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

**Online, Nov 2nd – 13th, 2020**

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

**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 shown 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

The proposals are clarified into following a/b/c/d categories:

1. a potential easy agreement, e.g. Proposals where consensus exists, that seem straightforward to agree
2. need further discussion. These should be tagged with e.g. [FFS] so they are clearly visible, and should indicate what the primary controversy is
3. a candidate for immediate postpone, e.g. issues that may require other WG discussions or is contentious such that it is unlikely to converge at e-Meeting.
4. Issues on ASN.1 – or specifications-specific CR proposals will go directly to email discussion on the corresponding CRs.

## 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. |
| Nokia | No additional scenario is needed |
| 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. |
| Intel | We agree with Qualcomm that ‘**Multiple and different slices can be supported on different frequencies**’ by itself is a scenario that needs to study on its own. UE may be camp on F1 for Slice 1 based on the operator setting on the dedicated frequency priority. UE needs to be able to fast access to Slice 2 in Cell 1 when Slice 2 is initiated. Hence, we think this scenario needs to be separated from the example scenario to be studied on its own. We propose to update the TR as follows: 5.1.1 Scenario and issue description *Editor Note: capture the description of scenario and issue.*  **General description for the scenario:**  **• Multiple and different slices can be supported on different frequencies**  **• Multiple and different slices can be supported on the same frequency in different regions.**  Editor Note: Additional scenarios can be discussed as part of the study.  Two scenarios are identified that fit to the general description:  Scenario 1: Multiple and different slices are on different frequencies in the same area  Scenario 2: Multiple and difference slices are on the same frequencies in different area  For each scenario we study both IDLE and INACTIVE and determine whether there is need for a solution and possible solutions. Connected mode will also be considered but with a lower priority.  We will investigate whether the R15 mechanism (e.g. dedicated priority mechanism) can solve the above issues and study if some enhancements are needed.  Editor Note: Both cell selection and cell re-selection will be studied.    **Figure 5.1.1-0: Scenario 1: Multiple and different slices are on different frequencies in the same area**    **Figure 5.1.1-1: Scenario 2: Multiple and difference slices are on the same frequencies in different area**  As shown in figure 1, slice1 (e.g. eMBB) is supported in both F1 and F2 everywhere, since the frequency resources are so valuable and the top requirement for all operators’ 5G network is to serve millions or billions of smart phone users. Slice2 (e.g. URLLC) is supported only in F2 in some area, e.g. factory or hospital.  Area 1 is deployed in the factory or hospital. In this area, F1 supports slice1 (e.g. eMBB), while F2 supports both slice 1 and slice 2 (e.g. eMBB and URLLC).  Area 2 is the public area. F1 and F2 all supporting slice1 (e.g. eMBB) for smart phone users, no slice2 (e.g. URLLC) is supported in area 2. And F2 is deployed as hotspot to provide wideband access.  eMBB and URLLC slices are used only as an example of various slices. The deployment of any slice on any frequency band is up to network implementation. |
| Lenovo / Motorola Mobility | Yes, we think that the additional scenario as proposed by Qualcomm can be considered as well. |
| Convida Wireless | We think both of the agreed scenarios are already reflected in Figure 5.1.1-1, However, to minimize confusions, we are OK to add the figure provided by Qualcomm as another illustration of the first scenario. However, RAN2 might need to consult with SA2 to ensure this doesn’t violate any architecture principle as it relates to network slicing, for example, network slice isolation for CP and UP. |
| vivo | The scenarios currently captured in the TR are basic and realistic. But, we are fine to consider more scenarios, as far as, they are realistic. |
| LGE | Figure 5.1.1-1 reflects agreed scenarios in RAN2#111-e meeting and no additional scenario is proposed. We are open to discuss the detailed cases (e.g. CA/DC, preferred slices) based on the agreed deployment scenarios.  The deployment scenario from RAN2 point of view should be realistic and should not be conflict with SA2. |
| ZTE | The agreed scenarios have been captured in the TR. No additional scenarios proposed from our side. |
| SoftBank | We think the scenarios captured in TR cover the typical slice deployments, but we are open for other scenarios. |
| Fujitsu | The agreed scenarios in the last meeting are typical scenarios. Figure 5.1.1-1 merely depicts just an example as the title indicated, so that adding more examples may not be so useful.  If more scenarios are identified, Fujitsu is fine to take discussions.  One potential useful scenario which was pointed out in the last meeting is that RAN slice and BWP (Bandwidth Part) can have some mapping. |
| ITRI | No additional scenario is needed. |
| Spreadtrum | The figure 5.1.1-1 captured the two agreed scenarios. We are open to consider more scenarios if they are realistic. |
| KDDI | We are fine to add an example for slice deployment scenario, as Qualcomm proposing. However, we think that we don’t have to list up all possible examples. |
| Samsung | Similar to the figure by Qualcomm, we think different slices can be supported on different frequencies in the same area. |
| T-Mobile USA | We would like to have following scenarios. In same location have same slice to support multiple band (F2 and F3), may be with NR CA and NR DC |
| Sharp | The scenarios captured in TR is fine to us. |

Summary for Q1:

24 companies share comments for Q1.

7 companies (QC, HUAWEI, Google, Lenovo, Convida, KDDI, Samsung) support to capture one more figure for the first scenario, to indicate the frequencies supporting different slices can be different. See the figure below:



2 companies (Ericsson, Google) suggest to capture one more scenario that slices are available via multiple frequencies, and one or a set of frequencies are preferred for certain slice. See the figure below:



F1

Slice 1 + Slice 2 (preferred)

Cell 6

F2

Slice 1 (preferred) + Slice 2

Cell 5

**Area X**

Intel comments that the scenario that ‘Multiple and different slices can be supported on different frequencies’ needs to be separated from the example scenario to be studied on its own, and TP is also provided by Intel.

T-Mobile USA proposed a scenario that in same location have same slice to support multiple band (F2 and F3), may be with NR CA and NR DC.



6 companies (CMCC, CATT, Nokia, LGE, ZTE, ITRI) think the agreed scenarios are sufficient and no further scenario is needed.

2 companies (vivo, Spreadtrum) are fine to consider more scenarios, if they are realistic.

2 companies (Xiaomi, LGE) comments that we need to clarify whether the deployment scenarios from RAN2’ view is conflict with SA2.

*Rapporteur suggest we can have a separate discussion on the SA2 LS in next meeting based on the output of this email discussion.*

Convida comments that RAN2 might need to consult with SA2 to ensure this doesn’t violate any architecture principle as it relates to network slicing, for example, network slice isolation for CP and UP.

Fujitsu proposed one more scenario that RAN slice and BWP (Bandwidth Part) can have some mapping.

The following 2 scenarios are supported by several companies, and RAN2 is suggested to discuss whether to capture these two figures

**[cat b] Proposal 1: Capture the following figure in the TR, and Cell X in the figures denote group of cells.**

 

### 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. |
| Nokia | The intended slice information should come from NAS to AS in all cases. It is up-to SA2/CT1 to specify how UE learns it. If AS does not know (e.g. NAS cannot provide it for MT services), then it will not be considered in AS level procedures. The requirement to enhance AS level procedures to help NAS to learn slice information (e.g. to add slice information to paging message) should come from SA2/CT1. |
| 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. |
| Intel | In our view, the intended slices are slices which the UE intends to access the network for, and it can be:   1. one of the slices in the allowed NSSAI; or 2. a new one that the UE wants to request for over NAS signalling (i.e. part of requested NSSAI).   Assuming that the definition of intended slice refers to slices from the allowed NSSAI as in (i): For MO, the slice info is known to the UE since it is part of the allowed NSSAI and UAC and network access control based on establishment cause can already be done via Rel-15 access categories corresponding to the slice info. For MT, the slice info is not known to the UE |
| Lenovo / Motorola Mobility | To our understanding we have to consider three cases:  Case 1: For NAS registration purposes (initial/update) the term “intended slice” refers to the S-NSSAI(s) in IE “Requested NSSAI” to which the UE wants to register.  Case 2: For MO services the term “intended slice” refers to the S-NSSAI (from the ones in “Allowed NSSAI”) of the PDU Sessions, for which the UE wants to activate the UP resources.  Case 3: For MT services the UE does not know the “intended slice” when it receives paging. Only after RRC connection establishment and sending NAS Service Request messages to the network, the network will activate the PDU Session(s) associated with the S-NSSAI for which the UE was paged. |
| Convida Wireless | In our view, the “intended slice” is a network slice that the UE intends to use. or is likely to use upon transitioning to connected mode. An intended slice may correspond to a slice in the Requested NSSAI or the Allowed NSSAI.  When in idle/inactive mode, the UE AS could use assistance info (for e.g. the intended slice based on e.g. Requested NSSAI, or Allowed NSSAI) provided by the NAS together with the cell quality to (re-)select a cell that supports the intended slice; i.e. the slice the UE likely to use upon transition to connected mode. Similarly, when actually transitioning from idle/inactive to connected mode, the intended slice is the slice that is associated with the activity that triggered the RACH procedure, as indicated by CATT in their response.  With regards to MO service, it is possible in Rel-15 in the case of operator-defined access categories, for the UE AS to implicitly get the intended slice info from the operator defined access category, provided the operator has configured the access categories such that they are dependent on the slice that is being accessed.  With regards to MT service, we agree with the views by Qualcomm, and are open to discuss whether/how the UE AS will get the intended slice info, including indicating the intended slice information in paging message for the UE. |
| vivo | Our understanding is that “intended slice” is the slice that may satisfy UE service(s) requirements and the UE intends to access. This intended slice can be the same as the network slice or different form the network slice. To access to this intended slice, UE is allowed perform selection/reselection. Specially in case of MO service, if the slice the UE is not the intended slice, UE can first perform cell reselection to access to the intended slice before the MO service starts. |
| LGE | “Intended slice” could be different depending on UE operation and/or state. In general, Configured NSSAI could be Intended slice for cell reselection, RACH configuration or access barring. If UE is in RRC\_INACTIVE, the UE could narrow the Intended slice down to a particular S-NSSAI supporting suspended services.  For MO services, the UE knows the intended slice assuming that the UE is provisioned (by UE itself or the network).  For MT services, we don’t think the UE needs to distinguish MT services based on slicing as long as the UE is the right target for the services. |
| ZTE | In our understanding, the intended slice is the slice UE wants to get access for service and transit from idle/inactive mode to connected mode.  For MO service, UE AS layer can be aware of the intended slice implicitly via the access category and can then (re)select an appropriate cell and use the corresponding RACH resources.  For MT service, since UE is not aware of the slice to be used, maybe some enhancement is needed. |
| SoftBank | We agree the meaning of intended slice is different for each of UE state. In cell selection/reselection, the intended slice means UE supported slice, and in MO/MT case, it means a slice which triggers the RACH procedure. |
| Fujitsu | We don’t think that the interpretation of “intended slice” has such complicated meaning that companies are indicating above. Fujitsu’s view is that “intended slice” means a slice supporting the service that the UE wishes to be served.  Regarding SA2 assumption indicated by Xiaomi, Fujitsu also understands that SA2 assumption so far is that an S-NSSAI in the Allowed NSSAsI is supported in all the registration area (e.g. tracking area). However, several companies in SA2 indicates that not all cells in a TA supports all the S-NSSAIs and the validity of the assumption is still discussed in SA2. Therefore, RAN2 is better to waif for the SA2 progress. |
| ITRI | We share the same view with CATT. Besides, we think for the purpose of access barring there is no need to know the intended slice for MT services because access attempts triggered by paging will be always allowed in the legacy system. However, it may be useful to know the intended slice for MT services if we want to prioritize the slice during the RA procedure. |
| Spreadtrum | We think the intended slice is the slice that UE is going to request for services in the next period of time no matter whether the UE is in Idle/Inactive state or Connected state. The intended slice is dynamic and UE specific, it could belong to allowed NSSAI the NW allows UE to use, and it may also belong to the requested NSSAI. For latter cases, it may need further discussion on solutions.  For MO services, UE could know the intended slice from its NAS layer or via access categories.  For MT service, UE has no idea about the intended slice unless informed by NW. |
| KDDI | We tend to agree with the different meanings that CMCC mentions above.  In our understanding,   * In “a. Slice based cell reselection under network control”, the UE takes all the slices supported by UE into account. * In “b. Slice based RACH configuration or access barring”, the UE takes the slices that triggering MO or MT paging. |
| Samsung | Intended slice for MO (referred to allowed NSSAI or requested NSSAI) is known by UE itself if slice info for the MO is configured. Regarding MT service, we think that the slice info about MT does not have to be known to UE. It should be clarified first why UE need to know the intended slice for MT. |
| Sharp | We think that an intended slice refers to an S-NSSAI in the Allowed NSSAI, which is intended to be used for a future PDU session.  Speaking of MO/MT services, our understanding is that an S-NSSAI is used to establish a PDU session in a slice. Since a PDU session establishment is always initiated by a UE, the UE should know what slice the UE attempts to use. |

**[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. |
| Nokia | It is out of scope of RAN2 whether the UE always knows the intended slice. RAN2 should focus how to enhance the AS procedures when the UE knows it. |
| 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. |
| Intel | We are also a bit confused by the question about what “obtain” means - whether it means UE knows the intended slice or UE can get service on the intended slice.  If the question is about knowing the intended slice, as mentioned in our previous question, UE does not know the intended slide for MT services.  If the question is about whether UE can get service on the intended slice: In some cases, due to radio conditions or deployment scenario, the intended slice may not be in the coverage area of the UE and hence the intended slice may not be obtainable by the UE.  We think further discussion is needed on what happens when the UE has data for the intended slice that is not available, when UE is in Area 2. Does the UE:   1. buffer the data and try continuously to obtain the intended slide and discard the data when the discard timer runs out? Or 2. Is it required to release the PDU session such that the higher layers are aware that the slice is not available and should not send data?   This may require checking with SA2/CT1 to understand what the NAS behaviour will be when the UE cannot get the service for the intended slice. |
| Lenovo / Motorola Mobility | For NAS registration purposes (initial/update) and MO services the UE NAS has the information.  For MT services the UE can obtain the “intended slice” only after RRC connection establishment and exchange of NAS messages with the network. |
| Convida Wireless | In our view, this should be the case...see our response to Q2. |
| vivo | For MO service we think yes, as UE can perform cell reselection to access the intended slice. For MT service it may not always possible, as if the UE is not camping on intended slice, UE my not perform the MT service on intended slice. If the UE perform cell reselection to intended to the intended slice UE would experience service interruption. |
| LGE | Referring to the answer for Q2, Yes.  The UE knows the intended slice for MO services assuming that the UE is provisioned (by UE itself or the network), and we think it depends on the network operators. If the network provides network slice information to UEs, the UE can decide Intended slice for the services. |
| ZTE | For MO service, UE AS layer can be aware of the intended slice implicitly via the access category and can then (re)select an appropriate cell and use the corresponding RACH resources.  For MT service, since UE is not aware of the slice to be used, maybe some enhancement is needed. |
| SoftBank | Not clear question, but for MT case, the Rel-15/16 UE cannot know the slice. |
| Fujitsu | Fujitsu think that there is a case that the intended slice cannot be obtained. One example is that time-frequency resources are not enough to support the intended service due to resource shortage e.g. when UE wishes to perform initial access to the intended slice.  Such a resource shortage scenario has been discussed in case of CONNECTED mode in RAN3 and the TP to TR38.832 has been agreed in R3-205783. Fujitsu would stress here that the resource shortage scenario occurs regardless of RRC state. Specifically, there is also a case that radio resources for the intended slice is already running out when UE tries to perform initial access to the intended slice. |
| ITRI | We share the same view with CATT. |
| Spreadtrum | We share similar views with ZTE, UE could know the intended slice for MO service anyway, e.g. from NAS.  For MT service, UE has no idea about the intended slice unless informed by NW. |
| KDDI | Share the view with CMCC. For MT case, if slice info is not available in the UE, then it may be added to the paging message. |
| Samsung | UE is configured with subscribed slice and mapping information between application and slices. This should be same for MO service and AS layer is not involved in the provisioning. Regarding MT service, we are not sure UE need to know the slice info for MT. |
| Sharp | See our response in Q2. |

Q2 and Q3 are quite related, so they are summarised together.

9 companies (CATT, CMCC, Xiaomi, OPPO, Convida, LGE, ITRI, Spreadtrum, KDDI) comments that the meaning of intended slice can be different for different use cases.

Case1: During cell selection/reselection

10 companies (CATT, CMCC, Xiaomi, OPPO, Convida, vivo, ITRI, Spreadtrum, KDDI, Sharp) comments that in case of cell selection/reselection, the intended slice means the allowed or requested NSSAI.

Case2: During transition from idle/inactive to connected mode

17 companies (Qualcomm, CMCC, CATT, Huawei, Xiaomi, Ericsson, OPPO, Intel, Lenovo, Convida, vivo, LGE, ZTE, ITRI, Spreadtrum, Samsung, Sharp) agree that for MO service, the intended slice is 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.

17 companies (Qualcomm, CMCC, CATT, Huawei, Xiaomi, OPPO, Ericsson, Nokia, Google, Intel, Lenovo, Convida, LGE, ZTE, ITRI, Spreadtrum, Samsung) agree that for MT service, UE is unaware of the intended slice in current NR spec.

Whether UE need to know the intended slice for MT service?

9 companies (Qualcomm, CMCC, CATT, Huawei, Xiaomi, OPPO, Convida, ZTE, ITRI) are open to study how to include intended slice information in paging message for the UE.

5 companies (Ericsson, Nokia, Google, LGE, Samsung) comments that for MT traffic, UE need not know the slice.

Nokia comments that the requirement to enhance AS level procedures to help NAS to learn slice information (e.g. to add slice information to paging message) should come from SA2/CT1. Fujitsu also prefers to wait for SA2 progress on the TA.

**[cat b] Proposal 2.1: In case of cell selection/reselection** **(NOT triggered by MO and/or MT), the intended slice means the allowed or requested S-NSSAI(s).**

* **For the initial registration, and requesting new S-NSSAI(s): intended slices = Requested S-NSSAI(s)**
* **For idle-mode mobility: intended slices = allowed S-NSSAI(s)**

**[cat b] Proposal 2.2: In case of cell selection/reselection and RACH (triggered by MO and/or MT), the intended slice means the S-NSSAI associated with MO / MT traffic.**

**[cat b] Proposal 3: For MO service, the intended slice is 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.**

**[cat a] Proposal 4: For MT service, UE is unaware of the intended slice in current NR spec. FFS whether UE needs to know the intended slice.**

## 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 plane latency for the UE to access the network.

**Issue 5:** If the intended slice is no longer available (e.g. UE moves from Area 1 to 2), the UE behaviour may be unspecified when it has data for the intended slice while Slice 2 is initiated and ongoing (PDU session is still active).

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

|  |  |  |
| --- | --- | --- |
| **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 |  |
| Nokia | YES for ALL, but  comments for issue 4 | Issue 1: This is the main issue to be solved in RAN2  Issue 2 and 3: These are problems of the solution using dedicated signaling for issue 1. RAN2 should discuss whether they can be solved.  Issue 4: RAN2 may have solution(s) for the case when the UE is in IDLE/INACTIVE. The case when the UE is in CONNECTED mode is not fully in the scope of RAN2 |
| Google | All | We agree with CATT that issue 4 is of lower priority. |
| Intel | All including issue 5 | We think another issue based on the scenario(s) identified is that If the intended slice is no longer available (e.g. UE moves from Area 1 to 2), and the slice 2 is ongoing (PDU session is still active). Does the allowed NSSAI need to be updated and this may also affect the data handling at the UE as explained in our response to Q3 (e.g. will the UE buffer the data, will the PDU session for the slice no longer available be released)? If the PDU session is released and available slices updated while in Area 2, how are the allowed NSSAI updated and PDU session re-established when the UE moves back to Area 1? If the PDU session is not released, what does the UE do when it has data for the intended slice – discard data at AS level?  We have listed this as Issue 5.  As on the issues identified by the rapporteur:  For **Issue 1,** While the UE may not be aware of the slices supported on different frequencies in some transient cases, whether it is an issue depends on the overall system perspective. For example, in the example scenario in Section 2.1, if the UE is entering area 1 from area 2, UE may not be immediately aware of the slice availability in another frequency. As soon as it makes a connection in area 1, it will be provided with the appropriate dedicated priority and the UE will then be aware. Also, further discussion may be needed on whether the UE will have an intended slice if the PDU session is released while the UE is outside the coverage area of the slice.  We think the clean way to address the example scenario in Section 2.1 is to use different registration areas for area 1 and 2. This will update the allowed NSSAI, PDU sessions and dedicated priorities when the UE moves between the two areas.  For **Issue 2:** This issue is not specific to Slicing. For the validity of the dedicated priorities, if it is seen as an issue, RAN2 can include longer time as well as introducing ‘infinity’ for T320. Similar signalling reduction could be considered also regarding release of dedicated priority configuration at each connection establishment. If it is considered an issue, it is not limited to slicing and we should discuss separately how big an issue it is, and whether a solution is needed.  For **Issue 3**, as mentioned in our response on Issue 1, if the PDU session for the intended slice is released while the UE is in Area 2, using different priorities in different areas on its own may not help UE access the intended slice immediately after coming back to Area 1 because the PDU session will need to be established first.  If different frequency priority configurations are required per area, different UE registration areas can be configured to those areas so that different dedicated frequency priority configurations can be provided. Hence we think that the Rel-15 dedicated priority configuration using different UE registration areas as mentioned above is a clean solution.  For **Issue 4**, taking the example scenario in Section 2.1 as example, with appropriate dedicated frequency priority configuration, the additional signalling should only happen for the first access after the UE moves between the Areas and hence the additional signalling may not be an issue. Further discussion is needed as mentioned above on whether there will be PDU session establishment signalling if UE has released the PDU session for the slice while it was in Area 2 and moves to Area 1. |
| Lenovo / Motorola Mobility | Issue 1, 2 and 4 | Issue 3 is not fully clear to us and needs further clarification. Does “different areas” refer to the same PLMN or different PLMNs (i.e. roaming scenario)? Furthermore, if it refers to the same PLMN, does it refer to different registration areas or different geographical areas within a registration area? For instance, if “different areas” refer to different registration areas, then in this case the UE would perform a NAS registration update. After successful registration update, the gNB can configure new dedicated priorities which are applicable in the new area in the RRC release message.  [CMCC comments:] Issue 3 was proposed by us. May I further clarify that, different areas refer to the cell 2 and cell 4 in the figure 5.1.1-1. Cell 2 & 4 can be configured with the same PLMN and within the same TA. So there is no TAU or RAU when UE is moving from cell 2 to cell 4. But within the same TA, as we explained in our above comments, there is the case that UE needs different frequency priority in cell 2 & 4. |
| Convida Wireless | All |  |
| vivo | All |  |
| LGE | All | However, the scope should not be conflict with SA2. |
| ZTE | All |  |
| SoftBank | All |  |
| Fujitsu | All | The scope of this SID is “enable UE fast access to the cell supporting the intended slice”. All issues listed above are potential problematic cases for the UE to enable fast access to the intended slice.  **For newly added Intention 5**, it is unclear whether it is talking about IDLE/INACTIVE mode or CONNECTED mode. RAN3 is discussing this case and the scenario is captured in the TR according to R3-205783. Therefore, it is too early to make the conclusion that UE behavior would be unspecified. |
| ITRI | All |  |
| Spreadtrum | All |  |
| KDDI | All |  |
| Samsung | Issue 2, 4 | If all cells in the same TA support the same slice, then 1 and 3 seems no issue.  Regarding issue 2, we think that this is not that critical. Regarding issue 4, this is inevitable if UE is in coverage of cell that does not support the intended slice but it is a tradeoff with cell reselection rule whether to select non best cell for slice. |
| T-Mobile USA | All | We agreed all, specific for issue 3 & 4. Issue 3, operator-defined access category is needed for specific slices in FR1.  In issue 4, It is ok to handover to the target cell that can support requested slice type (SST) as long as user plan meet SLA |
| Sharp | All | Including Issue 5. |

Summary for Q4:

21 companies (Qualcomm, CMCC, CATT, Huawei, Vodafone, Ericsson, OPPO, Nokia, Google, Intel, Convida, vivo, LGE, ZTE, SoftBank, Fujitsu, ITRI, Spreadtrum, KDDI, T-Mobile USA, Sharp) support all of the issues 1~4.

Lenovo support issue 1,2,4

Samsung support issue 2, 4

Intel also proposed issue 5, Sharp support issue 5.

Majority companies support issue 1~4. And issue 5 is supported by 2 companies. Rapporteur suggest that we try to agree on issue 1~4. And we can come back to issue 5 if there is more support or candidate solution is identified.

**[cat a] Proposal 5.1: These issues will 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 plane latency for the UE to access the network.**

**[cat b] Proposal 5.2: Issue 5 is FFS.**

* **Issue 5: If the intended slice is no longer available (e.g. UE moves from Area 1 to 2, or UE switches to a cell not supporting Slice 2), the UE behaviour needs further study when it has data for the intended slice while Slice 2 is initiated and ongoing (PDU session is still active).**

***[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?**

|  |  |
| --- | --- |
| **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. |
| Nokia | As issue 2 and 3 show, Rel-15 dedicated priority signaling is not a full solution. RAN2 should investigate whether Rel-15 mechanism can be enhanced to solve those issues. |
| 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. |
| Intel | We think the Rel-15 mechanisms should be able to solve the “issues” described previously  As discussed in our response to previous question, we think the clean way to address all “issues”, including the new Issue 5 and how UE handles data for a slice that is not available, is to use different registration areas and to update the dedicated priority appropriately. With this, the UE will always be aware of the slices supported and will camp on the optimal frequency and none of the “issues” mentioned above will arise. This approach also addresses the new issue on how the PDU Session will be established when the UE moves to Area 1 if it was released while it was previously in Area 2. This approach also addresses all the data handling at the UE (e.g. whether UE buffer the data when moving from Area 1 to Area 2 in the example scenario and also updating allowed NSSAI and dedicated frequency priority configuration when moving from Area 2 to Area 1). |
| Lenovo / Motorola Mobility | The R15 dedicated priority mechanism relies on the assumption that the slices included in Allowed NSSAI are available anywhere (i.e. in any cell) within the UE’s Registration Area. With this assumption the gNB can configure the dedicated priorities to a UE according to the load situation of the cells/slices on the different frequencies.  However, in R17 when slices can be configured specifically to a frequency band, then the R15 dedicated priority mechanism cannot work properly as now slice-specific frequency information need to be taken into account by gNB for configuring the dedicated priorities to a UE. The same applies for the R15 broadcast common priorities.  Furthermore, dedicated priorities may not work because there’s no predictability of which application (slice) will trigger RRC connection. So, network may prioritize a frequency-A for Slice-A but rather Slice-B on frequency-B triggers RRC connection. Therefore, we need a new mechanism so that no matter where the UE is currently camped on, it can quickly reselect to the frequency of the concerned slice when required. |
| Convida Wireless | No. Agree with the views expressed by the other companies above who indicated No. |
| vivo | No,  Agree with Qualcomm and Huawei |
| LGE | No. Agree with the other companies’ comments. |
| ZTE | No.  **Issue 3** cannot be achieved by the existing R15 mechanisms as the reselection priority is either cell specific or UE specific and has no clear relationship with the slices.  Take the deployment in figure 5.1.1-1 as an example and assume that slice 1 is eMBB while slice 2 is URLLC.    As shown in the above figure, in area 1 the operator expect UE access for eMBB to camp on cell2 with first priority and cell1 with second priority while UE access for URLLC to camp on cell1 with first priority.  If we follow R15 mechanism and have the following configuration for the TA:  Cell 1: TA 1 Cell 2: TA 2 Cell 3, Cell 4: TA 3   |  |  |  |  | | --- | --- | --- | --- | | Registration area configuration | UE access for URLLC | UE access for eMBB | Results | | RA config#1 | TA1  (Allowed slice: URLLC) | TA1+TA2  (Allowed slice: eMBB) | For the broadcast reselection priority:  if F2<F1, UE access for URLLC may reselect to cell2 and get rejected when performing registration update.  If F2>F1, UE access for eMBB and UE access for URLLC will pour into cell1, making cell1 congested and causing negative impact on the user experience of UE access for URLLC. | | RA config#1 | TA1  (Allowed slice: URLLC) | TA2  (Allowed slice: eMBB) | For the broadcast reselection priority:  if F2<F1, UE access for URLLC may reselect to cell2 and get rejected when performing registration update.  if F2>F1, UE access for eMBB may reselect to cell2 and get rejected when performing registration update. |   Based on the analysis in the above table, we can see that UE is not able to (re)select to the cell or frequency supporting the intended slice at the first step (as mentioned in **issue 1**) and then HO, release with redirect and release with dedicated priority is needed, causing additional signaling overhead as well as latency (as mentioned in **issue 4**). UE may face the same situation afterwards as the HO or release with redirect is somehow a one shot solution while the dedicated priority has validity time (as mentioned in **issue 2**). |
| SoftBank | No. Agree with the comments above. |
| Fujitsu | The occurrence of the issues indicated in previous question Q4 implies that the R15 mechanism may not be enough. |
| ITRI | No. |
| Spreadtrum | No, Agree with the other companies’ comments. |
| KDDI | No, agree majorities’ comments above. |
| Samsung | It depends on whether this study will consider a scenario that all cells in the same TA do not have to support the same slice. |
| Sharp | No. Agree on the majority of the comments above. |

Summary for Q5:

18 companies (Qualcomm, CMCC, CATT, Huawei, Vodafone, OPPO, Google, Lenovo, Convida, vivo, LGE, ZTE，SoftBank, Fujitsu, ITRI, Spreadtrum, KDDI, Sharp) think that R15 mechanism cannot solve the above issues 1~4.

(Nokia) comments that issue 2&3 cannot be fully solved by R15 mechanism.

(Ericsson, Google) comments that with appropriate TA/RA configuration, the issues can be solve by R15 mechanisms.

In summary, majority companies think that R15 mechanism cannot solve issue 1~4, and RAN2 need to study the solutions to address them.

**[Cat a] Proposal 6: R15 mechanism (e.g. dedicated priority mechanism) cannot solve the above issues, and RAN2 will study the solutions to address the issues 1~4.**

### 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.

**Solution 5:** Rel-15 mechanisms such as HO, CA, DC and redirection can be used to access the intended slice in different cell

**Solution 6:** Area 1 and Area 2 are in different UE registration areas

…

**[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.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Which ones?** | **Comments** |
| Fujitsu | TBD | Fujitsu would ask to discuss details of each solution before agreeing to capture solutions to the TR. |
| Qualcomm | Solution 1, 2, 5 | Solution 1:   * It is legacy solution and we are fine to include it in TR to at least show the intention why enhancement is needed in Rel-17 RAN slicing SI   Solution 2:   * It is intended to resolve issue 1. The solution is straight forward and should have least impact on spec, i.e. including Slice ID in SIB (S-NSSAI or only SST if payload size in SIB is a concern). Thus, we support it and think it can be included in RAN2 TR   Solution 3:   * We are not sure whether it is really needed if solution 2 is agreed, i.e. solution 3 can be regarded as one enhancement of Solution 2. * Its payload size in SIB may be an issue   Solution 4:   * We understand SA2 is studying this solution (i.e. solution #30 in SA2 TR 23.700-40). Then, we think RAN2 need to do nothing until SA2 ask RAN specific question/impact, to at least avoid misalignment between SA2 and RAN2. So, we don’t think RAN2 needs to capture it in RAN2 TR for now.   Solution 5:   * At least for below scenario (i.e. the UE allowed S-NSSAI includes both slice 1 and slice 2. However, slice1 is not available in cell 5 and slice 2 is not available in cell 6), HO/CA/Redirection based solution is needed when the UE is in CONNECTED state:   + Case 1: DC/CA is available and thereby both Slice 1 and Slice 2 can be available and active at the same time via DC/CA.   + Case 2: DC/CA is not available. So, Slice 1 and Slice 2 cannot be active at the same time. Then HO/redirection is required when intended slice is not available in current cell. And we think RAN2 can discuss the handling of PDU session of one slice when UE is on frequency of other slice.   Please note that CONNECTED solution was agreed to be included in scoping in last RAN2 meeting.    Solution 6:   * We think it is out of RAN2’s expertise. We suggest to wait SA2 progress. |
| RadiSys | Solution 1, 2, 3 and 5 | Solution 1: Dedicated frequency priorities in RRC Release should be mapped under prioritized slices. In RRC Release there shall be a list of prioritized Slices. Each of the Slice shall contain prioritized frequencies.  Solution 2: This is needed for UE to perform MO services based on Requested Slice. FFS needed on SIB1 size  Solution 3: Cell Reselection priority should be provided in the RRC Release message to help the network manage the cell capacity for a particular slice for IDLE mode mobility  Solution 5: legacy Procedure, can be used as a fallback mechanism |
| Nokia | 1, 3, 5  2 and 4 are only acceptable with comments  6 is unclear  Other Solution | These are not solutions, just solution approaches. It depends on the solution details which ones are acceptable for us.  **Solution 1 and 5:** Legacy methods, these are the only solutions for pre-Rel-17 UEs. It should be highlighted when they are not good enough  **Solution 3:** Studying this type of solution is OK, but SIB size limitation should be considered.  **Solution 2:** This should be split to selection and reselection   * Selection: Serious concerns how slice specific information can fit in SIB1. * Reselection: Similar to solution 3, this type of solutions should be studied.   **Solution 4:** This should be split to two cases:   * Selection and NAS triggered reselection (e.g. due to changes in intended slices): This type of solutions should be considered. * Normal (AS triggered) reselection: using these parameters can conflict/interfere with RAN provided reselection parameters. As only RAN knows the current deployment, load etc. situation, using UE configuration parameters for normal cell reselection may cause very bad user experience. Instead of this dedicated signaling or Solution 2 or 3 should be used for normal cell reselection.   **Solution 6:** Unclear what the solution approach is.  **Other Solution:** Another approach could be that CAGs are assigned to slices, and NAS provides the allowed CAG list according to the intended slices. In this way it is assured that a UE (re)selects a cell that supports the intended slices. |
| BT | Solutions 1, 2, 3, 5 | Solution 1:  It seems reasonable to include legacy procedures as the starting point.  Solution 2:  Required to solve issue 1 and should be included in the TR.  Solution 3:  It is our understanding this solution tries to solve issue 3 but with current text, this is not clear. We propose the following update.  Solution 3: Cell reselection priority per slice should be provided in the system information or RRCRelease message, i.e., frequency prioritization per cell.  Solution 4:  Wait for SA2 to avoid misalignments.  Until SA2 provides its inputs and in order to avoid more discussion on this topic, we may add a note to make clear this is considered but we’re waiting for SA2 inputs.  Solution 5:  Rel-15 mechanisms aren’t enough to ensure to access to intended slice but they can be use as backup. |
| Convida Wireless | 1, 2, 3, 4, 5 | Solution 1: We agree to include this solution in the TR, but in our view, it is not sufficient to address the issues discussed in Q4.  Solution 2: We agree to include this solution in the TR. The details of how to provide the slice information can be discussed further.  Solution 3: We agree to include this solution in the TR. However, we view this as an enhancement of Solution 2.  Solution 4: We think solutions where preferred slice info provided by NAS is used to influence cell (re-)selection decisions should be included in the TR.  Solution 5: May need to consult with SA2 to ensure this solution doesn’t violate any architecture principle as it relates to network slicing, for example, network slice isolation for CP and UP.  Solution 6: Solutions based on performing Registration Updates are outside RAN2 scope and should be left to SA2. |
| Google | 1,2,4,5 | Solution 1 and 5 are legacy solutions that should be available in any case.  Solution 2 and Solution 4 are needed so that UEs can use their intended slices to camp on the appropriate cells (solving issue #1).  We are open to considering slice specific cell (re)-selection mechanisms but solution 3 as stated may be bit of an overkill. |
| vivo | 1,2,3,4,5 | Solution 1 to 5 can be captured in the TR and further down prioritization can be considered later. For solution 6, we think it is not fully in RAN2 scope. So we would prefer not to capture it this TR. |
| CMCC | 1,2,3,5 | Solution 1: In Q5, majority companies agree that legacy dedicated priority cannot solve the issues listed in Q4. We think that can be pointed out in the TR.  Solution 2: We agree to include this solution in the TR.  Solution 3: Solution 3 can address the issue 3 in Q4, so we support to capture solution 3 into the TR. If SIB size is a concern, SST can be used instead of S-NSSAI.  Solution 4: The details for this solution are not clear in the contributions in last meeting. So, this approach may need some further clarification and discussion.  Solution 5: Slice based HO and redirection are the legacy behaviours that can be supported by R15 by network implementation. But we are not sure with CA, DC. We are ok to study solution 5 but with a lower priority as agreed in last meeting.  Solution 6: We agree with companies’ view that it should be left to SA2. |
| Intel | Solution 1 and 6 if separate TA is used for Area 1 and 2  Solution 5 is needed for accessing intended slice that is not available in the UE’s camped cell    Need for Solution 2 is FFS depending on the resolution of issue 5 if the same TA is used for Area 1 and 2 | As explained in our response to Q5 if separate TA is used for the 2 areas, we think the Rel-15 mechanisms (dedicated priority and Area 1 and 2 are in different UE registration area) should be able to sufficiently solve the proposed “issues” including issue 5.      Solution 5 addresses the issue when UE is not camping on the frequency layer of the intended slice.  Depending on discussion on issue 5.  If Area 1 and 2 are in the same TA, Solution 2 may be needed in order for the UE to know that its attended slice (e.g. Slice 2) is available when it moves back to Area 1 (while previously it moves out of Area 1 to Area 2 and Slice 2 is “released”) such that UE can attempt to ”reestablish” Slice 2 in Area 1 |
| Vodafone 1 | Solutions 1, 2 and 3 | These 3 cases relate to practical scenarios |
| Fujitsu | Solutions 1, 2, 3, 5 | Solutions 1 and 5: Legacy mechanism should be always available.  Solution 2: It is straightforward solution and to be captured in TR.  Solution 3: The priority setting for reselection is up to implementation but priority is needed for slice-based reselection. |
| CATT | 1,2,3,4,5 | In this stage, we’re open to capture solution1 to 5 with some clarification.  For solution 2, we still have security concern for broadcasting supported slices on the air, so to have more flexibility for WI to study, we’d like to revise solution 2 as below:  Solution 2: Slice related cell (re)selection info, the slice info of serving cell and neighboring cells should be provided in the system information/RRCRelease message. FFS: whether full slice ID is broadcast or not.  For Solution 4, the intended slice info may be request NSSAI/Allowed NSSAI/configured NSSAI, in the current spec, these slice info is not available at UE AS, so UE AS may get request NSSAI/Allowed NSSAI/configured NSSAI from NAS or from RRCRelease message. |
| Futurewei | 1,2,3,5 | Solutions 1 & 5 are existing mechanisms that can be used for slice-based cell (re)selection and connection.  Solutions 2 & 3 seem to be straightforward enhancements for slice-based cell (re)selection.  Solutions 4 & 6 would be more suitable for SA2 to study. |
| OPPO | Solution 1,2,3,4,5 | Solution 1:   * It is a baseline mechanism, which can be used for some ideal cases, e.g. the gNB knows the UE intended slice. But, it is clear that solution1 cannot resolve the issues in Q4 at all times.   Solution 2:   * Solution 2 is tended to resolve issue 1, and it can avoid introducing issue 4 to some extent. It is helpful for UE to select a proper cell in cell selection/reselection if the slice related info is indicated by the gNB. * In addition, we wonder the meaning of “slice related cell (re)selection info”, does it mean slice-based cell selection/reselection parameters?   Solution 3:   * Solution 3 can be a supplementary to Solution 2. * In addition, frequency priority per slice indicated in RRCrelease is an enhancement to Solution 1.   Solution 4:   * Solution 4 reflects the UE behavior when UE performing cell selection/reselection. UE performs cell selection/reselection to the cell with intended slice and satisfied cell quality. If UE finds its intended slice is not supported in the candidate cell, it will continue cell selection/reselection procedure.   Solution 5:   * It is legacy mechanism, and it seems no UE impact is required. * The study on Solution 5 is with a lower priority according to the latest agreement.   Solution 6:   * It is out of RAN2 scope, let’s wait for SA2 progress. |
| Lenovo / Motorola Mobility | 1, 3 (partly), 4, 5, 6 | Solution 1, 5: can be considered as fallback solutions although they are not ideal for the scenarios we consider in this study.  Solution 2, 3: due to security issues we have concerns to disclose slice information in cleartext in System Information. However, providing slice information in ciphered RRCRelease would be acceptable to us.  Solution 4: we understood that this solution may go in the direction of UE assistance information provisioning what looks acceptable to us.  Solution 6: depends on SA2 decision whether to stick with homogeneous slice support in Rel-17 or not. However, we understood that in the RAN study we are considering slice deployment scenarios deviating from the Rel-15/16 homogeneous slice principle. And configuration of Tracking Areas (as part of registration areas) is in RAN scope. |
| Huawei, HiSilicon | 1, 2, 3, 5 | For solution 2, the slice info of serving cell in SIB is to address the slice related cell selection, and the slice info of neighboring cells in SIB is to address the slice related cell reselection.  For solution 3, we think it is an enhancement or alternative of the mechanism to solve the slice related cell reselection of solution 2. And it can solve the **Issue 3** listed above.  For solution 4, it is not clear about the intention of UE preferred slice info, and it will complicate the discussions, so we suggest to not consider it for now.  For solution 6, it is out of the RAN2 scope. At RAN2#111-e meeting, there was the following agreement:   * **TA discussion will not take place in RAN2, we will wait for SA2 input** |
| ZTE | 1,2,3,5 | * The R15 mechanism such as dedicated reselection priority or redirection via RRCRelease, HO, CA and DC can be used to help UE get access to the intended slice.   => Solution 1 and solution 5 has already been supported but more latency is required before successful access to the intended slice.   * Solution 2 and solution 3 are effective enhancements to help achieve fast access to the intended slice.   For solution 2, UE awareness of the supported slice info of the camping cell and neighbor cell would be helpful for UE to make cell (re)selection decision and fasten the reselection procedure. Based on companies’ feedback to Q7 and Q8, the supported slice information of the camping cell would be aware to UE if slice specific RACH resources and prioritization is configured.  Solution 3 addresses issue 3, making it possible for network to perform load balance among cells with the slice info taken into consideration and would also help fasten the cell reselection procedure for UE.  In addition, considering that there has been some security concern from SA3 on exposing the NSSAI/S-NSSAI (or parts of it) in system information in R15 discussion (R2-1703762\_S3-170902 Reply LS on privacy of registration and slice selection information), implicit indication of the supported slice info or slice specific reselection priority in system information should be considered if such security concern still exists.   * Solution 4 is under SA2 discussion and we agree with Qualcomm that we need to wait for SA2 progress to avoid parallel discussion in SA2 and RAN2. * For solution 6, registration area allocation is within the working scope of SA2/CT1 and we would prefer not to capture it in RAN2 TR. |
| ITRI | 1,2,3,4,5 | Solution 1: It is legacy mechanism and may be feasible in some deployment scenarios.  Solutions 2 & 3 & 4: “UE preferred slice info” (solution 4) is necessary to perform slice based cell selection and reselection based on the “slice related cell (re)selection info” (solution 2) or “Cell reselection priority per slice” (solution 3). However as described by CATT it is not available at UE AS.  Solution 5: Connected mode will be considered but with a lower priority.  Solution 6: Out of RAN2 scope. |
| NEC | Solutions 1, 2, 3, 5 | Solutions 2 and 3: This seems like a natural enhancement for RAN Slicing cell (re)selection and should be included in the TR, further discussion and solutions regarding SIB size should be studied as well during the SI.  Solution 4: We prefer to down-prioritize Solution 4 for now  Solution 6: as other companies pointed out, it is likely out of RAN2 scope |
| Spreadtrum | 1,2,5 | Solution1: Solution 1 is the legacy mechanism, though it cannot solve all the challenges that arise with slice, it is still effective in some cases.  Solution2: It seems like a straightforward and acceptable method with which Idle/Inactive UE could know the slice info deployed in RAN side. Then UE could execute slice based cell reselection when dedicated frequency priority is invalid. To prevent the oversize of system information, the slice info could be represent by smaller info, like SST. And for consideration of security, the detail of slice info could be expressed implicitly.  Solution3: We think if the cell reselection priority per slice is one kind of slice related cell reselection info mentioned in solution 2, then there is no need to discuss “Cell reselection priority per slice should be provided in the system information”when the solution2 is agreed.  As for the latter sentence of solution 3, we think it still cannot solve the issues when UE in new area where the deployment of slice is different from the source area and dedicated signaling timer is still not expired.  Solution4: The details for this solution are not clear for now. We suggest to discuss it later when it is clear.  Solution5: It has been supported in legacy system.  Solution6: Wait for SA2 output. |
| Ericsson | 1,2,3,5,6 | In our response to Q5 we clarified our understanding that existing rel-15 mechanisms (**Solutions 1, 5, 6**) with proper RA configuration (by mistake we used TA1, TA2 TA3 in the Q5 response) provide a working solution at the cost of some extra signaling. So this is the clear baseline, since those mechanisms support also rel-15/16 UEs.  From this baseline, RAN2 could study further mechanisms to optimize signaling.   1. **Solution 2** would provide information to guide the UE to access the frequency/cell of the intended slice without network interaction in the serving/camped cell. We are ok to study solutions that avoid excessive SI size, as well as the security concern. Gain in delay need to be evaluated. 2. On providing Cell reselection priority per slice in the system information (first part of **Solution 3**), we agree with other companies that this can be considered as same Solution 2. 3. Cell reselection priority per slice in RRCRelease message (second part of **Solution 3**), we consider rather as providing slice-specific cell re-selection information to UE, i.e. an alternative to Solution 2.   For **solution 4**, the description is not clear to us.  It can be argued that the “TA discussion” should be solved by SA2. Still, we would like to comment here that deviating from Rel-15/16 principles would mean that the network operator will have to manage slice-to-cell mappings differently for legacy (Rel-15/16 UEs) and new UEs. |
| Sharp | 1, 2, 3, 5 | Solution 1: Legacy solution that is always available, but it may not solve issue #4. Furthermore, it will not be sufficient if there are multiple intended slices with different frequency priorities.  Solution 2: We are not sure if broadcasting slice information involves security issues. This may need to consult with SA3.  Solution 3: As mentioned by OPPO, this is supplementary to Solution 2, an enhancement of Solution 1.  Solution 4: Wait for SA2 input.  Solution 5: Always available.  Solution 6: Out of RAN2 scope. |
| SoftBank | 1,2,3,4,5 | But it should be highlighted that legacy solutions (1 and 5) are not enough to resolve the issues in this SI.  For solution 6, we agree that it is out of RAN2 scope and should wait for input from SA2. |
| LGE | 1, 2, 3, 4, 6 with comments | We assume that Solution 1 requires enhancements on legacy dedicated priority, and the enhancements are up to SA2.  We are fine with Solution 2 and 3 if SA2/SA3 doesn’t have concerns with broadcasting slice information.  Solution 6 scenario should be confirmed with SA2 for further discussion in RAN2. |
| Samsung | 1, 5  2/3 with comment | Solution 1 and 5: we are fine to consider legacy mechanism.  Solution 2/3: we have the similar concern with some companies above to transmit slice info in unsecure manner. So we may consider to use RRCRelease message.  Solution 4 and 6: we prefer to wait for SA2 progress. |
| KDDI | 2,3,4 | Solution 1 & 5  We are not motivated to capture something with regard to the existing mechanisms. We believe we should focus on the solutions not standardized yet.  Solution 2  It should be captured in TR. UE recognizing slice capabilities of Network sides is needed not only for its sell selection/reselection. But, we should be careful about the SIB size increased by the slice info. If the SIB size becomes too large, it would affect the coverage.  Solution 3  It should be captured in TR. But, “priority per slice” is not clear, so we need further discussion to clarify this. May be “priority per slice” indicates how the UE reconfigure the priority of the cell which supports the intended slice, but we need further discussion for the details.  Solution 4  Need further discussion. It may be beneficial for UE to be provided additional information for selection criteria. For example   * a UE has two intended slices, slice 1 and slice 2 * cell1 supports only slice1 and cell2 supports only slice2   In such case, the UE needs additional information to decide which cell to camp on.  Solution 6  It would be more suitable for SA2 to study. |
| Xiaomi | 1,2,3,4,5 | Solution1:  We also agree that it can be captured in the TR.  As legacy solution, it can be used by pre-Rel-17 UEs and may have further enhancement as baseline when it is not enough for Rel-17 use cases.  Solution2: It can be captured in the TR but we have following concerns:  A) whether there is a case that no cell can provide all intended slices.  B) whether different slices may have different frequency priority.  Solution3  Considering B) mentioned in solution2, we think solution3 and can be capture in the TR as the enhancement to help UE which support different slices to get suitable and specific frequency priority used in cell selection/reselection.  Solution4:  As SA2 has mentioned in the TR23.700 solution#30, it can be considered and discussed by RAN2, and we can also wait for SA2 decision on it.  We think solution4 can also be captured in the TR and may be further discussed by RAN2.  Solution5:  As CONNECTED solution, we think it can be captured in the TR but has a lower priority.  Solution6:  Out of RAN2 scope, we can wait for SA2 progress. |
| Apple | 1, 2, 3, 4, 5 | Solution 1 is legacy scheme thus naturally can be inherited.  Whether any enhancements are needed can be discussed.  Solution 2 and 3 are for slice based cell selection and re-selection and are straightforward. We can discuss SIB size limitation based on contributions.  To our understanding, solution 4 is more related to SA2/CT1 decision but we think in order to support slice based cell selection and re-selection, solution 4 is already there since UE needs to know its intended (preferred) slice while performing cell selection/re-selection.  Part of solution 5 (HO/redirection) is already supported in legacy network. Using CA/DC scheme to support slices is captured in SA2 TR 23.700 as Solution #44. Thus we think they should be feasible in terms of NW implementation.  Solution 6 should be up to SA2 to decide. |

Summary for Q6 on candidate solutions for slice based cell (re)selection:

29 companies shared comments for Q6.

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

Solution 1 is supported by **27** companies (Qualcomm, RadiSys, Nokia, BT, Convida, Google, vivo, CMCC, Intel, Vodafone, Fujitsu, CATT, Futurewei, OPPO, Lenovo, Huawei, ZTE, ITRI, NEC, Spreadtrum, Ericsson, Sharp, SoftBank, LGE, Samsung, Xiaomi, Apple)

Majority companies agree to capture solution 1 as legacy mechanism.

**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 2 is supported by **24** companies. (Qualcomm, RadiSys, BT, Convida, Google, vivo, CMCC, Vodafone, Fujitsu, CATT, Futurewei, OPPO, Huawei, ZTE, ITRI, NEC, Spreadtrum, Ericsson, Sharp, SoftBank, LGE, KDDI, Xiaomi, Apple)

CATT propose to revise Solution 2: Slice related cell (re)selection info, the slice info of serving cell and neighboring cells should be provided in the system information/RRCRelease message. FFS: whether full slice ID is broadcast or not.

**Solution 3**: Cell reselection priority per slice should be provided in the system information or RRCRelease message. Solution 3 is supported by **23** companies. (RadiSys, Nokia, BT, Convida, vivo, CMCC, Vodafone, Fujitsu, CATT, Futurewei, OPPO, Lenovo, Huawei, ZTE, ITRI, NEC, Ericsson, Sharp, SoftBank, LGE, KDDI, Xiaomi, Apple)

**4** companies (CATT, Lenovo, ZTE, Samsung) concern about disclose slice information in cleartext in System Information. KDDI comments that we should be careful about the SIB size increased by the slice info. If the SIB size becomes too large, it would affect the coverage.

**3** companies (Qualcomm, Convida, vivo) see Solution 3 is an enhancement for Solution 2.

Since majority companies are supportive for solution 2 & 3, rapporteur propose to capture both of them in the TR and we will further study the details to address companies’ concerns.

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

Solution 4 is supported by **12** companies. (Convida, Google, vivo, CATT, OPPO, Lenovo, ITRI, SoftBank, LGE, KDDI, Xiaomi, Apple)

**7** companies comment that Solution 4 should be more suitable for SA2 to study, and should be down-prioritized by RAN2 (Qualcomm, CMCC, Futurewei, ZTE, NEC, Spreadtrum, Sharp).

Xiaomi suggest to modify the solution 4 as: UE preferred slice info (e.g. TR23.700 solution#30) can be considered for slice-based cell reselection design.

Rapporteur suggest that we keep solution 4 open and can be further discussed based on contributions.

**Solution 5**: Rel-15 mechanisms such as HO, CA, DC and redirection can be used to access the intended slice in different cell.

Solution 5 is supported by **25** companies. (Qualcomm, RadiSys, Nokia, BT, Convida, Google, vivo, CMCC, Intel, Fujitsu, CATT, Futurewei, OPPO, Lenovo, Huawei, ZTE, ITRI, NEC, Spreadtrum, Ericsson, Sharp, SoftBank, Samsung, Xiaomi, Apple)

Majority companies see solution 5 as legacy mechanism, so rapporteur suggest to capture solution 5 in the TR.

**Solution 6**: Area 1 and Area 2 are in different UE registration areas.

Solution 6 is supported by **4** companies. (Intel, Lenovo, Ericsson, LGE)

**13** companies comment that Solution 6 should be left to SA2. (Qualcomm, Convida, CMCC, Futurewei, OPPO, Huawei, ZTE, NEC, Spreadtrum, Sharp, SoftBank, Xiaomi, Apple)

Since majority companies prefer to left solution 6 to SA2, rapporteur suggest we don’t discuss solution 6 in RAN2 for now.

Nokia also proposed a CAG based approach that CAGs are assigned to slices, and NAS provides the allowed CAG list according to the intended slices. But since this approach was provided in the later stage, no companies share view on that.

**[cat a] Proposal 7: The following solution approaches are captured in the TR and will be studied in this SI:**

* **Solution 1**: Legacy dedicated priority via *RRCRelease* message.
* **Solution 2**: Slice related cell selection info, the slice info of serving cell and neighboring cells is provided in the system information or *RRCRelease* message. FFS: what information is broadcast.
* **Solution 3**: Slice related cell reselection info (e.g. Cell reselection priority per slice), the slice info of neighboring cells is provided in the system information or *RRCRelease* message. FFS: what information is broadcast.
* **Solution 5**: Rel-15 mechanisms such as HO, CA, DC and redirection can be used to access the intended slice in different cell

**[cat a] Proposal 8: Keep solution 4 open and can be further discussed based on contributions.**

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

**[cat c] Proposal 9: Postpone Solution 6.**

* **Solution 6**: Area 1 and Area 2 are in different UE registration areas

## 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.**

|  |  |  |
| --- | --- | --- |
| **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. |
| Nokia |  | These are the solutions, but before discussing them the requirements should be clarified. The main question is whether the RA resources are really so problematic that we should allocate RA resources for slices. After that RAN2 should check whether there are legacy mechanisms that can solve the issue and what enhancements new solutions are needed.  Comment on I3: this can work without any real specification change. What is the use-case that cannot work using this?  Consider also that slice-based cell (re)selection results in that mainly the UEs that are intending to use the slices available in the cell are camping in the cell. If only the right UEs are in a cell, then RA enhancements may not be important anymore, as most of the UEs in a cell will belong to the same slices. |
| Google | All |  |
| Intel | Intention 2 | In our view, the intentions of having slice-based RACH are as follow:   1. To allow network to be able to identify and differentiate between the different slices (e.g. RACH partitioning, RACH resource partitioning allowing to identify the slices) and being able to perform network based access control based on the identification of the slice. 2. To provide resource isolation between the slices 3. To prioritise the different slices in terms of RACH resources (not dedicated partitioning for identifying the slices) and RACH parameters.     For (i), we do not see the need to introduce another access control mechanism for slices. UAC based on access category is sufficient to provide access control also for slice, since each slice is categorized with an access category. For Connection setup and resumption, we think the cause values in ConnectionReq and ResumeReq could be considered sufficient for the network to perform congestion control and perform the rejection if needed.  For (ii), this may reduce system capacity and waste precious RACH resource if no occurrence arises. Hence we prefer not to have this unless there is market need for such resource isolation.  For (iii), this is currently not possible in idle/inactive mode except for MPS and MCS which allows RACH parameters differentiation. This can be investigated further to extend RACH prioritization to slice. |
| Lenovo / Motorola Mobility | None | The RA resource isolation was discussed in R15 and not agreed in order to support large number of slices (e.g. hundreds of slices) in a network. And RA resource isolation as such is not trivial as number of resources (#preambles, #PRACH occasions in time and frequency) is dependent on FR1/FR2, and it may impact legacy R15/16 UEs what we would like to avoid.  Furthermore, disclosing slice information in cleartext per broadcast may result in security issues.  In general, we think that in case of a congested cell the UAC (by using operator-defined Access Categories and setting the associated barring info) is the much better tool to control RACH load to a specific slice. In a non-congested cell there is no issue if the RA resources are shared by all slices.  On Slice access prioritization (“Intention 2”): It might be good to have some more description to better understand the intention. Where does the slice access prioritization come from? Is it set by UE or network? If it is set by UE individually, how does network know to partition RA resources properly? |
| Convida Wireless | All |  |
| vivo | **Intention 1 and Intention 2** | For Intention 3, we think we need more discussion. At least we have to first consider impact on Rel-15 current UAC mechanism. RA resource isolation should also be considered. And avoid unnecessary complication. |
| LGE | Intention 2. | I1. The gain of resource isolation, e.g., RAP division, RA resource division, is not clear because the collision probability within the isolated resource would be increased. It should be noted that similar discussion has already been there from NR beginning, e.g., for URLLC, but resource isolation was not introduced.  I2. HO and BFR are prioritized in RA by using high priority of power ramping step and scaling the BI. Similar approach can be considered for prioritizing a specific slice in RA.  I3. UAC is sufficient. |
| ZTE | All | We see value in RACH resource isolation for different slices so that specialization and individuation service can be provided.  For intention 3, we understand that since some access categories can be linked to specific slices, the RACH resources can be associated with these categories and thus can be implicitly linked to the slices. NW would be aware of the access category and the associated slice and then decide whether to send RAR or not. |
| SoftBank | Intention 1 and 2 | For intention 3, we don’t have strong views. It seems to need more discussion e.g. for benefits. |
| Fujitsu | Intentions 1 and 2 | We are not sure the use cases of access control of MSG1 and MSGA. Fujitsu needs some clarification about Intention 3 from perspective of use cases and the issues. |
| ITRI | Intention 2 | We think slice-based RACH parameters (e.g., power ramping step, backoff time, etc.) is useful and enough to prioritize a slice during the RA procedure. We do not see the need to introduce slice-based RACH resources, especially considering that it may cause fragments of RACH resources. |
| Spreadtrum | Intention 1 and Intention 2 | We think intention 3 is not needed, because the benefit is not clear and extra complexity and signallling overhead will be introduced. |
| KDDI | Intention 1 and 2 | Share the view with Qualcomm. |
| Samsung | Intention 1 and 2 | Regarding intention 3, separate RA resources may not be a simpler way due to the limitation of RA resources and complexity to monitor multiple different RA resources. |
| T-Mobile USA | Intention 1 and 2 | We agreed intention 1&2 to have RACH access based on service type if slice supports different type of SST in same band |
| Sharp |  | We do not have a strong opinion but have some sympathy to Lenovo. |

Summary for Q7:

24 companies shared comments for Q7

18 companies support Intention 1: Qualcomm, CMCC, CATT, Huawei, Vodafone, Xiaomi, Ericsson, OPPO, Google, Convida, vivo, ZTE, SoftBank, Fujitsu, Spreadtrum, KDDI, Samsung, T-Mobile

21 companies support Intention 2: Qualcomm, CMCC, CATT, Huawei, Vodafone, Xiaomi, Ericsson, OPPO, Google, Intel, Convida, vivo, LGE, ZTE, SoftBank, Fujitsu, ITRI, Spreadtrum, KDDI, Samsung, T-Mobile

9 companies support Intention 3: CMCC, CATT, Huawei, Vodafone, Ericsson, OPPO, Google, Convida, ZTE

Rapporteur suggest we agree with intention 1&2.

**[cat a] Proposal 10: The intentions and use cases for slice-based RACH configuration are as follows:**

* **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.**

### 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.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Which ones?** | **Comments** |
| Fujitsu | TBD | Fujitsu would ask to discuss details of each solution before agreeing to capture solutions to the TR. |
| Qualcomm | Solution 2 is preferred | As we mentioned in Q7, RACH resource partitioning (Solution 1) may cause fragmentation of RACH resource, especially when the number of slices supported by one cell is large. The fragmentation will worse the usage of valuable RACH resource. Thus, we think it may be difficulty to deploy such feature.  Instead, we think RACH parameter prioritization (Solution 2) is a more practical solution because it will not result in fragmentation of RACH resource. In addition, RAN2 has specified RACH prioritization for MPS and MCS in NR Rel-16 TEI. It is quite similar and straight forward to extend it to slice based RACH parameter prioritization. Thus, we prefer to Solution 2. |
| RadiSys | Solution 2 | Agree with Qualcomm. Fragmentation of RACH resources is not preferred. |
| Nokia | Both | These are not solutions, just solution approaches. We think that both type of solution approaches should be studied. It depends on the solution details which ones are acceptable for us.  In principle we should avoid any changes in the basic RA procedure, only fine tuning of the parameters and procedure is possible. We also think that existing methods specified for RA prioritization should be re-used if possible.  To avoid resource fragmentation due to separate RACH resource pools and too many parameters to be sent to UEs for prioritization, the use of group of slices is needed with both solution approaches. |
| BT | Both but solution 1 needs further study | As QC mention, RACH resource partitioning may cause fragmentation but under certain limits, it might be beneficial for a few critical slices. A hybrid solution might result in the most flexible an efficient way to do it.  An operator without specific slices won’t implement solution 1 but when that is required, i.e., a subset of UEs in a medical ambulance that requires an ultra-reliable connection completely isolated, the tool should be there. |
| Convida Wireless | 1 and 2 | We think both solutions should be studied. We sympathize with the view that Solution 1 may cause fragmentation of the RACH resources. However, such a solution may be necessary to meet the RA resource isolation requirements for some use cases. |
| Google | 1 and 2 | Both resource partitioning and prioritization can be used for slice-specific differentiated performance. Without a proper analysis, it is hard to say which option is better and in which scenario.  We agree with Qualcomm and RadiSys that RACH resource partitioning may lead to unnecessary fragmentation. However this is an aspect that can be managed via network implementation.  We think RACH prioritization should be baseline. Note thought that RACH prioritization (Solution 2) may not be needed if RACH resource partitioning (Solution 1) is used. |
| vivo | Solution 2 | Solution 2 is simple. With regard to solution 1 additional RACH fragmentation/partitioning would be required. So Solution 2 should be preferred, first, solution 2 can be later considered for optimization. |
| CMCC | 1 and 2 | We support to study both solution 1 and 2.  For solution 1, we don’t think fragmentation is a problem, network can balance the trade-off between RACH resource fragmentation and the requirement of slice resource isolation which come from vertical customers. |
| Intel | Solution 2 | As baseline, existing RA prioritization with the configured parameters *powerRampingStepHighPriority* and *scalingFactorBI* can be supported for slices that require such RA prioritization. |
| Vodafone | Both 1 and 2 | Both solutions have their uses and they should be studied. |
| Fujitsu | 1 and 2 | Solution 1: Fragmentation of RACH resource is not problem. It is up to NW configuration/implementation.  Solution 2: It can be easily achieved by parameter adjustment by NW. Besides, RACH prioritization mechanism has been specified from NR Rel-15, similar mechanism to which could be considered. |
| CATT | Both 1 and 2 | Both options are feasible before considering the complexity and signaling overhead. So we prefer to capture both in this stage and down select one during WI phase. |
| Futurewei | Both 1 & 2 | Both approaches can be studied to be available tools at network’s disposal. Whether solution 1 would be used or not is up to network deployment, balancing the need of resource isolation and the downside of resource fragmentation. |
| OPPO | Both | Regarding Solution 1, we agree that RACH resource fragmentation will be introduced, but RACH isolation may be required in some special case.  As it is SI, we think there is no needed to excluded either of potential solutions. |
| Lenovo / Motorola Mobility | None (both solutions need further study) | We are not convinced of either solution. On the reasons see our comments to [Phase 1] Q7. |
| Huawei, HiSilicon | Both 1 and 2 | For solution 1, we share similar views as some companies that the solution could be beneficial for some cases (e.g. a few critical slices) and it provides a flexible and efficient way to do it. |
| ZTE | Both 1 and 2 | RACH resource isolation can be achieved if solution 1 is supported while solution 2 will help differentiate the random access priority of different slices. We see value in both solutions and would like to capture them in the TR.  Considering that there has been some security concern from SA3 on exposing the NSSAI/S-NSSAI (or parts of it) in system information in R15 discussion (R2-1703762\_S3-170902 Reply LS on privacy of registration and slice selection information), the association between the slice and the RACH resource or the RACH prioritization parameters should be provided in an implicit way if the security concern still exists. For example, since the operator defined access category can be linked to one or more S-NSSAI, the RACH resource or the RACH prioritization parameters can be associated with such access categories to avoid direct exposing of the NSSAI/S-NSSAI (or parts of it) in system information. |
| ITRI | Solution 2 | See our response to Q7. |
| NEC | Both | Solution 1 alone can lead to poor RA resource utilization if separated in too many slices.  Solution 2 alone on the other hand may not provide sufficient guarantee of QoS.  We prefer a combination of a limited amount of resource partitioning with additional prioritization for finer tuning. |
| Spreadtrum | Solution 2 | We prefer solution 2 because it is more practical. We share similar concerns with other companies that solution 1 will cause severe RACH resource fragmentation. |
| Ericsson | Both | Both Solution 1 and 2 need further studies to motivate introduction. |
| Sharp |  | No strong view but agree with Qualcomm with regard to the fragmentation issue. |
| SoftBank | Both | In this stage, both solutions should be studied. |
| LGE | Solution 2 | Option 2 is sufficient and we should not optimize too much. Option 1 may lead to collision probability increase within the slice, e.g., if the number of UEs using the slice cannot be predicted precisely. |
| Samsung | Solution 2 | Separate RA resource pools may not be a simpler way due to the limitation of RA resources and complexity to monitor multiple different RA resources. |
| KDDI | Both 1 & 2 | Same view as the majority above. |
| Xiaomi | Both 1 & 2 | RACH resource partitioning can ensure isolation between slices and guarantee that users with low delay and high reliability requirements can access the system without being delayed by best effort traffic.  However, for the limited RACH resource, it may be assigned to a group of slices and multiple slices may need to share the same RACH resources. In this case, dedicated RACH parameters can be configured for different slices per UE to prioritize some slices.  We think a hybrid solution with solution1 and solution2 may provide flexible and guaranteed RACH resource for slices. And the detail of both solutions can be further analyzed and discussed. |
| Apple | Both | Though we also agree with the precedent of RACH prioritization for MCS/MPS solution 2 is easier to implement, solution 1 also has its merits to provide RACH resource isolation between slices. |

Summary for Q8 on candidate solutions for slice based RACH.

29 companies shared comments for Q8.

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

Solution 1 is supported by **18** companies. (Nokia, BT, Convida, Google, CMCC, Vodafone, Fujitsu, CATT, Futurewei, OPPO, Huawei, ZTE, NEC, Ericsson, SoftBank, KDDI, Xiaomi, Apple)

**6** companies (Qualcomm, RadiSys, Spreadtrum, Sharp, LG, Samsung) concern about RACH resource fragmentation and collision probability increasing.

**13** companies (BT, Convida, Google, CMCC, Fujitsu, CATT, Futurewei, OPPO, Huawei, ZTE, KDDI, Xiaomi, Apple) think solution 1 is necessary to meet the RA resource isolation requirements for some use cases. And it is up to network configuration/implementation to balance the trade-off between RACH resource fragmentation and the requirement of slice resource isolation which come from vertical customers.

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

Solution 2 is supported by **26** companies. (Qualcomm, RadiSys, Nokia, BT, Convida, Google, vivo, CMCC, Intel, Vodafone, Fujitsu, CATT, Futurewei, OPPO, Huawei, ZTE, ITRI, NEC, Spreadtrum, Ericsson, SoftBank, LGE, Samsung, KDDI, Xiaomi, Apple)

It can be seen both solutions get strong support, rapporteur suggest we study and capture both solution at this stage. And RAN2 will take the concerns into consideration while studying.

**[cat a] Proposal 11: The following solutions will be studied and captured in the TR 38.832:**

* **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.

## 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?**

|  |  |
| --- | --- |
| **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. |
| Nokia | An operator can prioritize access for some slices in a cell without change UAC procedure in AS level with the introduction of slice based ACs. The mapping between slices and ACs is out of scope of RAN2 (SA1/SA2/CT1 scope). Therefore, our view is that slice-based UAC is feasible without AS (RAN2) impacts. |
| Google | We also believe that no enhancement to UAC is needed. |
| Intel | We do not see the need to enhance further the access control, since there are already Rel-15 UAC and the network can also reject MO call via cause values in ConnectionReq and ResumeReq during RRC Setup/Resume. |
| Lenovo / Motorola Mobility | We see no issues with R15/16 UAC and thus, no need for any enhancements. |
| Convida Wireless | No strong view on enhancing UAC. |
| vivo | We think some enhancement should be considered, for example in case MO service and the intended slice s1 on cell1 is congested, but s2 on cell2 is not, UE should not be completely barred from accessing cell1. |
| LGE | Existing UAC already slice-based access barring so we don’t see the needs to enhance UAC. |
| ZTE | 1. Since the operator defined access category can be associated with S-NSSAI, configuring UAC parameters (e.g. barring factor and timer) per slice would be possible. 2. As mentioned in Q7, since some access categories can be linked to specific slices, the RACH resources can be associated with these categories and thus can be implicitly linked to the slices. NW would be aware of the access category and the associated slice and then decide whether to send RAR or not, which can be second barring check after UAC. |
| SoftBank | If majority companies think current UAC mechanism is sufficient, we are OK to not have this. |
| Fujitsu | Fujitsu are not sure if this topic is the scope of this SID. |
| ITRI | If SD (slice differentiator) specific access barring within the same slice/service type is desired, we should consider whether the number of operator defined ACs (i.e., AC 32-63) can provide sufficient support. |
| Spreadtrum | We think current UAC mechanism is enough. |
| KDDI | Share the view with Qualcomm. |
| Samsung | It seems that the use of operator defined access category is enough. So we do not see a need of enhancement. |
| T-Mobile USA | We would like to have operator-defined access category for a specific slice. Therefore, UAC enhancement is required |
| Sharp | Currently we do not see a need to enhance UAC. |

Summary for Q9:

16 companies (Qualcomm, Vodafone, Xiaomi, Ericsson, Nokia, Google, Intel, Lenovo, LGE, ZTE, SoftBank, Fujitsu, Spreadtrum, KDDI, Samsung, Sharp) don’t see the need to enhance UAC.

5 companies (CATT, Huawei, OPPO, vivo, T-Mobile) have interest in study the slice-based enhancement for UAC.

Since majority companies don’t see the need to enhance UAC, rapporteur suggest we should first focus on the slice-based cell (re)selection and RACH issues which is interested by majority companies, and take the UAC as low priority in this SI. We may come back if there is enough time in this SI.

**[cat c] Proposal 12: Slice-based enhancement for UAC is down prioritized.**

### 5.2 Candidate solutions

Since Q9 shows that there is limited support for studying Slice-based enhancement for UAC and we will probably down prioritize UAC, Q10 is only for information.

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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Fujitsu | Before discussing solutions, Fujitsu would ask to check if this topic is the scope of this SID. |
|  |  |
|  |  |
|  |  |

## 6 Conclusion

29 companies participated this 2 phases email discussion. Here are the proposals:

**[cat b] Proposal 1: Capture the following figure in the TR, and Cell X in the figures denote group of cells.**

 

**[cat b] Proposal 2.1: In case of cell selection/reselection** **(NOT triggered by MO and/or MT), the intended slice means the allowed or requested S-NSSAI(s).**

* **For the initial registration, and requesting new S-NSSAI(s): intended slices = Requested S-NSSAI(s)**
* **For idle-mode mobility: intended slices = allowed S-NSSAI(s)**

**[cat b] Proposal 2.2: In case of cell selection/reselection and RACH (triggered by MO and/or MT), the intended slice means the S-NSSAI associated with MO / MT traffic.**

**[cat b] Proposal 3: For MO service, the intended slice is 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.**

**[cat a] Proposal 4: For MT service, UE is unaware of the intended slice in current NR spec. FFS whether UE needs to know the intended slice.**

**[cat a] Proposal 5.1: These issues will 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 plane latency for the UE to access the network.**

**[cat b] Proposal 5.2: Issue 5 is FFS.**

* **Issue 5: If the intended slice is no longer available (e.g. UE moves from Area 1 to 2, or UE switches to a cell not supporting Slice 2), the UE behaviour needs further study when it has data for the intended slice while Slice 2 is initiated and ongoing (PDU session is still active).**

**[cat a] Proposal 6: R15 mechanism (e.g. dedicated priority mechanism) cannot solve the above issues, and RAN2 will study the solutions to address the issues 1~4.**

**[cat a] Proposal 7: The following solution approaches are captured in the TR and will be studied in this SI:**

* **Solution 1: Legacy dedicated priority via *RRCRelease* message.**
* **Solution 2: Slice related cell selection info, the slice info of serving cell and neighboring cells is provided in the system information or *RRCRelease* message. FFS: what information is broadcast.**
* **Solution 3: Slice related cell reselection info (e.g. Cell reselection priority per slice), the slice info of neighboring cells is provided in the system information or *RRCRelease* message. FFS: what information is broadcast.**
* **Solution 5: Rel-15 mechanisms such as HO, CA, DC and redirection can be used to access the intended slice in different cell**

**[cat a] Proposal 8: Keep solution 4 open and can be further discussed based on contributions.**

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

**[cat c] Proposal 9: Postpone Solution 6.**

* **Solution 6: Area 1 and Area 2 are in different UE registration areas**

**[cat a] Proposal 10: The intentions and use cases for slice-based RACH configuration are as follows:**

* **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.**

**[cat a] Proposal 11: The following solutions will be studied and captured in the TR 38.832:**

* **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.**

**[cat c] Proposal 12: Slice-based enhancement for UAC is down prioritized.**

## 7 [Phase 2] Context Table

Since upload announcement is not mandatory required, indicating contact person is helpful in case companies would like to offline.

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email** |
| CMCC | Ningyu | chenningyu@chinamobile.com |
| Qualcomm | Peng Cheng | chengp@qti.qualcomm.com |
| RadiSys | Geetha Rajendran | Geetha.rajendran@radisys.com |
| BT | Salva Diaz | salva.diazsendra@bt.com |
| Convida Wireless | Joe Murray | Murray.joseph@convidawireless.com |
| vivo | Kimba D.A. Boubacar | kimba@vivo.com |
| Intel | Seau Sian Lim | seau.s.lim@intel.com |
| Vodafone | Manook Soghomonian | Manook.soghomonian@vodafone.com |
| Fujitsu | Ohta, Yoshiaki | ohta.yoshiaki@fujitsu.com |
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## 8 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