification CRs.

For slice based RACH, the slice specific agreements are as below:

Bulk agreements

* 3 Network based solution is introduced to resolve the issue of prioritization parameter collision with MPS/MCS, i.e., Network indicates whether slice override MPS or MPS override slice.
* 5 For slice based RACH prioritization, RAN2 will stick to the current baseline parameters, i.e., scalingFactorBI and powerRampingStepHighPriority, and no additional parameters for this release.
* 7 Reuse the legacy threshold for the selection between 2-step and 4-step slice initiated RACH

#### 2.2 RAN2 impacts and discussions

Based on the RAN2 agreements made so far, the following impacts are observed:

|  |  |
| --- | --- |
| Impacted functionality | Impacts |
| SIB | Add slice information, e.g. slice group, frequency priority |
| RRCRelease | Similar impacts as SIB |
| RACH info in SIB1 | Add the following information:Indicate the override flag between MPS/MCS and slicingSlice based RACH prioritization, i.e. scalingFactorBI and powerRampingStepHighPriority |

For slice info for cell reselection, the following table shows the structure. The rightmost column is FFS and it depends on the discussion on step 5 for option 4.

|  |
| --- |
| SliceInfo-List |
| Slice Id-1/ Slice-Group Id-1 | Supported-on-Freq-x | Freq-x-priority | Cell list |
| Supported-on-Freq-y | Freq-y-priority | Cell list |
| Slice Id-2/ Slice-Group Id-2 | Supported-on-Freq-x | Freq-x-priority | Cell list |
|  | Supported-on-Freq-z | Freq-z-priority | Cell list |
| … | … | … |  |

There are some questions related to ASN.1 changes, and some tables are also provided in order to collect companies’ comments.

For legacy frequency priority mechanism, T320 is to indicate the validity of dedicated priorities.

| Timer | Start | Stop | At expiry |
| --- | --- | --- | --- |
| T320 | Upon reception of *t320* or upon cell (re)selection to NR from another RAT with validity time configured for dedicated priorities (in which case the remaining validity time is applied). | Upon entering RRC\_CONNECTED, upon reception of *RRCRelease*, when PLMN selection or SNPN selection is performed on request by NAS, when the UE enters RRC\_IDLE from RRC\_INACTIVE, or upon cell (re)selection to another RAT (in which case the timer is carried on to the other RAT). | Discard the cell reselection priority information provided by dedicated signalling. |

Since RAN2 agreed to introduce slice based cell reselection priorities to both SIB and RRCRelease messages, it needs to check whether a timer (like T320) is required or not.

**Question 1: For slice based cell reselection priorities in dedicated signalling, is there a need to introduce a timer (like T320)?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Qualcomm | Yes | We have agreed it in RAN2#113b-e:* 3 In the case that slice info is also provided to the UE in the RRC Release message while SIB also provides the slice info, UE follows the dedicated slice info from RRC Release while T320-like timer is running and only if it expires that it follows the slice info in the SIB
* 4 In the case that existing dedicated priority configuration is provided to the UE in the RRC Release message while SIB also provides the slice info, UE follows the dedicated priority configuration while T320 is running as per legacy and only if it expires that it follows the slice info in the SIB
 |
| Nokia | Yes | FFS if T320 or other timer to be used.FFS if other validity criterion (e.g. TA) can also be used |
| Lenovo, MotM | Yes |  |
| Huawei, HiSilicon | Yes | We prefer to introduce a new timer but it will be similar as T320. |
| Apple | Yes |  |
| CATT | Yes | We have the same concern as Nokia on whether the current T320 can be reused. |
| Spreadtrum | Yes | FFS whether T320 to be reused or other enhancement like valid area.  |
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In the running 38.331 CR, the slice based cell reselection priorities has been added to SIB4 (for inter-frequency cell reselection). Currently, for intra-frequency cell reselection, the UE ignores the priority information and consider all intra-frequency cells to be the same priority.

Based on the slice info list above, the relevant frequencies may involve the serving frequency. Currently, SIB2 indicates intra-frequency cell reselection parameters and SIB4 indicates inter-frequency cell reselection parameters, so it is suggested to discuss which of SIBs are to be impacted.

**~~Question 2: For slice based cell reselection priorities, whether the serving frequency should be involved?~~**

**Based on Lenovo’s comments, the original question is not very clear so this question is changed into the following:**

**Question 2: Whether the serving frequency should also have slice priority?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Qualcomm | Yes | Similar to NR V2X, we think 38.304 should specify how to assign frequency priority to serving frequency, for example in clause 5.2.4.1 of TS 38.304:“*When the UE in camped normally state, has only dedicated priorities other than for the current frequency, the UE shall consider the current frequency to be the lowest priority frequency (i.e. lower than any of the network configured values). If the UE is configured to perform both NR sidelink communication and V2X sidelink communication, the UE may consider the frequency providing both NR sidelink communication configuration and V2X sidelink communication configuration to be the highest priority. If the UE is configured to perform NR sidelink communication and not perform V2X communication, the UE may consider the frequency providing NR sidelink communication configuration to be the highest priority. If the UE is configured to perform V2X sidelink communication and not perform NR sidelink communication, the UE may consider the frequency providing V2X sidelink communication configuration to be the highest priority.”* |
| Nokia | Yes | If the Serving Frequency has no priority for a slice or slice group then it is considered to be the lowest priority as in the legacy specification. |
| Lenovo, MotM | Yes | The question is not 100% clear. If we are being asked “**if the serving frequency should also have slice priority**”, the answer is “yes”. We believe that each slice would indicate its preferred frequencies and this can be any frequency including serving frequency.However, if the question is trying to ask “**does serving frequency play a role in cell reselections, when slice info is available in the UE**?” Our answer is still “yes”. Serving frequency still must be having a priority corresponding to *selected slice* and then the remaining cell reselection triggers (for intra frequency or inter-frequency lower/ same/ higher priority) must be same as in the legacy. |
| Huawei, HiSilicon | Yes | We think that different slices on the serving frequency can have different cell reselection priorities, so it should be possible to have slice priority for the serving frequency. |
| Apple | Yes | Slice specific configuration for serving frequency should also be supported. Don’t see why serving frequency should be excluded. |
| CATT | Yes | We think the priority of the serving frequency should be used for slice based cell reselection to determine which frequency is suitable to be reselected. |
| Spreadtrum  | Yes | The serving frequency should have slice priority and been considered during cell reselection. |
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For Q2, if the answer is No, it seems that slice relevant parameters can be put in SIB4. If the answer is Yes, there may be the following options regarding where to put the slice relevant parameters:

Option 1: put all parameters in SIB4

Option 2: put all parameters in SIB2 and SIB4 separately, e.g. SIB2 carries parameters related to the serving frequency, and SIB4 carries others

Option 3: put all parameters in SIBs other than SIB2/SIB4

Option 4: put all parameters in a new SIB

**Question 3: If the answer for Q2 is Yes, regarding where to put the slice relevant parameters, which of options are preferred?**

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| --- | --- | --- |
| **Company** | **Preferred option(s)** | **Comments** |
| Qualcomm | Option 4 | Compared with the solution to include slice info in SIB3/4/5, new SIB can reduce impacts to legacy UE. In addition, the payload size will be large as Rapporteur mentioned. Thus, we don’t prefer to include them in SIB3/4/5.  |
| Nokia | Option 2 | This is aligned with current specification where priority of the current frequency is in SIB2, and priorities for other bands are in SIB4. |
| Lenovo, MotM | Option 2 | Seems working and sufficient. |
| Huawei, HiSilicon | Option 2 | The option is following the existing SIB definitions. |
| Apple | Option 2 | Agree with Nokia it is aligned with current design on SIB2 and SIB4. |
| CATT | Option4 | We agree with Qualcomm, the slice relevant parameters can be put in one new to reduce the impacts to the legacy UEs, considering the slice (group) list and the corresponding frequency list may be large. |
| Spreadtrum | Option 2 | SIB2 is suitable to carry slice parameters related to the serving frequency. |
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At RAN2#115-e, RAN2 made the following agreement. For RACH prioritization parameters, it may need to discuss whether they are per slice/slice group configuration, if Yes, it means the parameters are separate for different slice(s)/slice group(s); if No, it means the parameters are common for slice(s)/slice group(s).

* 5 For slice based RACH prioritization, RAN2 will stick to the current baseline parameters, i.e., scalingFactorBI and powerRampingStepHighPriority, and no additional parameters for this release.

**Question 4: For slice based RACH prioritization (i.e. scalingFactorBI and powerRampingStepHighPriority), whether the parameters are per slice/slice group configuration?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Qualcomm | Yes | It makes sense to have per slice group RACH prioritization. |
| Nokia | No | Following the RAN2#115-e agreement (referred in section 5 here) :**A new slice grouping mechanism is introduced for RACH configuration. One slice belongs to one and only one slice group.**RACH configuration for RACH resources will already be supporting slice grouping. RACH prioritization parameters are used afterwards, thus, the same allocation (to the slice group) can be assumed for both: RACH resources configuration & RACH prioritization, with no need to configure parameters per group. |
| Lenovo, MotM | Yes | No strong opinion but at least for signaling reduction this works better. |
| Huawei, HiSilicon | Yes | In the WID (RP-212534), the objective for slice based RACH prioritization is as below:1. Configure RACH parameters prioritization (e.g., *scalingFactorBI* and *powerRampingStepHighPriority*) for slice or slice group

The per slice/slice group configuration has been explicitly requested by the WID. |
| Apple | Yes | We feel this is straightforward to have the same manner (i.e. per slice/slice group) on configurations to slice based RACH resource and slice based RACH prioritization. It’s strange to us why should all slices/slice groups have the same prioritization. |
| CATT  | Yes | We think the question is to ask whether *scalingFactorBI* and *powerRampingStepHighPriority* can be configured per slice/slice group. Our answer is Yes. |
| Spreadtrum | Yes | From our views, different slice(s)/slice group(s) may have separate RACH prioritization parameters. Note that payload size should also be considered.  |
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For the running 38.331 CR, if there are other comments, please add them in the table below or in the running CR.

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| **Company** | **Comments** |
| Nokia  | Comments (detailed comments can be found in the draft CR revision from Nokia)1) Descriptions from the procedures are missing2) The proposed structure of slice based reselection information is misaligned with the current structure of SIB2 and SIB4 where information are provided per frequency band3) The CR assumes the answer to the Q4 is ‘yes’. Maybe too premature to put the sliceGroupID (FFS) in the CR, as there maybe also other options how to implement RACH prioritization for slice groups. We think that the outcome of the common RACH enhancement work should be seen before we can start working on ASN.1 additions for slicing in RACH area. |
| Lenovo, MotM | There are many slices (at least 256) and we still do not know how many slice groups would need to be used and must be supported to be broadcasted by a cell in the end. Assuming even 20 slice groups each supported on an average 2 frequencies, signaling 40 frequencies will be waste of broadcast signalling resources, especially knowing well that in the neighborhood only 8 inter-frequencies can be present. The same logic goes to repeatedly broadcasting 32 slice IDs (S-NSSAI) and cell identities (PCI or *CellIdentity*). Some discussion for containing signalling overhead would be good – this should be considered as necessary rather than optimization. |
| Huawei, HiSilicon | At the last RAN2 meeting, it was agreed to have a common RRC CR to capture RACH partitioning for all relevant WIs, so slice based RACH partitioning part has not been captured in the running 38.331 CR.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. |
| Apple | For *CellReselectionPrioritiesForSlicing*, we have the same feeling as Nokia. It would be better to follow the legacy per-frequency configuration. |
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### 3 Conclusion

[To be added]

### 4 References

[1] R2-2108831, RAN2-115-e LTE 71 GHz DCCA Multi-SIM and RAN slicing (Tero)\_2021-08-27-EOM2

### 5 List of RAN2 agreements

## **RAN2#115-e agreements**

Slice based cell reselection

* Agreements
* RAN2 needs to check with SA2/ CT1 if it is alright for AS to expect to receive slice list as well as slice priority information from NAS for cell (re)selection. Ask about both slices and slice groups.
* Agreements
* 2 Following is taken as the baseline for Solution Option 4:
* The “slice info” (for a single slice or slice group) agreed to be provided to the UE in the last RAN2 meeting using both broadcast and dedicated signaling are provided for the serving as well as neighboring frequencies. The following steps are used for slice based cell (re)selection in AS:
* Step 0: NAS layer at UE provides slice information to AS layer at UE, including slice priorities.
* Step 1: AS sorts slices in priority order starting with highest priority slice.
* Step 2: Select slices in priority order starting with the highest priority slice.
* Step 3: For the selected slice assign priority to frequencies received from network.
* Step 4: Starting with the highest priority frequency, perform measurements (same as legacy).
* Step 5: If the highest ranked cell is suitable (as defined in 38.304) and supports the selected slice in step 2 then camp on the cell and exit this sequence of operation; FFS: How the UE determines whether the highest ranked cell supports the selected slice.
* Step 6: If there are remaining frequencies then go back to step 4.
* Step 7: FFS: If the end of the slice list has not been reached go back to step 2.
* Step 8: Perform legacy cell reselection.
* 1: Solution Option 4 is selected for further work i.e., resolve the FFSs, send any required LSs and consequently start to draft specification CRs.
* Other solutions can be discussed based on company contributions (with technical analysis) next time.
* After online session, it was noted that the solution 4 FFSs were not resolved. Email discussion is assigned to try to tackle those (as they may involve LS to RAN4).

R2-2108928 LS on Slice list and priority information for cell reselection RAN2 LS out Rel-17 NR\_Slice-Core To: SA2, CT1 Cc: SA1

* The above LS was approved after email discussion “[Post115-e][241][Slicing] Slice list and priority information for cell reselection (Lenovo)”.

Slice based RACH

* Bulk agreements
* 3 Network based solution is introduced to resolve the issue of prioritization parameter collision with MPS/MCS, i.e., Network indicates whether slice override MPS or MPS override slice.
* 5 For slice based RACH prioritization, RAN2 will stick to the current baseline parameters, i.e., scalingFactorBI and powerRampingStepHighPriority, and no additional parameters for this release.
* 7 Reuse the legacy threshold for the selection between 2-step and 4-step slice initiated RACH
* 1 A new slice grouping mechanism is introduced for RACH configuration. One slice belongs to one and only one slice group. Slice groups are assumed to be only updated when UE does Registration Update.
* 2 Working assumption: The mapping between S-NSSAIs and slice groups should be configured to the UE through NAS signalling. Discuss problems for cell- vs. UE-specific signalling via post-meeting email discussion.
* 4 If no network indication is sent in case of slice prioritization parameter collision with MPS/MCS, it will be left to UE implementation.
* 8 It is RAN2 common understanding that 4-step common RACH needs to always be supported in initial BWP for legacy UE. And whether to configure 2-step slice specific RACH only or 4-step slice specific RACH only or both is left to network configuration.

*6 For RACH type selection, UE first selects between slice-specific and common RACH, then selects between 2-step and 4-step.*

*9 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.*

*10 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.*

* 6, 9, 10 will be aligned to the common RACH partitioning discussion decisions

## **RAN2#114-e agreements**

Slice based cell reselection

**1: Frequency priority mapping for each slice (slice -> frequency(ies) -> absolute priority of each of the frequency) is provided to a UE.**

**Note: Signaling optimizations are not excluded.**

**Note: "slice may also mean "slice group"**

**1b: Frequency priority mapping for each of the slice (slice -> frequency(ies) -> absolute priority of each of the frequency) is part of the “slice info” agreed to be provided to the UE using both broadcast and dedicated signaling.**

**2: RAN2 kindly allow one more meeting cycle for understanding the necessity of Slice priority along with the following shortlisted solution directions for Idle mode mobility:**

**a) Option 4): Slice priority first looping over slice-frequency combination**

**b) Option 5): Maximize slice support**

**c) Option 6): Frequency priority of highest priority slice with adjustment based on actually supported slice(s) in best ranked cell, without multiple iterations of cell reselection**

**d) Option 7): Perform legacy cell reselection mechanism based on slice specific frequency priority**

**3: RAN2 consider a scenario in its work for slice specific cell (re)selection where it is possible that (Suitable) cells on the same frequency belonging to different TAs support different Slice(s).**

* 4: Working assumption: The Best cell principle according to absolute priority reselection criteria specified in clause 5.2.4.5 of TS38.304 needs to be met also for slice specific cell (re)selection.

**6: In addition to proposal 2, following aspects are FFS:**

**a) Content of “Slice Info” – to what extent the information needs to be and should be provided to support the Principle in proposal 5**

**b) If used, who provides the “Slice priority” (NAS/ AS, UE/ Network)**

**c) Can RAN2 continue to use “intended” slice for initial registration and idle-mode mobility**

**d) How UE in each of the solutions from proposal 2 uses slice info for cell reselection if both slice info and existing cell reselection priority is signaled (in the SIB and/ or dedicated signaling)**

Slice based RACH

* 4: RAN2 confirm for a slice group, separated RO and/or separate preamble can be configured within the existing RACH-ConfigCommon and RACH-ConfigCommonTwoStepRA
* 5: Same as NR Rel-15 conclusion, RAN2 conclude that there is no RA-RNTI collision between slice specific RACH and legacy RACH in shared RO
* 6: Same as NR Rel-15 conclusion, RAN2 conclude that the RA-RNTI collision between slice specific RACH and legacy RACH may happen in separate RO.
* Working assumption: this can be left to network implementation to resolve it (e.g. network configure RO in different time)
* FFS how many slice groups we can have and how they are indicated.

## **RAN2#113b-e agreements**

Slice based cell reselection

* Agreements
* 1 RAN2 aligns with SA2 assumption that support of slices in a TA is homogenous also for Rel-17 (i.e. all cells within a TA supports the same slice availability). If SA2 decides to support heterogeneous deployments, RAN2 can revisit this.
* 2 The criteria for determining the cell reselection priority for inter-frequency cell reselection should not be left to UE implementation, but should be defined in the specification (just like cell reselection priorities currently). The details of slice info and how the UE determines its priority list from slice info is FFS.
* 2b FFS how to define slice priorities for reselection and how to handle conflicts between different priorities (e.g. broadcast vs. dedicated slice-specific priorities)
* 5 UE is only configured with either the existing dedicated priority configuration or the slice info in RRC Release.
* 3 In the case that slice info is also provided to the UE in the RRC Release message while SIB also provides the slice info, UE follows the dedicated slice info from RRC Release while T320-like timer is running and only if it expires that it follows the slice info in the SIB
* 4 In the case that existing dedicated priority configuration is provided to the UE in the RRC Release message while SIB also provides the slice info, UE follows the dedicated priority configuration while T320 is running as per legacy and only if it expires that it follows the slice info in the SIB
* 6 For UE supporting slice based cell reselection, the UE should use slice info in the SIB for cell reselection if both slice info and existing cell reselection priority is broadcast in the SIB.
* 1: With regard the main solution for prioritisation for slice based cell reselection, the following topics to be the initial focus for discussion: Details of slice availability in terms of Slice grouping and frequency priority information for broadcast and RRC Release message, usage of “intended slice” (FFS whether we use this term in specification), UE prioritisation of slice when there is more than one intended slice and how UE determines frequency priority for inter-frequency cell reselection based on these.
* 2: Following topics are only considered after some progress on the main solution for prioritisation for slice based cell reselection: which SIB(s) to carry slice availability, whether an LS to SA3 is needed (if SST/SD is agreed for slice info), whether SIB segmentation/on-demand is required (if new SIB is defined).
* 3: Other topics that have some support and could be discussed further depending on companies providing more details on the motivation and level of support: slice based reselection for MO, different RSRP/RSRQ thresholds for inter and intra-frequency slice based cell reselection, need for Validity area in RRC Release

Slice based RACH

* Agreements
* 1 RAN2 aims to support both RO partition and preambles partition.
* 2 scalingFactorBI and powerRampingStepHighPriority can be configured at least in SIB (FFS for dedicated RRC signalling).
* 3 Network can configure slices with 4-step or 2-step (or both) RA resources.
* 4 Legacy 2-step RA fallback mechanism is supported.
* 2: RAN2 will prioritize the discussion for slice specific RACH for IDLE and INACTIVE mode. And CONNECTED mode is down prioritized and can be considered if time allows.
* 3: Slice specific RACH (including RACH isolation and RACH prioritization) is only applied for CBRA but not for CFRA.
* 4: To ensure the backward compatibility, it is RAN2’s common understanding that common RACH resource should be configured in initial BWP if the slice specific RACH resource is configured in initial BWP.
* 6: RAN2 confirms that the issue of prioritization parameter collision with MPS/MCS need to be resolved. There is UE based solution (option 1, fixed rule) or network based solution (option 2, configurable rule) or both. Discussion on pros and cons can be left to next meeting.
* 5.1: RACH type selection between 2-step slice specific RACH and 4-step slice specific RACH is based on a RSRP threshold.
* FFS to introduce a slice specific threshold or reuse the legacy threshold.
* FFS UE should first select between slice specific RA and common RA or UE should first select RA type between 2-step RA and 4-step RA
* 5.2: The table from [R2-2104322](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2104322.zip) can be used for further discussion.
* Slice specific RACH is only applicable if there is slice information (e.g., slice group or slice related operator defined access category) available for AS layer when access. FFS on details of slice group.