**3GPP TSG-RAN WG2 Meeting #112 electronic R2-20xxxxx**

**Online, Nov 2nd – 13th, 2020**

**Agenda Item:**  **RAN Slicing SI**

**Source: CMCC**

**Title:** **Email discussion on open issues for RAN slicing SI**

**Document for: Discussion and Decision**

## 1 Introduction

At RAN2#111-e meeting, the following email discussion was agreed:

Post-meeting email discussion

* **[Post111-e][916][NR RAN slicing] RAN slicing study questions (CMCC)**

Scope: Based on online agreements. Discuss issues to address in the SI and in which deployment scenarios, meaning of “intended slice”. Can also discuss candidate solutions (including whether Rel-15 mechanisms can work), e.g. slice-based reselection or slice-based RACH.

Phase 1(From 14 Sep to 25 Sep): Discuss on scenarios and issues, i.e. section 2, 3.1, 4.1, 5.1

Phase 2(From 28 Sep to 15 Oct): Discuss on the solutions, i.e. section 3.2, 4.2, 5.2

Intended outcome: Email discussion summary + TP

Deadline: Thursday 15 OCT, 0700 UTC

Regarding the scope, there were some agreements as below:

*[Cat a] Proposal 3: The scope for the long term email discussion is:*

*- Discuss the issue that RAN2 needs to address in this SI for the agreed scenario, and whether to add new scenarios can be also discussed.*

*- Discuss the meaning of the intended slice, and how or whether the UE knows the intended slice for MO and/or MT services. In addition, discuss whether the intended slice can always be obtained by UE.*

*- Discuss the candidate solutions which can address the above issues, and the solutions in the contributions in RAN2-111-e meeting will be summarized by rapporteur.*

*- Discuss whether the R15 mechanism (e.g. dedicated priority mechanism) can solve the above issues.*

*- Discuss the use cases or intentions for slice-based RACH configuration or RACH parameters prioritization, and discuss whether identified issues can be solved by legacy mechanisms.*

*The above discussions are the priority for this SI, and other aspects may be also considered if there are enough supports to be studied.*

* P1 and P2 are noted
* Post-meeting email scope according to P3. Can use phases in discussion to help not having too huge discussion at once.

The structure of this email discussion is showed in section 2, 3, 4 and 5. For efficient and constructive email discussions, it is proposed to have two phases:

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| **Phases** | **Scope** | **Time plan** |
| Phase 1 | Section 2  *Aim at scenarios*  Section 3.1, 4.1 and 5.1  *Aim at issues including whether existing solutions could solve the issues or not* | From 14 Sep to 25 Sep |
| Phase 2 | Section 3.2, 4.2 and 5.2  *Aim at candidate solutions to address the issues* | From 28 Sep to 15 Oct  And then rapporteur will prepare the summary and TP.  Note: submission deadline of RAN2-112-e meeting may be 22 Oct, 2020. |

**In addition, the following principles are suggested:**

* For scenarios, issues, existing solutions, and candidate solutions, the contributions at RAN2#111-e are to be used for inputs, and the intention is to avoid diverse discussions
* For solutions mentioned in this email discussion, only concept and key designs are mentioned, i.e. avoid too much details. In addition, if there are some impacts related to other WGs, it should limit the discussions, e.g. from RAN2 point of view, these impacts can be recorded in an efficient way

## 2 Scenarios for RAN slicing

### 2.1 Scenarios

***[RAN2 agreements on the scope]*** *Discuss the issue that RAN2 needs to address in this SI for the agreed scenario, and whether to add new scenarios can be also discussed.*

In RAN2#111-e meeting, the draft TR 38.832 v0.1.0 was endorsed in R2-2008549 which captured the scenarios to be studied in this SI. The general description for the scenario is copied here:

**• Multiple and different slices can be supported on different frequencies**

**• Multiple and different slices can be supported on the same frequency in different regions**



**Figure 5.1.1-1: An example for slice deployment scenario**

**[Phase 1] Q1: Is there any additional scenario that companies propose to study?**

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| **Company** | **Comments** |
| Qualcomm | Yes.  During RAN2#111-e, we agreed two scenarios. However, in our understanding, figure 5.1.1-1 in current TR only captured 2nd scenario (i.e. Multiple and different slices can be supported on the same frequency in different regions). The 1st scenario is still missing now (i.e. Multiple and different slices can be supported on different frequencies). We think it should also be captured in TR. An example can be illustrated below:  It is worth noting that this scenario needs to consider the following 2 different cases:   1. Case 1: DC/CA is available and thereby both Slice 1 and Slice 2 can be available and active at the same time. 2. Case 2: DC/CA is not available. So, Slice 1 and Slice 2 cannot be active at the same time. |
| CMCC | We see the agreed scenarios are the most widely deployed scenarios and need to be emphasized in this SI.  We also open to see companies views. |
| CATT | We think both agreed two scenarios are already reflected in Figure 5.1.1-1, from our side, no more scenarios are identified in phase 1 before discussing detail solutions. |
| Huawei, HiSilicon | The figure 5.1.1-1 in TR 38.832 v0.1.0 is a typical scenairo for RAN slicing, and we have seen that many operators support to study it. We just have some suggestions on the wordings:  **• Multiple and different slices can be supported on different frequencies**  To be more specific, we suggest to add a clarification, i.e. the frequencies supporting different slices can be different. And this clarification is similar as Qualcomm’s proposal.  **• Multiple and different slices can be supported on the same frequency in different regions**  To be more specific, we suggest to add a clarification, i.e. The same frequency in different regions can support different slices. |
| Vodafone | Yes we also agree with the illustrated scenarios although we would require more than 2 slices per frequency, but in general we also agree   * **Multiple and different slices can be supported on different frequencies** * **Multiple and different slices can be supported on the same frequency in different regions**   In many scenarios envisaged on Mobile network we would require having equivalent of slicing capability of LTE with SPID of 256 with differing QCI etc For example Slices to be allocated to   * Emergency services, * Gaming with low latencies * News and broadcast applications * IoT applications * Etc. |
| Xiaomi | Yes.  It should be noticed that SA2 had sent a LS to RAN2, and proposed that **SA2’s assumption is that all S-NSSAIs in the Allowed NSSAI are supported within the TA and also in all TAs of the RA, and** not considering changing any of the Rel-15 and Rel-16 assumption on support of the S-NSSAI in the TA that would create deployments incompatible with Rel-15/16 UEs in the field.  In this case, we need to clarify firstly that whether the deployment scenarios from RAN2’ view is conflict with SA2. |
| Ericsson | We share the view that RAN2 need to focus on realistic scenarios. Having slices available only via some dedicated frequencies should be carefully deployed by a network operator, and only in very specific cases.  We expect a more common and typical scenario is that slices are available via multiple frequencies, and one or a set of frequencies are preferred for certain slice. We should ensure new mechanisms, if introduced, cover also this scenario.  F1  Slice 1 + Slice 2 (preferred)  Cell 6  F2  Slice 1 (preferred) + Slice 2  Cell 5  **Area3** |
| OPPO | From our perspective, the scenarios which are already captured in TR 38.832 is the typical ones. We are fine to consider more cases if majority want. |
| Google | We think that this feature needs to be future-proof, and we should not artificially limit how slices are mapped to frequencies and cells. So we support including both the QC/Huawei/HiSilocon proposal and the Ericsson proposal in the study. |
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### 2.2 Slicing handling in UE side

***[RAN2 agreements on the scope]*** *Discuss the meaning of the intended slice, and how or whether the UE knows the intended slice for MO and/or MT services. In addition, discuss whether the intended slice can always be obtained by UE.*

In the objective of SID, intended slice is mentioned. As companies commented during the short email discussion, it would be good to achieve common understanding on the meaning of intended slice.

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| 1. Study mechanisms to enable UE fast access to the cell supporting the intended slice, including [RAN2] 2. Slice based cell reselection under network control 3. Slice based RACH configuration or access barring   Note: whether the existing mechanism can meet this scenario or requirement can be studied. |

**[Phase 1] Q2: What’s the meaning of the intended slice, and how or whether the UE knows the intended slice for MO and/or MT services?**

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| **Company** | **Comments** |
| Qualcomm | In our understanding, “intended slice” means the UE is able to distinguish the slice type (e.g. S-NSSAI) associated with the coming MO and/or MT traffics, and thereby can perform different behaviors (e.g. cell reselection and RACH parameters) depending on the slice type associated with the coming traffics.  For MO service, we think it is more or less already available in NR Rel-15 via traffic indication from NAS to AS, i.e. the access category provided by NAS can be mapped to different slice type.  For MT service, we think it is not available in current NR spec. One simple way is to include intended slice information in paging message for the UE. The signaling details can be discussed further. |
| CMCC | There maybe two different understandings of the intended slice:   * Option 1: Intended slices = all the slices supported by UE   Which traffic the UE is going to launch in the near future is actually unpredictable. So one understanding is to consider all the supported slices as intended slices. And study how to let UE always reselect to the cells that supporting most of the supported slices.   * Option 2: Intended slices = the slices that triggering MO or MT paging   For MO service, both IDLE and INACTIVE mode UEs are aware of the slice triggering state transition.  For MT service, since the paging message doesn’t contain any slice info, neither IDLE nor INACTIVE UE has any idea on which slice the UE is being paged, before the UE turns to CONNECTED mode.  We don’t have strong view between the two options. |
| CATT | We think the meaning of the intended slice is different if we discuss different use cases:  Case1: During cell selection/reselection  If no preferred slices info is provided by NAS, based on R15 spec, UE will always select a best cell or highest ranked cell according to the cell signal quality during cell selection/reselection. The drawback for R15 mechanism is that UE may do cell reselection again or the UE wanted slice service may be barred if the wanted slice service UE triggered in the near future is not supported in the current selected cell, which is not friendly for user experience.  If some slice assisted info can be get by UE AS, like the allowed CAG list info in NPN WI, UE AS can have a more efficient and accurate cell reselection based on slice assisted info along with cell quality info.  In this case, the meaning of the intended slice is the slice assisted info, like UE allowed/configured slice.  Case2: During transition from idle/inactive to connected mode  In this case, the intended slice is the slice which triggers the RACH procedure including both MO and MT service.  As mentioned by Qualcomm, for MO service, UE AS can implicitly get the intended slice info from the operator defined access category as we think there is a mapping rule between slice and operator defined access category.  As for MT service, we’re open to discuss whether/how the UE AS will get the intended slice info. |
| Huawei, HiSilicon | For MO service, we think the intended slice is the slice which is to trigger the state transition, and we think UE should be aware of the slice. For MT service, the paging message can be used to indicate such slicing info, which can be further studied.  In addition, we think the value of the intended slice is to let UE select an appropriate cell for slice purposes before any state transitions. |
| Vodafone | For MT, the slice allocation, Class and Quality of service is dictated by the network and the incoming type of service, for example for emergency service, the network would allocate the appropriate slice and then connect to the UE. For MT the network is aware of the UE’s capabilities and is able to connect with the UE on that particular slice.  For the MO the user would somehow select the service intrinsically or from the type of application that it is running, again using the emergency services as an example, the UE at the disposal of the emergency service would initiate a call on a particular slice which carries the emergency service communications.  For emergency services to be able to use the slice the UE must have a way of switching from a normal mode to an emergency mode, either by a special key or by soft switching. |
| Xiaomi | We agree with CATT that the meaning of intended slice is different for different use cases.  For cell selection/reselection, we think deployment scenarios need to be clarified first.  Based on SA2’ assumption that allowed S-NSSAI(s) are supported on all cells/frequencies in a RA, UE can perform cell selection/reselection based on legacy mechanism(i.e. frequency priority) without awareness of slice.  On the other hand, SA2 is discussing preferred frequency(s) configured per slice by NAS for cell selection/reselection. If it is adopted, UE AS may need to be aware of slice information to adopt slice-specific frequency priority to perform cell seletion /reselection.  In this case, NAS needs to provide AS the intended slice based on e.g. Requested NSSAI, or Alllowed NSSAI together with preferred frequency information.  For RACH configuration, the intended slice is the slice which triggers RACH procedure. For MO service, as operator-defined access category can be set to S-NSSAI, UE AS can implicitly get the intended slice info from the operator-defined access category.  For MT service, since the paging message doesn’t contain any slice info in current NR spec, UE can not get the intended slice which triggers RACH procedure. |
| Ericsson | We tend to share the view that “intended slice” means slice of the service which the UE is accessing the network for. We believe this is enough for the Rel-15/16 mechanisms. For MO, traffic, UE knows the slice. For MT traffic, UE need not know the slice. |
| OPPO | We think we need to discuss the meaning of the intended slice case by case.   * In case of cell selection/reselection, the intended slice means the allowed/configured NSSAI or the interested slice. In cell selection/reselection, if the allowed/configured NSSAI or the interested slice is obtained by UE AS, such slice information can be used to check whether the intended slice is supported by the potential cell.   1. If the intended slice in UE AS is matched to the supported slice in the potential cell, the cell can be chosen to camp on.   2. If UE is already camped on the cell on which the intended slice is not supported, UE can trigger cell selection/reselection procedure and cell reselection measurement * In case of data arrival to trigger RACH or UAC, the intended slice means the request/allowed NSSAI or the slice associated to the arriving service. In details,   1. For MO service, UE AS can get the intended slice from UE NAS in implicit way (i.e. access category, although it is not accurate).   2. For MT service, the intended slice can not be obtained by the UE side unless something is included in paging message. |
| Google | In our view “intended slice” or “intended slices” is the set of slices that the UE intends to use at any point of time. This set can be dynamic based on the activity that the UE is involved in (including network configuration). These intended slice(s) are used by the UE to perform slice-specific cell selection/reselection in idle and inactive states. For connected state, intended slice has no real meaning since at that point the UE is connected to one or more network slices, and the intended slice should not make much difference. Of course the intended slices could belong to the network slices that the UE is connected to.  We also believe that it is needlessly complicated to talk of an intended slice for MT services. If the UE is paged, then the UE has to transition to connected mode and there is not much gain in attempting to connect to a cell that the UE is not camped on. So we do not think paging should be modified to include slice identity. The contents of the paging message are not entirely within RAN2 scope in any case. |
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**[Phase 1] Q3: Whether the intended slice can always be obtained by UE.**

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| **Company** | **Comments** |
| Qualcomm | Yes (although we don’t fully understand the intention of this question)    In our understanding, the intention of this study item is for enhancement of either cell reselection or RACH depending on different slice type associated with the coming traffics to UE. Then for either slice based cell reselection and RACH, we don’t understand how they can be achieved if the UE is not aware the intended slice of coming traffic. |
| CMCC | For option 1 in our comment for Q2, YES.  For option 2 in our comment for Q2, YES for MO. For MT, slice info may need to be added to the paging message. |
| CATT | We’re a little bit confused by the question, so try to clarify and share our understanding.  In our view, two use cases may be identified in Q2 for intended slice:  Case1: During cell selection/reselection  Case2: During transition from idle/inactive to connected mode due to MO/MT service.  For Case1, UE allowed/configured slice info is not available by UE AS, e.g. only maintain in NAS layer. If the UE AS would like to use allowed/configured slice info to assist cell reselection procedure, UE NAS should inform AS of the allowed/configured slice info. But in current spec, this behavior is not specified. we think this SI can discuss how to achieve slice aware cell reselection.  For Case2, if this requirement is confirmed by RAN2, for MO service case, the current spec may still work as mentioned in Q2, but for MT service, some spec enhancement can be further studied, anyway, the current spec is not sufficient. |
| Huawei, HiSilicon | This Q3 is related to Q2. Based on our responses to Q2, for MO service, our comment is Yes for NAS but FFS for AS currently; and for MT service, it depends on the discussions of Q2. |
| Vodafone | For the UE to be able to select and communicate on a particular slice, it is very much dependent on the network to let the UE know of the availability of a particular services on a particular slice.  The available network slices can be sent to the UE during the idle mode and stored in the UE and used when the UE is paged to connect to the network in the connected state.  The main issue that we have identified is the handover and roaming: during a idle or connected mode how would the network and the UE respond in in the adjacent cell or region, a particular slice is not available?  Also Qualcomm has a very good point : *we don’t understand how they can be achieved if the UE is not aware the intended slice of coming traffic:*  the network and the UE need to communicate with each other :   1. Network to inform the UE of the available slices 2. UE to let the network know slices that it can support 3. A fallback solution if a particular slice is not supported say in cell selection/ re-selection 4. Roaming scenarios? |
| Xiaomi | For cell selection/reselection, as same reason as Q2, the deployment scenarios need to be clarified first.  And as analysed in Q2, considering SA2’ assumption and if preferred frequency is configured per slice by NAS, UE need to get the intended slice. However, currently, the slice info is provided to AS layer only when a CM-IDLE UE sends an initial NAS message, i.e. AS can not get the intended slice during cell selection/reselection. Also, intended slice should be updated by NAS when needed, e.g. allowed slices are updated by network.  During RACH procedure, for MO service, as operator-defined access category can be set to S-NSSAI, UE AS can always implicitly get the intended slice info from the operator defined access category.  For MT service, in current NR spec, UE can not get the slice information. The intended slice information may need to be indicated in paging message, and then UE can access the system using separate PRACH resources assigned to specific slices. |
| Ericsson | As responded in Q2, with existing Rel-15/16 mechanisms:   * For MO traffic, UE would typically know the slice * For MT traffic, UE need not know the slice |
| OPPO | UE can obtain the intended slice if we support a bit enhancement.   * In the case of cell selection/reselection, the allowed/configured NSSAI or the interested slice is unaware by UE AS but aware by UE NAS. Some work may need to assure UE AS obtained such information from UE NAS. * In case of data arrival to trigger RACH or UAC, for MT some work is needed, e.g. extend paging message to include the slice information. But for MO, due to the inaccuracy of access category, maybe some work is needed to allow UE AS obtaining the requested/allowed NSSAI info. |
| Google | We agree with Qualcomm and others that for the MO case, the UE should be aware of its intended slice(s).  We think that RAN2 should not really work on how UE determines the intended slice(s). For our purposes, this can be a list of slices provided by higher layers (NAS) just like Requested NSSAI.  For MT,the concept of intended slice does not really apply as it is part of the UE’s internal state. In any case, as observed earlier, there is no clear benefit in the UE knowing the slice identity of the service that caused paging. |
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## 3 Slice based cell selection and reselection under network control

### 3.1 Issue discussions

***[RAN2 agreements on the scope]*** *Discuss the issue that RAN2 needs to address in this SI for the agreed scenario, and whether to add new scenarios can be also discussed.*

In the contributions in RAN2#111-e, here are the issues raised by companies to be studied in this SI:

**Issue 1**: The UE is unaware of the slices supported on different cells or frequencies, which prevents UE from (re)select to the cell or frequency supporting the intended slice.

**Issue 2:** Dedicated priorities would not be available to the UE prior to first RRC connection establishment and only remain valid before T320 expires upon entering IDLE mode. In addition, dedicated priorities are discarded each time when UE entering CONNECTED mode and need to be configured again before UE leaving CONNECTED mode.

**Issue 3**: Operator may require different frequency priority configurations for the specific slice in different areas, however the dedicated priority always overwrites the broadcast priorities if configured.

**Issue 4:** If the serving cell is unable to support the requested slices for the subsequent access of the UE, the serving cell may bring on handover or rejection of access request. That may increase control plane signalling overhead as well as long control plan latency for the UE to access the network.

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**[Phase 1] Q4: Do you agree that the above issues should be addressed? And any additional issues can be added.**

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| **Company** | **Which ones?** | **Comments** |
| Qualcomm | All |  |
| CMCC | All | All of the issue 1/2/3/4 need to be addressed in Rel-17.  We would like to emphasize the Issue3. As shown in Figure 5.1.1-1, in Area 1, F2 is primarily to provide service for Slice2 UEs. So, the Slice2 UEs need to prior to camp on F2, and Slice1 UEs prior to camp on F1 to avoid occupying too much resources for Slice2 on F2.  While in Area 2, both F2 and F1 only serve Slice1 service, and F2 with wider bandwidth is deployed as hotspot for Slice1, which means Slice1 UEs should prior to camp on F2. So, in Area1, the frequency priority for Slice1 UE is F1>F2. But in Area2, the priority for Slice1 should be F2>F1.  The use case for Issue3 is that operator may require different frequency priority configurations for the specific slice in different areas. If the UE is configured with dedicated priority F1>F2 in Area1, that dedicated priority will still working when UE moving to Area2. |
| CATT | All | For issue3, we agree with CMCC that the requirement is reasonable and valid, but the current dedicated priority can’t cover this new requirement.  For issue4, in last RAN2 meeting, we agree that connected mode issues should have second priority, so we agree to study issue4, but with low priority. |
| Huawei, HiSilicon | All |  |
| Vodafone | All | Issue 1 – Slice availability and slice performance (Throughput latency QoS etc) is a fundamental issue and both Network and the UE need to be aware of each other’s’ performances/characteristics.  there would be other issue and scenarios that would be identified as we proceed with Rel17 work. |
| Xiaomi | FFS | If we follow SA2’ assumption that slice are support on any cell/frequency in a RA, we think the legacy mechanism can work, and there is no issue 1/2/3/4.  If we do not follow SA2’s assumption, we agree with issue 1/3. For issue 2, we don’t see it as an issue, there is no need to optimize this. For issue 4, performing cell reselection before cell access procedure will introduce too much delay, especially considering that UE may need to perform cell measurement before cell reselection. |
| Ericsson | All | We are fine to address/discuss all 4 issues.  Comment on Issue 1: We assume this issue is supposed to cover the scenario UE is camped on a cell, and wants to access a slice not supported by the camped cell (e.g. UE is in Area 1, camped on Cell 1/F2 and wants to get access to Slice 2 on Cell 2/F1). |
| OPPO | All |  |
| Google | All | We agree with CATT that issue 4 is of lower priority. |
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***[RAN2 agreements on the scope]*** *Discuss whether the R15 mechanism (e.g. dedicated priority mechanism) can solve the above issues*

**[Phase 1] Q5: Whether the R15 mechanism (e.g. dedicated priority mechanism) can solve the above issues?**

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| **Company** | **Comments** |
| Qualcomm | No.   1. It can’t resolve issue 2: The dedicated priorities are provided to the UE in RRC Release message. So, it means dedicated priorities would not be available to the UE prior to first RRC connection establishment and only remain valid before T320 expires upon entering IDLE mode. 2. It can’t resolve issue 1 and 4: we think there may be scenarios where no frequency may provide all the slices (i.e. the agreed 1st scenario: multiple and different slices can be supported on different frequencies). In such case the UE may camp on a frequency based on legacy reselection rules and chose to reselect to a frequency providing the intended slice prior to access. No matter NW uses HO or redirection, it will incur signaling overhead and latency, which is unnecessary 3. It can’t resolve issue 3 for agreed 2nd scenario (i.e. Figure 5.1.1-1 in current TR): The frequency priorities are different in different regions (i.e. different in area 1 and area 2). However, the dedicated priority always overwrites the broadcast priorities, which means the UE can’t switch frequency priority when moving across area 1 to area 2 if dedicated priority is configured. So, region-dependent frequency priorities can’t work in this scenario. |
| CMCC | No.  We don’t think the legacy mechanism can address any of the 4 issues listed in Q4. |
| CATT | Agree with Qualcomm |
| Huawei, HiSilicon | No.  We have the following extra comments.  RAN has no knowledge of the intended slice of the UE, so by configuring dedicated priority of frequency can‘t solve issue 1. Issue 4 is usually caused by issue 1, and due to the wrong selection of the target cell, there are some negative impacts to both UE and network sides, which can’t be solved by current scheme.  R15 dedicated priority mechanism may result in Issue 2 and 3. The consequences are more network handling will be initiated, e.g., redirections/rejections, which are bad for network KPIs. That is, current scheme can’t solve issue 2 and 3. |
| Vodafone | No. Agree with all the comments above. |
| Xiaomi | If we follow SA2’s assumption, there is no issue, legacy mechanism works .  Otherwise, Legacy mechanism may need to be enhanced:  1. For preferred frequency per slice: UE needs to know the intended slices and possibly slice priority, frequency priority.  2. For different slices supported on different cells/frequencies: current dedicated frequency cannot work, as it applies within a RA(when out of RA, RAU can update the parameter).  3. For different frequency priority configurations for the specific slice in different areas: current dedicated frequency cannot work, as it applies within a RA(when out of RA, RAU can update the parameter). |
| Ericsson | Common to all issues 1-4 is that with Rel-15 mechanisms, TAs (Tracking Areas) are arranged such that every cell of a TA support the same slices. A feasible TA configuration for the scenario in Fig 5.1.1-1 is:  Cell 1: TA 1 Cell 2: TA 2 Cell 3, Cell 4: TA 3  This means that a UE moving from e.g. Area 2 to Area 1 (or, similarly, from Cell 2 to Cell 1 within Area 1) will trigger NAS registration.  Furthermore, existing CN-RAN functional split and signalling does not allow that RAN is made aware of “rejected slices” (i.e. slice requested by UE is not supported in the current cell/TA). Hence, RAN/gNb has currently no means to realize that UE needs to be moved to another cell/frequency.  To enable that the UE can access a slice not served in the current cell/frequency, new CN-RAN signaling should be introduced, for CN to pass the rejected NSSAI to RAN/gNb. RAN/gNb will then be able to move (handover or re-direct) the UE to the cell/frequency that serves the slice. This is for RAN3 to take care of.  **Issue 1:**  Upon UE access to connect to slice not supported by current cell/frequency, the network can use the following existing Uu (RRC) mechanisms:   * Redirect UE (RRCRelease with redirectedCarrierInfo) to the frequency of the slice. UE will select a suitable cell on the target frequency and attempt to access the slice. In Fig 5.1.1-1, UE camped on Cell 2 (on F1) will be directed to F2, select Cell 1 and trigger NAS registration.   **Issue 2:**  UE triggers NAS registration when entering new TA. Then UE can be configured with new dedicated priorities suited for the camping strategy in the new TA. Furthermore, a network is expected to use a shorter timer on NAS registrations, such that T320 never expires.  These principles on dedicated frequency priorities has been discussed earlier in RAN2 for 3g and 4g.  **Issue 3:**  As explained above, with appropriate TA configuration, UEs can be assigned dedicated frequency priorities according to the cell camping strategy of the network operator.  E.g., in Fig 5.1.1-1, a UE that is configured with dedicated priority F1<F2 in Area1 (e.g. camped on Cell2 (TA2)), when moving to Area 2 (e.g. Cell4/TA3) can get dedicated priority F2>F1.  **Issue 4:**  RAN2 should quantify signalling delay and/or overhead, as well as the advantages with a mechanism that also support Rel-15/16 UEs. |
| OPPO | No, agree majorities’ comments above. |
| Google | We think that cells should broadcast the slices they support to address issues 1 and 4. This is currently not possible in legacy mechanisms. Of course RAN can always redirect the UE to appropriate cells but that would introduce additional latency.  For issues 2 and 3, we think that dedicated priorities can be sufficient if RA/TA is configured appropriately as suggested by Ericsson. However, this may result in unnecessary RAU load which should be considered. Some enhancements to broadcast frequency priorities are still needed. |
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### 3.2 Candidate solutions

***[RAN2 agreements on the scope]*** *Discuss the candidate solutions which can address the above issues, and the solutions in the contributions in RAN2-111-e meeting will be summarized by rapporteur.*

In the contributions of RAN2#111-e, the following solutions are proposed:

**Solution 1**: Legacy dedicated priority via *RRCRelease* message.

**Solution 2**: Slice related cell (re)selection info, the slice info of serving cell and neighboring cells should be provided in the system information.

**Solution 3**: Cell reselection priority per slice should be provided in the system information or *RRCRelease* message.

**Solution 4**: UE preferred slice info can be considered for slice-based cell reselection design.

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**[Phase 2] Q6: How do you think about the solutions and do you agree to capture above solutions in the TR? Addition solution can also be added.**

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| **Company** | **Which ones?** | **Comments** |
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## 4 Slice based RACH configuration or RACH parameters prioritization

### 4.1 Issue discussions

***[RAN2 agreements on the scope]*** *Discuss the use cases or intentions for slice-based RACH configuration or RACH parameters prioritization, and discuss whether identified issues can be solved by legacy mechanisms.*

During the online session, chairman suggest we should first understand on the intention and use case for slice-based RACH configuration. Here are the intentions or use cases mentioned in the contributions in last meeting:

**Intention 1:** RA resource isolation. From marketing point of view, some of the industrial customers have the requirement for access resource isolation, in order to provide guaranteed RA resources for their sensitive slices.

**Intention 2**: Slice access prioritization. In R15/16, all slices are sharing the same RA resources and cannot be differentiated by network side. But some slices may need to be prioritized during the RA procedure.

**Intention 3**: MSG1 or MSGA access control. Separate RA resources for slices provides a simpler way for slicing access control comparing with UAC. Network can decide which MSG1 or MSGA to reply based on the corresponding slices.

**[Phase 1] Q7: Do you agree with the intention or use case for slice-based RACH configuration or RACH parameters prioritization? Any addition intention can also be added.**

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| **Company** | **Which ones?** | **Comments** |
| Qualcomm | Intention 1 and 2 | For intention 1, we agree the requirement is valid. However, it is worth noting that RACH resource partitioning may cause fragments of RACH resource, especially when the number of slices supported by one cell is large.  For intention 3, NR had spent a lot of efforts on UAC in Rel-15. We don’t think it can provide much benefit over UAC, and its functionality will be overlapped with UAC, which is not preferred |
| CMCC | All of the 3 intentions | The above intention 1&3 came from our contribution.  For intention 1, we see the requirement from the industrial customers.  For intention 3, the R15 UAC is perfect but a bit complex for us to deploy, which requires both RAN and CN configurations and impacting both AS and NAS layers. If the RA resource can be separately configured for different slices, the RAN node can directly perform access control for the slices, without impact on CN and NAS layer. |
| CATT | All |  |
| Huawei, HiSilicon | All | For intention 1 and 2, we have extra analysis:   * **For business scenarios (e.g., factory, hospital)**, RACH resource hard isolation will achieve high performance, e.g., the URLLC type UE will not be affected by the access of normal UE. * **For normal scenarios**, dynamic RACH resource isolation will decrease the impacts to normal UE, e.g., the RACH resource can be allocated to URLLC type UE on demand.   For intention 3, we also think that slice based RACH resources or the slice notification in MSG1 or MSGA could be applied as a complement to the slice-based access control. |
| Vodafone | All | All scenarios are real possibilities.  For Mission Critical / Emergency Service we would require (if practical) a slightly different random access from the UE side to let the network know that this is a high priority call. |
| Xiaomi | Intention 1 and 2 | For intention 3, there are many access barring mechanisms introduced in LTE, and in NR Rel-15, UAC is introduced to provide a single access control frame. We have not seen that there are enough benefits to have such a separated access control mechanism from UAC. |
| Ericsson | All | We agree that with existing Rel-15/16 mechanisms there is currently no support for slice-based RACH configuration or RACH parameters prioritization for the initial RA at RRC Connection establishment. This could be further analysed. |
| OPPO | All | For intention 3, we also agree that slice based RACH for access control can be a complement to current access control mechanism. |
| Google | All | Google |
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### 4.2 Candidate solutions

***[RAN2 agreements on the scope]*** *Discuss the use cases or intentions for slice-based RACH configuration or RACH parameters prioritization, and discuss whether identified issues can be solved by legacy mechanisms..*

In the contributions, following candidate solutions were proposed:

**Solution 1**: Separate RACH resources pool can be configured per slice or per slice group, in addition to the existing common RACH resources.

**Solution 2**: RACH parameters prioritization can be configured per slice.

**[Phase 2] Q8: How do you think about the solutions and do you agree to capture above solutions in the TR? Additional candidate solutions can also be provided.**

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| **Company** | **Which ones?** | **Comments** |
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## 5 Slice based access barring

### 5.1 Issue discussions

Since R15 UAC has already supported operator defined access category which can be mapped to slices, it would be good to understand first what’s the intention for the enhancement and the issues for R15/16 UAC.

**[Phase 1] Q9: What’s the intention to enhance slice-based access barring?**

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| **Company** | **Comments** |
| Qualcomm | We don’t see the need to enhance UAC.  In current spec, we support operator based access categories (based on e.g. DNN, slice etc.) can also be provided to UE in Registration Accept and Configuration Update Command. And we have 32-63 available. So, the space should be enough to support different slice. |
| CMCC | No strong view. Open to see companies’ views. |
| CATT | For MO service, in current spec, most of the MO service/slice will use the same cause value in MSG3, e.g. ‘MO data’, if this service attempt is rejected in MSG4, all the slice service will be barred during T302 running except AC ‘0’ and ‘2’. But this is not the intended network/UE behavior for slice based access control, the network may want to bar the service attempt per AC except all ACs. Even if the operator defined ACs are used to imply the triggered slice behind, this per slice rejection requirement by the network is still valid and should be considered in this SI. |
| Huawei, HiSilicon | In our paper R2-2007772 (submitted at RAN2#111-e meeting), we provided some analysis on the R15/16 UAC issues regarding RAN slicing. Basically, we observe that a slice may include one or more services, and thus one or more categories are assigned. For example, a slice is associated with access category 32 and also access category 0 due to MT access. In this case, it is possible that one access category may be used for controlling slice or non-slice services, so it may lead to inefficient AC for slice purposes.  Therefore, slice based enhancement of the current UAC scheme could be studied in RAN2. |
| Vodafone | At this stage we do not see the need for additional barring like UAC Baring etc. however during the Rel17 study we may find that we would need barring for particular scenarios. |
| Xiaomi | We think there is no need for further enhancement on UAC in Rel-17.  In Rel-15, for MT service, access attempt triggered by paging will not be barred . And for MO service, operator-defined access categories have considered slices (e.g. DNN, S-NSSAI etc) to enable differentiated handling for different slices. If there is no clear scenario indicates that 32-63 can not provide sufficient support, we suggest to defer enhancement.  As for the issue mentioned by Huawei, we think it can be solved by current NR spec. If the access attempt matches more than one rule, the access category of the lowest rule number shall be selected. In other words, one access attempt can only be mapped to one access category. |
| Ericsson | We agree exiting UAC is sufficient. |
| OPPO | Firstly, we share the similar view as CATT, besides MSG1/MSGA based solution for network control, a new cause associating slice info can also be considered for exact network control.  In addition, we would like to consider in the following issue:   * For UAC, current UAC mechanism is the one related to operator-defined access category not to a specific slice. Considering multiple S-NSSAIs can be mapped with only one access category, even though the overload of different S-NSSAIs in one access category is different, there is no mechanism to ensure different access control results for different slices. |
| Google | We also believe that no enhancement to UAC is needed. |
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### 5.2 Candidate solutions

**[Phase 2] Q10: What’s the candidate solutions for slice-based access barring?**

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| **Company** | **Comments** |
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## 6 Conclusion

[To be added]

## 7 Tdocs under AI 8.8 RAN slicing SI

*Note: contributions highlighted in grey are LS related.*

1. R2-2006513 Response to 5GC assisted cell selection for accessing network slice (R3-202558; contact: ZTE) RAN3 LS in Rel-17 FS\_NR\_slice To:SA2 Cc:RAN,RAN2,SA1
2. R2-2006527 Reply LS on GSMA NG.116 Attribute Area of service and impact on PLMN (S1-202294; contact: Nokia) SA1 LS in Rel-17 FS\_eNS\_Ph2 To:SA2, CT1, RAN2, RAN3, GSMA 5GJA, GSMA WAS
3. R2-2006528 LS on 5GC assisted cell selection for accessing network slice (S1-202264; contact: ZTE) SA1 LS in Rel-17 FS\_eNS\_Ph2 To:SA2 Cc:RAN2, RAN3 Withdrawn
4. R2-2006529 LS on 5GC assisted cell selection for accessing network slice (S2-2001728; contact: ZTE) SA2 LS in Rel-17 FS\_eNS\_Ph2 To:SA1, RAN2, RAN3 Withdrawn
5. R2-2006534 LS on SA5 Rel-17 work on SLA (S5-203370; contact: CMCC) SA5 LS in Rel-17 EMA5SLA To:GSMA 5GJA, SA2, RAN3, IETF TEAS WG Cc:SA, SA1, SA6, RAN2, ETSI ISG ZSM
6. R2-2006632 Initial Discussion on the Scope and Requirements for Slicing CATT discussion Rel-17 FS\_NR\_slice
7. R2-2006655 LS on 5GC assisted cell selection for accessing network slice (S1-202264; contact: ZTE) SA1 LS in Rel-17 FS\_eNS\_Ph2 To:SA2 Cc:RAN2, RAN3
8. R2-2006656 LS on 5GC assisted cell selection for accessing network slice (S2-2001728; contact: ZTE) SA2 LS in Rel-17 FS\_eNS\_Ph2 To:SA1, RAN2, RAN3
9. R2-2006707 Considerations on slice aware cell selection KDDI Corporation discussion
10. R2-2006767 Discussion on RAN slicing enhancement Qualcomm Incorporated discussion Rel-17 FS\_NR\_slice
11. R2-2006854 Considerations on slice-based cell reselection Nokia, Nokia Shanghai Bell discussion Rel-17 FS\_NR\_slice
12. R2-2006871 Consideration on the scope and solutions for RAN slicing enhancement ZTE corporation, Sanechips discussion Rel-17 FS\_NR\_slice
13. R2-2006883 Considerations on scope of RAN slicing enhancements Lenovo, Motorola Mobility discussion Rel-17 FS\_NR\_slice
14. R2-2006887 5G RAN Slicing Framework During Cell Reselection MITRE Corporation discussion Late Withdrawn
15. R2-2006951 Slicing based cell (re)selection Intel Corporation discussion Rel-17 FS\_NR\_slice
16. R2-2006970 Considerations for RAN slicing Samsung Electronics Co., Ltd discussion Rel-17 FS\_NR\_slice
17. R2-2007051 Consideration on RAN slicing Spreadtrum Communications discussion
18. R2-2007088 Scoping of RAN Slicing Apple discussion Rel-17 FS\_NR\_slice
19. R2-2007140 Consideration on Rel-17 slicing OPPO discussion Rel-17 FS\_NR\_slice
20. R2-2007250 Assistant information to enable UE fast access network slice ITRI discussion FS\_NR\_slice
21. R2-2007302 Consideration on RAN slicing vivo discussion Rel-17 FS\_NR\_slice
22. R2-2007402 Discussion on RAN Slicing LG Electronics UK discussion Rel-17
23. R2-2007419 Skeleton for TR 38.832 CMCC draft TR Rel-17 38.832 0.0.0 FS\_NR\_slice
24. R2-2007420 Work Plan for RAN Slicing CMCC, ZTE discussion Rel-17 FS\_NR\_slice
25. R2-2007421 Discussion on support of RAN slicing CMCC discussion Rel-17 FS\_NR\_slice
26. R2-2007521 Enhancement on RAN support of network slicing Beijing Xiaomi Software Tech discussion Rel-17
27. R2-2007606 Considerations on Frequency Band Selection for RAN Slicing SHARP Corporation discussion Rel-17
28. R2-2007607 Basic requirements for RAN slicing Google Inc. discussion Rel-17 FS\_NR\_slice
29. R2-2007609 Discussion on Network Slicing’s Impact on Cell Reselection Convida Wireless discussion FS\_NR\_slice
30. R2-2007645 Methods for serving slices on different frequencies Ericsson discussion Rel-17 FS\_NR\_slice
31. R2-2007716 Scenarios and requirements for RAN slicing SoftBank Corp. discussion Rel-17 FS\_NR\_slice
32. R2-2007772 Considerations on enhancing the RAN support of network slicing Huawei, HiSilicon discussion Rel-17 FS\_NR\_slice
33. R2-2008071 Considerations scenarios on enhancing the RAN support of network slicing China Unicom discussion Rel-17 FS\_NR\_slice