**3GPP TSG-RAN WG2 Meeting #113b-e *draft-R2-2104321***

**Electronic meeting, 12th – 20th April, 2021**

**Agenda item: 8.8.2 Cell reselection**

**Source: Intel Corporation (rapporteur)**

**Title: Summary of [AT113b-e][251][NR] Slice-specific cell reselection (Intel)**

**Document for: Report**

# Company contacts

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# Introduction

The following objectives for the email discussion [AT113b-e][251][NR] Slice-specific cell reselection was provided by the chair:

Scope:

* + - Summarize main open issues based on contributions and online agreements.
    - Highlight if there are topics that clearly require online discussion.
    - Identify topics that might benefit from email discussions.

Intended outcome:

* + - Discussion summary in [R2-2104321](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_113bis-e/Docs/R2-2104321.zip) (by email rapporteur)

Deadline for providing comments and for rapporteur inputs:

* + - Initial deadline (for companies' feedback): 1st week Fri, UTC 0900
    - Initial deadline (for rapporteur's summary): 2nd week Mon, UTC 1200

# Discussion

## Deployment scenario

One company proposed to focus on deployment scenario 1 and 2 [1]. The deployment scenario will impact the solution details about the prioritisation for slice specific cell reselection discussed in Section 2.3. The RAN2 agreement on homogeneous deployment should also be considered on top of the scenarios. Deployment scenario could be considered as part of the solution details; for example if a scenarios is not covered by the solution.

## Whether slice specific cell reselection happens at the time MO

Some companies discussed clarifying/updating the definition of intended slice. There are different definitions of intended slice depending on the context. The definition could be relevant if it is used to define the prioritisation mechanism for slice specific cell reselection. If cell reselection should be considered at the time of MO, MO could also be considered in the definition of intended slice for cell reselection

While some companies [5, 10] also considered the intended slice for MO for purpose of cell reselection (i.e., UE does reselection at the time of MO), other companies seems to be relating the intended slice for purpose of cell reselection with IDLE and/or INACTIVE. This issue could also be related to homogeneous deployments [4]. Online discussion was not able to conclude on this.

Question #1: Please provide any initial views on whether to support slice based cell reselection at the time of MO?

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| Company Name | Yes/No | Comments |
| Qualcomm | No | For the definition concluded in SI phase:  *- In case of cell selection and reselection, 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)*  *- In case of MO traffic, the intended slice means the S-NSSAI associated with MO traffic based on indication from NAS to AS. For MO service, UE is aware of the intended slice.*  Our understanding is that only the 1st part is for slice-based cell reselection as the highlighted part indicated. For 2nd part on MO traffic, we think it is only applied to slice-based RACH.  We suggest not to confuse these two parts. We don’t think RAN2 have the concept of service triggered cell reselection. It implies camping cell can’t support UE’s arriving slice so that cell reselection has to be triggered. |
| Huawei, HiSilicon | Yes | For MO, if the camping cell does not support the intended slice, slice based cell reselection could be triggered so that the UE can find the cell that supports the intended slice. Otherwise, an extra access delay would be introduced. |
| CMCC | Yes but with lower priority | We are interested in the MO triggered cell reselection.  But, since it is a new topic that RAN2 haven’t studied during the SI phase, we would suggest to first focus on the idle/inactive mode reselection. And if time allows, MO triggered reselection can be discussed later. |
| Lenovo | Yes | In general, we should support all deployment scenarios which were considered during the study phase. For MO call the deployment scenario 4 is one scenario where we think that the UE may need to perform slice-based cell reselection in order to reselect to the cell on a frequency where the corresponding slice of the MO traffic is preferred by network (i.e. according to cell reselection priority per slice).  In this context we think that we need to consider the concept of virtual cell (re)selection as explained in [5] to expedite access to slices when a MO call is initiated for a slice. |
| OPPO | Yes | If the camped cell and the neighbour cells have different frequency priorities for slice associated with MO traffic, or, if the camped cell does not support the slice associated with MO traffic, it is reasonable that the UE firstly reselect to a more proper cell before triggering RACH procedure. |
| BT | Yes | For the geographical location 3, a UE supporting slice 1 and 2 may camp in Cell 6 due to its priority on slice 1. If the MO occurs for slice 2, it is beneficial the UE performs the reselection to cell 5. Although this can be beneficial, our preference is to start the work once RAN2 concludes with slice-based cell (re)selection under network control. |
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## Slice info in SIB

### How to indicate slice info in SIB

Most companies seems to be considering broadcasting available slices in current/neighbouring cell/frequencies. In addition, priority and intra-frequency reselection parameters are also proposed and these are discussed in later sections.

There are different proposals along with pros and cons for providing slice information such as Slice access category, SST and possibly SD, Slice group, TA list based [14], encoded slice info [12] (please note that only the reference to the last two are provided as these options may not be well known and if someone wants to refer to the contribution for a better understanding). Based on the current contributions, SST, and slice group seems to have bigger majority. There is some support for Slice access category but also many concerns were also raised on this option [1, 2, 13, 19].

For slice grouping, companies also discussed whether to signal this over RRC or NAS [1, 7, 19, 20]. Rapporteur feels that this can be discussed after decision is made on the broadcast slice info.

Question #2: Please indicate company preference on what is broadcast as slice availability (e.g., Slice access category, SST and possibly SD, Slice group, TA list based, encoded slice info) or if you feel that email discussion could be helpful before online discussion? Online discussion is expected for final agreement.

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| --- | --- | --- | --- |
| Company Name | Preferred indication of slice availability  (e.g., Slice access category, SST and possibly SD, Slice group, TA list based, encoded slice info) | Progress by email before online: Yes/No? | Comments  (please avoid copy paste pros and cons from contributions) |
| Qualcomm | Slice group (prefer NAS config from a set of S-NSSAIs to a slice group) | Yes | Support slice grouping has been captured in section 5.1.2 of TR 38.832. Only FFS is to define a new grouping signalling or reuse UAC. We think it is better to respect TR conclusion and confirm via email this is starting point of followed discussion. |
| Huawei, HiSilicon | Slice group | Yes | There are some candidate solutions for slice group and they can be further discussed if slice group is to be decided. |
| CMCC | Slice group | Yes |  |
| Lenovo | Slice group, e.g. based on UE’s Allowed S-NSSAI | Yes | -SST value is not sufficient due to the fact that slice configurations of same SST value may differ across PLMNs (assuming RAN sharing scenario) and within PLMNs as well.  -Encoded slice info requires SA3 involvement and looks complicated. |
| OPPO | Slice group | Yes | We would like to emphasize slice group here means a new grouping parameter for slice(s). Using the new defined slice group can avoid the disadvantage of other solutions. |
| BT | Slice group | Yes |  |
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### Security risk of broadcasting NSSAI and need for SA3 LS

If NSSAI is broadcast, there were previously some concerns about security issue and an LS to SA3 was suggested to check for any issues with broadcasting SST [10]. Some companies [1, 2, 8] expressed a view that the security concern is related to the slice selection by UE and not about broadcasting the available slices. They felt that it is not essential to check with SA3. In any case, the security risk is only an issue if SST (optionally with SD) is chosen.

Rapporteur feels that an LS to SA3 may not be essential at this point, provided the lack of response from SA3 is not as an argument against use of SST option.

Question #3: Do companies agree that it is not essential to check with SA3 immediately about any potential security issue with broadcasting SST and possibly SD?

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| Company Name | Yes/No | Comments |
| Qualcomm | Yes | * We understand that the SA3 concerns during NR Rel-15 were about exposing which slices **the UE** is using, and we do not see an issue on what slices **the network** has available. * We don’t think there is much difference between CAG-ID and S-NSSAI. CAG-ID was agreed to be broadcast in SI * If Network intend to broadcast some sensitive slice supporting, the dedicated RRC signaling with security protection can be used. * Broadcasting slice group index/ID can also further resolve the security concern. |
| Huawei, HiSilicon | Yes | We share similar views as Qualcomm. For Q2, we support slice group solution, and we think it can solve the security issue. |
| CMCC | Yes | Agree with Qualcomm’s comments. |
| Lenovo | Yes | In general, RAN2 is not the WG who decides on security issues.  Until now we haven’t agreed yet on broadcasting SST and possibly SD, so we can consult SA3 when we made further progress on the slice info indication per SIB. It should be noted that SA3 has recently agreed a R17 SID on network slice security and one objective is the below. So, at a certain point in time we anyway need to coordinate with SA3.  Study potential security risks/threats related to broadcasting slice-related cell selection/reselection info, and provide security solutions if needed. |
| OPPO | Yes | If there is limited slice, we can use slice index to solve the security issue. If there are multiple slices, we can use a new slice group index to solve the security issue. |
| BT | Yes | It’s too early. RAN2 needs more progress. |
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### Which SIB, SIB segmentation and on-demand SIB

There were differing views [1, 6, 10, 9, 12, 21] expressed on which SIBs should broadcast the slice info (SIB1/2/3/4/5/new) depending also on what is broadcast. The details of this will depend on the prioritisation solution for slice specific cell reselection such as whether intra-freq, inter-frequency, inter-RAT is broadcast. Assuming slice availability for serving cell/frequency have to be provided:

Question #4: Should slice availability for neighbour cell/frequency be provided?

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| Company Name | Yes/No | Comments |
| Qualcomm | Yes, but… | According to agreement to follow SA2 homogenous assumption, we can assume all cells within a TA supports the same slice(s). Thus, it is not necessary provide slice availability for the cells within the current TA. However, it is still useful to provide it **for neighbour cells/frequency belonging to different TA(s)**. With such slice info, the UE can reselect to a cell (in different TA) supporting its intended slice when the UE is in boundary of two TAs.  For example, in below figure, when the UE camps in cell 3 moves towards Cell1/Cell2 in different TA, it is useful for the UE to know which slices supported in Cell1 in F2 and Cell 2 in F1, so that a UE supporting URLLC can prioritize to reselect to Cell 1 |
| Huawei, HiSilicon | Neutral | This may be useful in TA boundaries like Qualcomm mentioned. Since RAN2 agreed to align with SA2 assumption on homogeneous assumption, and we may have lots of slices in some deployments, the number of TAs may be increased and TA boundaries may be a common scenario. |
| CMCC | Yes | We confirm the scenario described by Qualcomm is valid.    Another scenario we would like to address is that different slices deployed on different frequencies, as shown in the Geography Location 1&3 in TR 38.832. RAN2 has agreed homogeneous slice inside TA is maintained. But when UE is moving and performing cell reselection ranking, UE has no idea which cells belongs to the current tracking area. UE still needs the slice info of neighbour cells in order to reselect to the cell supporting the intended slices. |
| OPPO | See comments | We support different frequencies support different slices, and/or, different frequencies supporting the same slice may have different frequency priorities. Thus, slice availability for neighbour frequencies is needed for UE to choose a proper cell, i.e. frequency-specific slice availability is needed.  But, what we want to confirmed here is whether we need to support the scenarios that different cells associated with the same frequency support different slices, or different cells associated with the same frequency have different cell reselection priorities for one slice. If the answer is yes, slice availability for neighbor cells is needed, i.e. cell-specific slice availability is needed. |
| BT | Yes | With the homogenous assumption, RAN2 should concentrate on the TA borders. |
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There were also different views on whether SIB segmentation [2, 8, 16] and on-demand SIB is needed [6, 10] or can be used if the slice information size is large. As discussed in section 2.2, most companies are proposing some shortened form of slice info. Considering this, and that is possible to use SIB segmentation/on demand if the slice info is found necessary later, rapporteur suggests to consider this after the discussion on the broadcast slice info.

Question #5: Do companies see a need to support segmentation/on-demand SIB?

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| Company Name | Support: Yes/No | Comments |
| Qualcomm | Yes (  a new SIB to support on-demand) | For on-demand SIB, the only spec impact is to introduce a new SIB type (e.g. SIB15) to include slice related info including per slice priority. Then, it is up to Network decide whether to use on-demand SIB or not. Furthermore, compared with solution to include them in SIB3/4/5, it is also helpful to reduce impacts to legacy UEs not interested in the slice info. |
| Huawei, HiSilicon | FFS | This question can be reviewed after details of slice info and SIB solutions are illustrated. |
| CMCC | Not sure | Maybe we can decide it after the broadcast information is clear. |
| Lenovo | No | We agree with rapporteur suggestion to consider this after the discussion on the broadcast slice info.  In general, providing slice info using segmentation and on-demand contradicts the intention for fast access to slices. |
| OPPO | FFS | Similar view as Huawei and CMCC |
| BT | FSS | This decision can’t be taken yet as it is not clear which information will be broadcasted. |
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## Prioritisation mechanism in UE for slice specific cell reselection

This aspect can be considered the key part of the solution required for the WI. Some companies provided some details of how to use the slice info for determining the priority for slice specific cell reselection, with varying level of details marked as FFS. Assumption on homogeneous deployment and the applicable deployment scenario can also impact the details of the solution. There are many inter-related aspects to consider regarding this that are mentioned in contributions, at high level (not an exhaustive list):

* Definition of intended slice

The definition is relevant if the term “intended slice” is used to define UE behaviour for slice specific cell reselection; e.g., prioritisation based on intended slice. Some update of definition was proposed by some companies [1,15, 19] such as allowed slice, suspended slices, requested slice, IDLE/INACTIVE/MO.

* How the highest priority slice is chosen when there is more than one intended slice in the UE

Depending on the definition of intended slice, it is possible that UE may have more than one intended slice (for example, if intended slice is the allowed slices). In this scenario, and also depending on the actual solution, UE may need to pick one of these intended slices to use for prioritisation for slice specific cell reselection. Companies proposed different algorithms for this selection [2, 3, 7, 21]

* Frequency priority information as part of slice info

Many companies propose to also provide the frequency priority as part of the slice info [1, 4, 10, 13, 16, 19, 20, 21], for example when the intended slice is available on more than one frequency. The UE uses this along with the intended slice/highest priority slice to decide which frequency layer to prioritise. Others [7, 9, 11, 12, 17], proposed a UE based algorithm for frequency prioritisation for slice based cell reselection. If priority is broadcast, the format for providing this information is also provided by some companies.

These are inter-related aspects of a particular solution, especially the second and third related to the actual frequency prioritisation. Further details of the solutions will most likely require company contributions into next meeting. Some discussion on the definition of intended slice could be progressed separately by email but it might be difficult to already check for company views this meeting.

Question #6: Do companies feel that progress by email on definition of intended slice could be helpful before online discussion? And other aspects of prioritisation mechanism for slice specific cell reselection to be based on company contributions into next meeting.

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| Company Name | Is email discussion on definition of intended slice helpful: Yes/no | Comments |
| Qualcomm | Yes for one topic | We suggest to only discuss via email whether to update definition of intended slice for INACTIVE UE. Both [1] (P1) and [15] (P3) have the same proposal. It may be easier to make progress. |
| Huawei, HiSilicon | Yes (also slice based cell cell reselection priority) | For intended slice, we think TR 38.832 and some contributions have concrete analysis.  As mentioned above, 8 companies propose slice based cell reselection priority, so we think we can try to progress on it. Regarding UE based algorithm, we think they are stage-3 details and can be discussed after basic solutions are to be decided. |
| CMCC | Yes | That would be helpful. |
| Lenovo | Yes | It will be better to understand individual company’s rationale for their suggested approach. We think that any approach will have the limitation that it can’t reliably predict the service that triggers MO establishment – therefore RAN2 needs to think of catering to also non-highest priority but important/ still-time-critical applications. |
| OPPO | Yes |  |
| BT | No | A single day cannot be sufficient to discuss this offline, reach a minimum agreement and go online when the agenda says 13:05 to 14:25  CB Tero  NR17 DCCA  - Outcome of [Post11e-e][234]  - Outcome of any SCG deactivation offline discussion(s)  Multi-SIM  - Outcome of any offline discussion(s)  RAN slicing  - Outcome of any offline discussion(s) |
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## Sliced based Intra-frequency and inter-frequency cell reselection parameters

There are a few proposals to also consider intra-frequency and inter-frequency slice specific cell reselection or providing different reselection parameters for slices [1, 14, 16, 17]. These companies feel that reselecting an intra/inter-frequency cell based on slice availability will be acceptable/needed from the radio perspective. It is difficult to judge the level of wider support for this based on the contributions given that only few companies discussed this.

Question #7: Please indicate whether slice specific Intra-frequency and inter-frequency cell reselection parameters should be supported?

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| Company Name | Intra-frequency parameters Supported:  Yes/No | Inter-frequency parameters Supported:  Yes/No | Comments |
| Qualcomm | FFS (only small enhancement can be considered) | Yes (only slice specific frequency priority) | For inter-frequency, we think RAN2 has agreed to introduce slice specific frequency priority in Tuesday. We think it is sufficient to only consider slice specific frequency priority and related UE behavior, i.e. other reselection criteria (e.g. RSRP/RSRQ threshold) are not in scope.  For intra-frequency, we tend to stick to radio strength based criteria (i.e. criteria-R), due to coverage concern. Only small enhancement can be considered (e.g. Alt-2 of Proposal 9 in our contribution [1]). |
| Huawei, HiSilicon | FFS | FFS | We think RAN2 should firstly discuss basic solutions, and then if time allows, these enhancements can be discussed. |
| CMCC | Yes | Yes | For intra-frequency, since there is the case that different slices deployed on the same frequency, slice info need also be considered.  The UE should consider the cells that supporting the intended slices as higher priority for cell reselection than other cells. |
| Lenovo | No | Yes | Additional intra-frequency parameters are not needed due to homogenous slice support. Otherwise, it may violate the “best cell” principle.  Additional inter-frequency parameters are needed to support deployment scenario 4 for MO call. |
| OPPO | FFS | Yes | Different frequencies may have different frequency priorities for one slice, thus slice-specific inter-frequency cell reselection parameters should be supported. For other enhancement on slice-specific intra-frequency and inter-frequency cell reselection parameters, we are open to consider when the requirement and scenarios are clear. |
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## Slice info in RRC release

### Additional information in RRC Release such as validity area

Some companies proposed that Information provided in RRC Release could be restricted to a certain restricted validity area [7, 8, 17]. As only very few companies discussed this, some discussion by email can be useful before online discussion. Given the RAN2 agreement to support homogeneous slice availability, there may be less motivation for restricted validity area.

Question #8: Please indicate whether Additional information in RRC Release such as validity area should be supported?

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| Company Name | Additional information in RRC Release such as validity area should be supported: Yes/No | Comments |
| Qualcomm | No | We think the same information agreed in SIB can be included in RRC Release.  For validity area, it has been discussed in last meeting but not agreed. Due to tight WI schedule, we don’t prefer to reopen this discussion. |
| Huawei, HiSilicon | No | We are not clear about the details, e.g. how to use validity area, or whether the info is related to slice info we discussed above.  During SI phase, this topic was discussed but was not agreed for normative phase. |
| CMCC | No | We are worrying that would be too complex for network to configure the validity area for each UE. |
| Lenovo | No | Concept of Validity area will go against homogeneous slice availability. |
| OPPO | Yes | During SI phase, issue3 is raised and captured in TR 38.832, i.e. the dedicated priority always overwrites the broadcast priority. If no validity area, e.g. cells, frequencies, is introduced for the usage restriction of per-slice frequency priority indicated in RRCRelease message, issue3 can not be solved. Thus, we suggest RAN2 considers per-slice frequency priority indicated in RRCRelease message is only valid in the validity area. |
| BT | No | It seems that we have enough tools already. |
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# Summary and proposals

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# References

[1] R2-2102696 Slice specific cell reselection Qualcomm Incorporated discussion

[2] R2-2102762 Considerations on slice based cell reselection Beijing Xiaomi Software Tech discussion Rel-17

[3] R2-2102773 Considerations on contents of slice based reselection KDDI Corporation discussion Rel-17

[4] R2-2102831 slice specific cell reselection Intel Corporation discussion Rel-17

[5] R2-2102988 Considerations on slice-based cell reselection Lenovo, Motorola Mobility discussion Rel-17

[6] R2-2103159 Discussion on slice based cell reselection China Telecommunication discussion Rel-17

[7] R2-2103213 Consideration on slice-specific cell reselection OPPO discussion Rel-17

[8] R2-2103239 Discussion on slice based cell reselection Spreadtrum Communications discussion Rel-17

[9] R2-2103269 Cell (re)selection for RAN slicing Asia Pacific Telecom co. Ltd, FGI discussion

[10] R2-2103375 Slice based cell reselection vivo discussion Rel-17

[11] R2-2103589 Slice based Cell Reselection Sony Europe B.V. discussion Rel-17

[12] R2-2103621 Discussion on slice based cell reselection LG Electronics UK discussion Rel-17

[13] R2-2103646 On solution for RAN slicing enhancement Ericsson discussion Rel-17

[14] R2-2103668 Slice-based cell reselection information Nokia, Nokia Shanghai Bell discussion Rel-17

[15] R2-2103695 Discussion on slice based cell reselection CMCC discussion Rel-17

[16] R2-2103745 Slice-specific system information for cell reselection Google Inc. discussion Rel-17

[17] R2-2103881 Discussion on slice based cell reselection Apple discussion Rel-17

[18] R2-2103961 System information contents for slice-aware cell reselection Sharp discussion Rel-17

[19] R2-2104004 Discussion on slice based cell reselection under network control Huawei, HiSilicon discussion Rel-17

[20] R2-2104032 Discussion on slice based Cell Reselection CATT discussion

[21] R2-2104063 Discussion on slice-aware cell reselection ZTE corporation, Sanechips discussion Rel-17

[22] R2-2104176 Discussion on slice based cell reselection Samsung Electronics Co., Ltd discussion Rel-17