3GPP TSG-RAN WG2 #116-bis R2-2200043

E-meeting, 17th – 25th Jan 2022

Agenda Item: 8.8.2

Source: Ericsson

Title: [Post116-e][242][Slicing] Slice-based cell re-selection algorithm (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This contribution summarizes the following discussion:

* [Post116-e][242][Slicing] Slice-based cell re-selection algorithm (Ericsson)

 Scope: Continue running CR for the 38.304 CR details. Should consider issues raised in discussion [AT116-e][241]. Also update CR based on meeting agreements. Should consider both previous running CR and Ericsson updates.

 Intended outcome: Running CR to 38.304

 Deadline: Long (December 17th, 0900 UTC)

Contact person(s) for each participating company:

|  |  |
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**Endorsed running CR**

[R2-2110239](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116-e/Docs/R2-2110239.zip) Running 38.304 CR for RAN slicing CMCC draftCR Rel-17 38.304 16.6.0 B NR\_slice-Core

* Endorsed as running CR (to be updated after the meeting, see discussion under 8.8.2 on CR structure)

**RAN2#115-e agreements**

Slice based cell reselection

**RAN2 needs to check with SA2/ CT1 if it is alright for AS to expect to receive slice list as well as slice priority information from NAS for cell (re)selection. Ask about both slices and slice groups.**

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

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

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

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

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

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

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

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

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

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

**Step 8: Perform legacy cell reselection.**

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

**Other solutions can be discussed based on company contributions (with technical analysis) next time.**

**After online session, it was noted that the solution 4 FFSs were not resolved. Email discussion is assigned to try to tackle those (as they may involve LS to RAN4).**

**RAN2#116-e discussions and agreements**

[R2-2109725](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116-e/Docs/R2-2109725.zip) [Post115-e][244][Slicing] Resolving FFSs for solution 4 (Lenovo) Lenovo, Motorola Mobility (Rapporteur) discussion Rel-17 NR\_slice-Core

Slice support of neighbour cells

*Proposal 1: A serving cell provides slice support of neighbour cells.*

- Ericsson thinks this relates to P3 and intra-frequency should not be needed.

- Xiaomi agrees but thinks some other information is also needed.

- QC is fine but thinks the wording makes it mandatory for network. Should make it optional.

- ZTE agrees with the principle and slice info should be per frequency. Can discuss details later. LGE and CMCC agree. Samsung agrees with the updated version with "can".

* 1: A serving cell can provide slice support of neighbour cells.

*Proposal 3: Use SIB3 for broadcasting slice info of intra-frequency neighbor cells.*

- Lenovo thinks that two cells can have different slice information in the same frequency if they belong to different TAs. That's why P3 is still needed. LGE agrees.

- QC has concern to use legacy SIBs. Should use new SIB e.g. to avoid SIB segmentation. LGE agrees.

- Apple is fine with P3/4 and thinks frequency ranking process considers intra-frequency and UE needs the slice info there. Best cell principle is still upheld.

- Huawei thinks the same discussion was done in the running CR discussion. Could consider alternatives first and then decide.

- Ericsson asks if UE should prioritize intra-frequency reselection based on slice info? Or should UE just use the best cell principle? Lenovo indicates this was discussed earlier and we didn't want to change the trigger conditions for reselection. So intra-/inter-frequency reselections would be triggered as in legacy. No new measurements are needed. Ericsson thinks why do we need it then if it's not used? Lenovo explains we need to take the different slice support into account.

- QC, Intel support best cell concept (as in legacy).

* Best cell principle for intra-frequency cell reselection should be maintained i.e. UE camps on the strongest cell according to existing cell reselection rules.
* Network broadcasts slice info for the purpose of inter-frequency reselection. This will also need slicing priority for the serving frequency. FFS in which SIB.

*Proposal 3: Use SIB3 for broadcasting slice info of intra-frequency neighbor cells.*

*Proposal 4: Use SIB4 for broadcasting slice info of inter-frequency neighbor cells.*

*Proposal 2: RAN2 further discuss how the slice support of neighbour cells can be optimally provided.*

LS to RAN4?

*Proposal 5: RAN2 send LS to RAN4 explaining the scenario and checking if measurements can be reused between different iterations (due to Step 7).*

* RAN4 is not in the scope of the WI

[R2-2110699](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116-e/Docs/R2-2110699.zip) Slice-based cell re-selection algorithm Ericsson discussion Rel-17 NR\_slice-Core

*Observation 1 The cell re-selection procedure as currently described in draft running CR to TS38.304 does not correctly cover the fallback from slice-based cell re-selection to legacy cell re-selection.*

*Observation 2 RAN2 should select the algorithm for deriving the SliceBasedReselectionPriority based on the wanted cell re-selection behaviour. There is no need to take algorithm complexity into account, since re-selection performance is not impacted.*

*Proposal 1 We ask RAN2 to agree that Slice Based Cell re-selection, just as in legacy, shall be based on reselection priorities for all frequencies that the UE may use. The priorities used may be called ‘SliceBasedReselectionPriorities’.*

*Proposal 2 We ask RAN2 to accept the TP in Appendix A.*

*Proposal 3 We ask RAN2 to discuss what behaviour is preferred for Slice Based Cell re-selection and agree on the algorithm for calculating the SliceBasedReselectionPriorities.*

*Proposal 4 We ask RAN2 to accept the TP in Appendix C.*

*Proposal 5 A new section is used to describe the calculation of a temporary reselection priority. The content of that section depends on what algorithm is selected for calculating the frequency SliceBasedReselectionPriorities.*

- Ericsson explains this tries to align with existing procedure and doesn't introduce new measurements.

- Nokia supports the proposal in principle: The outcome will be the same as in the procedure in current running CR, and this way the UE procedures are clearer. Some small clarifications can be discussed.

- Intel also promoted similar concept earlier and supports this. Thinks the current running CR is not exactly the same, determining frequency priorities is different.

- CMCC also supports the intention of the approach. Shuld also consider other slices than highest priority slice.

- QC thinks this is technically better than existing running CR but thinks this is late change and it looks complex. Don't need multiple algorithms.

* There is suppport to go with this approach.
* Offline discussion [241] (Ericsson) to sort out the details of this solution. If no problems are found, we adopt this approach in the running CR. We try to decide in 2nd week CB session.

[R2-2111566](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116-e/Docs/R2-2111566.zip) Summary of [AT116-e][241][Slicing] Slice-based cell re-selection algorithm (Ericsson) Ericsson discussion Rel-17 NR\_Slice-Core Late

*Proposal 1 Continue with (short?) email discussion to conclude whether to adopt the TP provided in Annex B in the 38304 running CR.*

- Lenovo thinks we have many open issues so should rather progress running CR. Intel thinks this is not alternative but work on the details of solution 4. The approach allows those details to be captured well. Nokia agrees.

- Lenovo wonders what is the baseline CR? Thinsk we could consider both alternatives to ensure we have a working CR in the end. Xiaomi agrees.

* Post-meeting email discussion to conclude the questions raised in [AT116-e][241] via the running CR.

# 2 Discussion

## 2.1 Introduction

In section 2.2.1 “UE Cell re-selection behaviour in Solution 4 variants”, we ask companies to discuss which slice-based cell reselection variant based on Solution 4 to use. This is a general topic, independent of TP discussions.

In section 2.2.2 and 2.2.3, we ask companies to discuss the existing TP in running 38.304 CR (Annex A), and the Alternative TP (Annex B), and finally we ask companies to provide their preference on TP alternative to use.

In section 2.3 we ask companies to discuss the UE behaviour when UE discovers that the best cell on the target frequency does not support the preferred slice.

In section 2.4, we ask companies to provide other comments on the 38.304 running CR.

## 2.2 Selecting frequencies for slice-based cell reselection

### 2.2.1 UE Cell re-selection behaviour in Solution 4 variants

Before discussing TP for cell re-selection, we need to agree on the wanted UE behaviour. Some alternatives/simplifications on the Solution 4 have been raised

In order to describe the UE’s behaviour with different Solution 4 alternatives, we will use a simple NW scenario with three frequency bands, where F1 and F2 provide full/continuous coverage, and F3 have partial coverage. There are three slices: slice A, slice B and slice C, which is the default slice. This is illustrated in figure 1

We will investigate 3 example UE’s:

1. UE 1 is in coverage of all cells. The prioritized slices are in priority order: {A, B}
2. UE 2 camped on cell 2, loses cell 2 coverage, and is in coverage of cells 1 and 3. The prioritized slices are in priority order: {A, B}
3. UE 3 is in coverage of all cells. The prioritized slices are in priority order: {B, A}

All UE’s have ongoing services on slice A and B, so the wanted behaviour is that the UE should when possible camp in cell 2, where both slice A and B are served. When out of coverage of cell 2, the UE’s should camp in cell 3, so that at least slice B can be served.

Frequency band F1

**Broadcasted Frequency Priorities**

There are slice-specific frequency priorities for slice A and B, but not for slice C.
Legacy reselection priorities are used for the (default) slice, C

|  |  |  |  |
| --- | --- | --- | --- |
|  | F1 | F2 | F3 |
| Slice A | - | 1 | - |
| Slice B | - | 1 | 2 |
| Slice C | (3) | (2) | (1) |

Frequency band F2

Frequency band F3

#### Solution Alternatives

With the **original solution 4**, the UE first uses the frequency priorities of the highest priority slice, and if no cell is found, it will use the priorities of other slices in priority order, and at last it will use legacy priorities.

With this solution, UE1 would select F2, since that is the only frequency supporting slice A, which is of highest priority. UE2 would select F3, since slice B is considered when slice A is not accessible.

UE 3 would select F3, since that frequency have highest priority for slice A. F3 does not support slice B, so UE would only be able to access slice A.

There are also two simplified alternatives of solution 4 discussed. One alternative is that if slice A is not available, the lower priority slices are not considered, but legacy priorities are used directly. The other alternative is that neither other slices or legacy priorities are considered. For these solutions, the behaviour will be similar as the original solution 4 for UE1 and UE3.

For UE 2, in the first alternative, when slice A is not accessible, legacy priorities will be used, and UE 2 will select F1, which only supports the default slice C. With the second alternative, when cell 2 (and slice A) is not accessible, the UE will after losing cell 2 coverage trigger cell selection, and may end up on either cell 1 or cell 3. There is no means to steer the UE camping.

In the table below, the UE’s camping frequency is shown for the different algorithms. It is marked with orange when the wanted slices are not available, and red when there is means to steer the UE.camping by re-selection priorities.

Table 1 Final Camping frequency of UE

|  |  |  |  |
| --- | --- | --- | --- |
|  | **UE 1** | **UE 2** | **UE 3** |
| 1. Ideal behaviour
 | F2 (Slice A&B) | F3 (Slice B) | F2 (Slice A&B) |
| 1. Solution 4, Original
 | F2 (Slice A&B) | F3 (Slice B) | F3 (Slice B) |
| 1. Solution 4, Only highest prio slice considered.
 | F2 (Slice A&B) | F1 (Slice C) | F3 (Slice B) |
| 1. Solution 4, Only first prio slice considered, legacy priorities not considered.
 | F2 (Slice A&B) | Short loss of coverage, unspecified cell camping. . | F3 (Slice B) |

It can be noted that with solution 4, the wanted behaviour will not be achieved for UE 3, since the support for slice B is not considered if frequencies supporting slice A are found

**Q1: Do you agree with the analysis (Yes/No), and which of behaviours A-D do you think is preferred/acceptable, e.g. when taking algorithm complexity into account?**

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **Yes/No** | **Preferred behaviour** | **Comments** |
| Nokia | Yes | A, but B and C are also acceptable | Note that the purpose of slice aware cell reselection is to specify a solution that works well in most of the cases. |
| Qualcomm | Yes | A and C | Option B is not acceptable to us because we don’t see much performance difference between Option B and C (they both can’t work for UE3) but Option B introduced extra /complex slice looping.We also don’t prefer Option D because it will cause unspecified UE behavior for UE2 and it can be simply improved by considering legacy priority (i.e. Option C). By the way, we don’t understand what below text means:“where F1 and F2 provide full/continuous coverage, and F3 have partial coverage.“And it seems to be misaligned with the figure. Thus, we suggest company to ignore this text. |
| Huawei, HiSilicon | Yes | C | We wonder how option A is considered as ideal behaviours. For UE3, we think it should camp on F3 as indicated by network configuration. So Option C should also be the ideal behaviour.In addition, we also have the following comments regarding the text above:**Firstly**, we think the above text “F1 and F2 provide full/continuous coverage, and F3 have partial coverage” seems to contract with the figure above, i.e. F3 have partial coverage, but Cell 2 is actually smaller than other cells in the figure.**Secondly**, the following text is strange, and it seems more about option 5 (in previous RAN2 discussion). In addition, here it is saying the UE should move from Cell 2 (full coverage) to Cell 3 (partial coverage), what is the motivation of doing this?All UE’s have ongoing services on slice A and B, so the wanted behaviour is that the UE should when possible camp in cell 2, where both slice A and B are served. When out of coverage of cell 2, the UE’s should camp in cell 3, so that at least slice B can be served.In the example, the email rapp does not provide the type of slices, and we think it is very important, otherwise, any companies can list any scenarios for slicing, which will cost a lot of time for RAN2.In our opinion: Slice C is obviously eMBB slice Slice A should be eMBB sliceFor Slice B and C, if they are URLLC slices, it depends on network policies, e.g. if there is no F3 coverage, the network should prioritize F2 for such URLLC slices; if there is F3 coverage, maybe F3 is higher priority than F2 |
| Intel | Yes (apart from some typos as pointed out above) | A or B | In our view, this analysis just shows that the slice based frequency priorities need to be considered for the frequencies that they are assigned. Without that, the UE may end up without coverage or end up not using the slice based frequency priority assigned (i.e. end up using legacy priorities). This can be observed with behaviours C and D where the frequency priority of only the highest priority slice is considered. This can be resolved by assigning the frequency priority for a frequency/cell corresponding to that of the highest priority slice supported on that frequency/cell - the alternative TP as in Section 2.2.3 or perform the iteration as in Step 7 in the existing TP for solution aims to achieve that in different ways. However, performing the iteration as in the original solution 4 will have other issues as highlighted by the rapporteur.We are actually not sure where solution D was taken from. |
| Xiaomi | Yes | B | For behaviour B and C, we prefer to consider more slices if the highest priority slice A can not be available so as UE2 can use the slice B at least. |
| BT | Yes | B | First, the term “ideal” is subjective and relative to each company view. It needs to be changed by something neutral.Options C and D are not acceptable for us. Option C implies that only the highest prioritized slice will be checked. It severely restricts the flexibility due to only 1 slice can be considered. How can be justified that 1 slice prioritization improves the performance of UE reselection process (other case what are we doing here) but avoid all the others have no impact? For BT, the fact that UE3 selects F3 and not F2 is correct. The network is engineered in a way that F3 – Slice B has preference over F2 – slice B. The reason is irrelevant, but this is how the network has been engineered and must be respected. It is something made on purpose to preclude the same priority in F3 and in F2 for slice B then, why UE3 will camp on F2? That is a misleading behaviour.With option C for UE2, it is possible to observe how UEs will camp in an undesired frequency. Operators that want to use a frequency as default will have to support UEs with default slice plus all the devices that cannot camp in its single prioritized frequency. That can result in RACH congestion or in an unnecessary overhead and an unnecessary power consumption due to once the UE is connected, it needs to be redirected to the proper cell.  |
| OPPO | Yes | C | We do not prefer Option D, since it introduces the unexpected UE behavior, which can be easily avoided by using the solution of fallback to legacy cell reselection. Compared to Option B, Option C is preferred at this stage, since it is a simple one and can avoid some effort/action, e.g. further checking the slice support of the next priority slice. |
| LGE | Yes | C but A and B are acceptable | We prefer to have simple solution although supporting more slices is good. The ideal solution is A, but C is preferred. |
| CATT | Yes | C | We also have the concern about the UE3’s ideal behaviors. Although the F2 supports both slice B and slice A, for the slice B specific frequency priority of F3 is higher than F2. We prefer UE3 to choose F3 as the ideal behavior. Between Option B and Option C, we prefer the Option C. It is the simplest and Option C can work well in most of cases. Although Option B can let UE to camp a frequency supporting other lower priority slice, the benefit will introduce more complexity and time consumption. |
| Spreadtrum | Yes  | C | We prefer Option C. It removes Step 7 of the original solution 4, which avoid excessive iterations and reduce reselection delay.  |
| Lenovo, MotM | Yes | B | The “ideal behavior” is not ideal from a different point of view. Take for example a case where a UE has 8 slices (signalled from NAS to AS) in priority order 8 to 1. Now, two lowest priority slices of a UE are supported on a certain frequency not supporting its highest priority slice. Which cell should the UE be on?I think this point have repeatedly come up and most companies in RAN2 had been clear that “the highest priority” slice needs to be catered first. Of course, if there are more than one frequencies supporting the highest priority slice with same frequency priorities, then the UE can prefer to reselect to a cell supporting higher number of slices (ceteris paribus). |
| Samsung | Yes | C, B, A | The following are our preferences in the following order:(1) Behavior C. Solution 4, Only highest prio slice considered.(2) Behavior B. Solution 4, Original(3) Behavior A. Ideal behaviourWe do not prefer behaviour D as it may result in coverage loss, since the UE will not consider other slices or legacy priorities, if it fails to find a cell that supports its highest priority slice. |
| CMCC | Yes | A and C, but see comment | First, with option A for UE3, we understand the intention of ideal behavior where the UE3 can use more slices on F2, but with the current configuration, we think it is not ideal behavior to camp on F2 because the frequency priority of F3 is higher than F2 for slice B which is the highest priority of UE3. From the respective of operator, the UE should follow and respect the network configuration. However, if the frequency priorities are not provided, we prefer to prioritize F2 which supports more prioritized slices (slice A and B) than F3 (slice B) for UE3.For option B, more slices can be considered and it is beneficial when the highest priority slice is not available but the second or lower slices can be available, e.g. UE2 can use slice B at least. However, this option will take longer time for cell reselection and introduce extra complexity and power consumption for UEs. For option C, it is simplest solution but only the highest priority slice can be considered. As we stated in the first paragraph above, we prefer to prioritize the frequency which supports more prioritized slices when the slice frequency priority is not provided.Option D is not acceptable for us because it is unreasonable and will lead to unpredictable UE behavior. |
| NEC | Yes | BCD + | A: require complicated solution which take all supports slice into account in one goB we would like to avoid too many loops, and in each loop the relative frequencies priority order comparing serving cell is likely changed, this will impact what to measure. But we are open to discuss it C should be fine, but need clarify to fallback to legacy priority on all frequencies or only remaining frequencies D To avoid extra loop, only considering first priority slice is also acceptable for us. but unspecified cell camping case should be avoided. if gNB provides slice-specific frequency priority for all listed frequency (add this restriction in RRC specification), there should be no unspecified call camping case in our understanding, we would like to know if this is acceptable for other companies or not  |
| Apple | Yes | B or A | We prefer considering other slices also. |

**Summary Q1:**

With this question, we had the ambition to come closer to an agreement on the general specific cell re-selection when it comes to UE behaviour. Our intention was to keep this decoupled from the actual TP discussion.

We realize that Behaviour A is clearly linked to the alternative TP (“TP B”), and this is also reflected by company comments.

From companies’ comments, it is not possible to get a clear conclusion from this discussion on the main alternatives

* only considering frequecnies supporting highest prio slice (C), or also
* consider other NAS-prioritised slices when frequency supporting highest prio slice is not found (B and A)

Behaviour D has no support.

1. RAN2 to further discuss and agree on UE behaviour for sliced-based priority re-selection
2. Solution 4, all NAS-prioritised slices with frequency priorities as well as legacy frequency priorities are consisdered, without iteration
3. Solution 4, original (UE first uses the frequency priorities of the highest priority slice, and if no cell is found, it will use the priorities of other slices in priority order, and at last it will use legacy priorities)
4. Solution 4, only highest prio slice considered, then legacy priorities considered

### 2.2.2 TP from running CR (See Annex A)

In Annex A, the relevant parts of the TP in the 38.304 running CR [2] are presented.

In the TP, the cell re-selection process is performed in **two iterations**.

* In the first iteration, the frequency priorities of the highest prioritized slice are used
* In the second iteration the legacy priorities are used.

This corresponds to the “simplified solution 4”, with only first prio slice considered (C), not taking lower priority slices into account.

There are issues with the TP, as expressed by companies in Tdocs and previous email discussions:

1. Cell re-selection is an ongoing process of evaluating the cell re-selection criteria. The second iteration with “fallback to legacy re-selection”, will not be performed, unless an exit condition is added to the first iteration. And after having fall-backed, there is no return to again toke slice priorities into account.
2. The TP is not aligned with how existing cell re-selection is described in 38.304. It is not clear how current TP interacts/relates to existing specification text, e.g.
	1. 5.2.4.2 Measurement rules for cell re-selection current cell re-selection
	2. 5.2.4.5 NR Inter-frequency and inter-RAT Cell Reselection criteria
3. The TP describes a simplified version of solution 4, as mentioned above.
4. Since only a subset of the frequencies are considered in the first iteration, a UE in bad coverage may experience additional delay before it re-selects to a frequency with better radio conditions.
5. Some frequencies will have both slice specific frequency and legacy priorities. This may need additional measurements, unless measurements can be re-used between iterations (RAN4 impact?)

**Q2: Do you agree with these issues (Yes/No)? Are there more issues with this solution?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | Yes |  |
| Qualcomm  | Yes | Besides the issues list above, we also see below other issues:1. It is not clear how frequency priority is assigned to inter-RAT frequencies. For example, we may have below alternatives
	* Alt-1: legacy LTE frequency priority is assigned
	* Alt-2: no frequency priority is assigned (i.e., LTE frequency can’t be reselected always
	* Alt-3: lowest frequency priority is assigned to LTE frequencies.

 Not sure whether companies have same understanding. 1. It is not clear what “the highest ranked cell is suitable (as defined in 38.304)” means. We think there are two different understandings on it among companies:
	* Understanding 1: It means that highest ranked cell only needs to satisfy the definition of “suitable” specified in clause 4.5 of TS 38.304.
	* Understanding 2: It means that highest ranked cell needs to satisfy both the definition of “suitable” specified in clause 4.5 of TS 38.304 and inter-frequency reselection criteria specified in clause 5.2.4.5 of TS 38.304.
2. It is not clear what is the Validity time of slice specific frequency priority (i.e., if the UE performs legacy cell reselection due to failures with slice specific frequency priority, it is not clear when the UE can use the slice specific frequency priority again).
 |
| Huawei, HiSilicon | Yes |  |
| Intel | Yes | The approach taken in the draft CR and Annex A is that the slice based cell reselection replaces the existing cell reselection mechanism. This approach requires us to develop a new complete solution for slice based cell reselection that also includes the behaviours and interactions defined in Clauses 5.2.4.2 [Measurement rules], 5.2.4.3 [Mobility States], 5.2.4.4 [Cell restriction], 5.2.5.5 [priority cell reselection criteria], 5.2.4.6 [cell ranking], 5.2.4.8 [Inter-RAT cell reselection in RRC\_Inactive state] and 5.2.4.9 [Relax measurement]). Clause 5.2.4.2 [Measurement rules]. Simply referring to these sections does not capture the interactions between them and slice based cell reselection and this is the primary cause of the issues listed above.For example, in the draft CR, it is unclear of how and when the slice based cell reselection is initiated after the first cell reselection; cell reselection is a continuous process and when in that process does this happen? Even during the slice based cell reselection, when the UE is going through one loop related to a selected slice, the legacy cell reselection mechanism has to apply together with inter-RAT handling. This means that the frequency priorities for the selected slice is also handled together with inter-RAT cell reselection priorities when the UE triggered by Clauses 5.2.4.2 [Measurement rules] is searching for a suitable cell based on the cell reselection criteria in Clauses 5.2.4.5 [priority based cell reselection criteria involving inter-frequency and inter-RAT cells) and 5.2.4.6 (cell ranking for intra-frequency cell). If inter-RAT cells are not considered when the UE is applying slice based cell reselection, it will not perform inter-RAT cell reselection at all which does not seem to be logical. For inter-RAT handling, with Annex A, the network will never be able to provide a higher priority to an inter-RAT as long as slice based cell reselection is applicable. For example, it should be possible for an operator to make LTE higher priority than NR for eMBB. With looping in solution 4, UE will continue to apply slice based cell reselection as long as any of the slices (eMBB) is available and UE will never have a priority for an inter-RAT carrier and will not be able to prioritise an inter-RAT carrier. As seen in behaviour C and D, if frequency priorities are not assigned for the frequencies that are available, the UE may lose coverage as there no reselectable frequency or end up using legacy priorities without considering the frequency priorities of other slices. Our understanding of the original solution 4 is that the looping through the slice list is just a form of modelling to determine the frequency priorities for NR. The TP in Annex B ensures that the available frequencies are assigned with frequency priorities as provided by the sliced based frequency priorities.One other issue without looping through the slice list is that UE may always end up using the legacy cell reselection. As mentioned in our contribution R2-2109616, in our understanding, the NAS provided list should include not only the Allowed NSSAI but also Requested NSSAI which the UE may have requested during registration that are not supported in the current registration area. We think this is essential for UE to be able to reselect to a cell in a different TA that is offering an additional slice. If we strictly follow step 2 as stated, then in our understanding, if the highest priority slice in the UE slice list provided by NAS (i.e., URLCC) is not available in any of the frequencies in the coverage region of the UE and Step 7 is removed (and not replaced by some other mechanism), the UE will fall back to legacy reselection mechanism. That is, a consequence of not supporting step 7 in the current solution 4 seems to be that UE will fall back to legacy frequency prioritisation if the highest priority slice is not found. For example, if a UE has URLLC and eMBB in its slice list from NAS, and URLLC is not available in any of the inter-frequency cells in that geographical region, UE will fall back to legacy reselection and will not follow the slice based frequency priority for eMBB. |
| Xiaomi | Yes |  |
| BT | Yes |  |
| OPPO | Yes |  |
| LGE | Yes |  |
| CATT | Yes |  |
| Spreadtrum | Yes |  |
| Lenovo, MotM | Yes (partially) | The TP is Work in Progress and was not at the accurate form when submitted in the last meeting. A subsequent TP will resolve the mentioned issues:1. We think “iteration” is only a theoretical problem since we agreed in last meeting “**A serving cell can provide slice support of neighbour cells**”, it will give a very clear picture of which slice support to assume in the neighborhood and it can start with the highest priority slices that are indeed supported in the geographical area. So, the need of any iteration will be practically very low, and only if the network chooses to not provide slice support of neighbour cells. We think slice support of neighbour cells will not be a dynamically changing information and can be provided to the UEs.
2. Fallback will be initiated when slice-based cell reselection does not yield. The UE will start slice-based cell reselection according to frequency comparison of section 5.2.4.2 – here a future CR shall contain determination of frequency priorities for NR frequency for slice-based cell reselection. Rest of the evaluation in this section is to be used “as is”. After UE has fall-backed, the next trigger of slice-based cell reselection also needs to be well-defined.
3. Linking of sections to the new added section must also be there to showcase a full implementation.
4. Also, UE implementation specific measurement optimizations can be allowed without necessarily going to RAN4.
 |
| Samsung  | Yes | Regarding issue (1), we also think that the UE may not perform legacy cell re-selection (i.e., Step 8) in a certain scenario, e.g. if the UE is configured with slice based dedicated priority configuration in dedicated signalling (e.g. RRCRelease ).Regarding issue (5), we are not sure why we need additional measurements. Moverover, regarding measurement reuse across different iterations, in last RAN2 meeting, RAN2 agreed that:= > RAN4 is not in the scope of the WI |
| CMCC | Yes |  |
| NEC | Yes for Some of them | 1. Yes
2. Yes, but every alternative need to clarify it
3. It is not an issue
4. Yes, so one solution of provide slice-specific priority for all list frequencies

If solution has several loops and if the frequencies priority order comparing serving frequencies changes, then it possibly requires additional measurement in our understanding |
| Apple | Yes | We think the most critical issue is: for each slice, UE needs to evaluate the frequency priority again. That makes the RRM procedure sequential in time. |

 **Summary:**

See Summary after Q3.

**Q3: Do you have proposals to solve these issues? (Can also propose new/draft text proposal inline in Word comments in Annex A)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | No |  |
| Qualcomm  | Yes | For the 3 issues we list in Q2, our proposals to fix them:1. We prefer Alt-3: i.e., lowest frequency priority is assigned to LTE frequencies
2. We prefer Understanding 2. So, clarify that condition “If the highest ranked cell is suitable (as defined in 38.304)” in Step 5 means that highest ranked cell needs to satisfy both the definition of “suitable” specified in clause 4.5 of TS 38.304 and inter-frequency cell reselection criteria specified in clause 5.2.4.5 of TS 38.304.
3. Clarify that after slice specific frequency priority is changed (e.g., the UE camps in a new cell, slice specific frequency priority in SIB is changed, or gNB sends a new slice specific frequency priority via RRC release), the UE performs slice specific cell reselection from highest priority slice when inter-frequency cell reselection is triggered.
 |
| Huawei, HiSilicon | Yes | Our responses are as below (for listed 5 issues):1. Cell re-selection is an ongoing process of evaluating the cell re-selection criteria. The second iteration with “fallback to legacy re-selection”, will not be performed, unless an exit condition is added to the first iteration. And after having fall-backed, there is no return to again toke slice priorities into account.

[Huawei] For the 2nd sentence, one alternative is to add a timer for UE doing slice based cell reselection.For the 3rd sentence, please refer to our responses to 3) below (related to the issues provided by Qualcomm).1. The TP is not aligned with how existing cell re-selection is described in 38.304. It is not clear how current TP interacts/relates to existing specification text, e.g.
	1. 5.2.4.2 Measurement rules for cell re-selection current cell re-selection
	2. 5.2.4.5 NR Inter-frequency and inter-RAT Cell Reselection criteria

[Huawei] the existing sections should be reused as much as possible.1. The TP describes a simplified version of solution 4, as mentioned above.

[Huawei] more time to check.1. Since only a subset of the frequencies are considered in the first iteration, a UE in bad coverage may experience additional delay before it re-selects to a frequency with better radio conditions.

[Huawei] it is related to network deployments and configurations.1. Some frequencies will have both slice specific frequency and legacy priorities. This may need additional measurements, unless measurements can be re-used between iterations (RAN4 impact?)

[Huawei] it can be up to UE implementation.For listed issues provided by Qualcomm, our responses are as below:For 1), we think that the UE will not consider inter-RAT measurements, and when the UE fallback to legacy cell reselection, the legacy inter-RAT measurements will be applied (legacy behaviours).For 2), we prefer understanding#2.For 3), we think that after the fallback, the UE will perform legacy cell reselection and select a suitable cell, so this cell reselection is over. From the network cell reselection procedure, the UE will start slice based cell reselection. |
| Intel |  | We think Annex B approach can solve these issues. |
| Xiaomi | Yes | For the 5 issues list by rapporteur, our response are as follows: 1. Cell re-selection is an ongoing process of evaluating the cell re-selection criteria. The second iteration with “fallback to legacy re-selection”, will not be performed, unless an exit condition is added to the first iteration. And after having fall-backed, there is no return to again toke slice priorities into account.

*Xiaomi’s response: For the fallback to legacy reselection, we have agreed that if UE can not find a cell which is a suitable cell and can support the selected slice in the slice based cell reselection, it will fallback to legacy reselection to find a suitable cell camped, minor changes seems needed for Annex A to make it clear. Besides these, we are not sure if we need other exiting case (e.g. timer) as the frequencies are not too many and the latency is not a critical issue for idle/inactive UE.**For the fallback from legacy cell reselection to slice based cell reselection, we share the same view with HW and think there is no spec impacts.*1. The TP is not aligned with how existing cell re-selection is described in 38.304. It is not clear how current TP interacts/relates to existing specification text, e.g.

5.2.4.2 Measurement rules for cell re-selection current cell re-selection5.2.4.5 NR Inter-frequency and inter-RAT Cell Reselection criteria *Xiaomi’s response: More time to check and complete it.And current spec can be reused as much as possible.*1. The TP describes a simplified version of solution 4, as mentioned above.

*Xiaomi’s response: More time to check and complete it.*1. Since only a subset of the frequencies are considered in the first iteration, a UE in bad coverage may experience additional delay before it re-selects to a frequency with better radio conditions.

*Xiaomi’s response: It is a issue related to the network deployment and priorities configuration.*1. Some frequencies will have both slice specific frequency and legacy priorities. This may need additional measurements, unless measurements can be re-used between iterations (RAN4 impact?)

*Xiaomi’s response: Up to UE implementation, and we think there is no extra measurements as long as the measurement results for a frequency are available and valid. And if not, measurements are performed no matter whether the slice based cell reselection is introduced.*For the 3 issues listed by QC, we share the same view with HW. |
| OPPO | Yes | Please find our reply below:1. For the second sentence, we agree some modification is needed. For the third sentence, the UE can use slice-specific cell reselection after e.g. the slice info changes or UE has selected a cell.
2. We need to reuse the existing sections as much as possible.
3. More details need to be discussed.
4. Depend on the configuration.
5. In our understanding, it can be reused. But, we can leave it to the implementation.

For the additional questions from Qualcomm:1. Depends on at which stage the frequency priority is considered. If the stage is the UE performs slice-specific cell reselection, such frequency priority can be considered lower than any slice-specific frequency priority. If the stage is the UE fallbacks to legacy cell reselection, legacy frequency priority is used.
2. We prefer understanding 2.
3. See the answer to above 1) for Q2.

  |
| CATT | Yes | Our reply for listed 5 issues:For 1) For fallback to legacy reselection, we think there is no need to add an exit condition. When UE performs slice based cell reselection, if UE cannot find a suitable cell supporting the highest priority slice to camp. This failure can be the natural exit condition of performing slice based cell reselection. This is also reflected in the current solution.For performing slice based cell reselection, maybe we can discuss the trigger condition. E.g., the supporting slice of neighbor cells changes.For 2) We need more time to check and complete it for both current solution and the new approach.For 3) Need more time to resolve and complete.For 4) It is related to network deployments and configurations.For 5) If we only consider the highest priority slice, the additional measurements is limited and acceptable.For the additional issues from QC:For1) We prefer UE will not consider inter-RAT measurements when performing slice based cell reselection.For 2) We prefer understanding 2.For 3) We think this depends on the type of cell reselection. The slice specific frequency priority is only valid when UE performs slice based cell resection. Maybe we should clarify the trigger condition for slice based cell reselection.  |
| Spreadtrum | Yes | For the listed issues in the summary from moderator.1. For the second sentence, we think the exit condition has already been captured in Annex A. For the third sentence, about the time to reconsider slice priorities, we share similar views with HW.
2. Reuse existing specification as much as possible.
3. It seems to be the description of the Option C in Q1, we can accept it. But more details could still be discussed.
4. It depends on NW configuration.
5. Could leave it to UE implementation.

For the issues from QC:1. Share same views with HW. Only consider frequency priority in legacy cell reselection procedure.
2. Understanding 2.
3. After UE reselected a cell or slice info changes (e.g., slice specific frequency priorities changes).
 |
| Lenovo, MotM | Yes | As described in the previous answer. |
| Samsung  | Yes | Issue (1) can be addressed using the following updated text for Step 8 in Option 4:**Step 8: ~~Perform legacy cell reselection.~~ If the UE is not configured with slice based priority via dedicated signalling, perform legacy cell reselection.** |
| CMCC | Yes | For the listed issues, our responses are as below:1. For the 2nd sentence, the alternative provided by Huawei (add a timer) is acceptable, or maybe we could set the number of iterations for slice-based cell reselection.

For the 3rd sentence, we can further discuss the trigger condition, e.g. add a timer or when slice info changes.1. We should reuse the existing sections as much as possible.
2. We can discuss the details and improve this version based on the companies’ comments.
3. It is related to network deployments and configurations. In addition, if solution 4 without iteration is adopted, the delay can be minimized.
4. It can be up to UE implementation.

For listed issues provided by Qualcomm, our responses are as below:For 1), we share the same view with Huawei that the UE will not consider inter-RAT frequency in slice based cell reselection, and when the UE fallbacks to legacy cell reselection, the legacy inter-RAT measurements will be applied.For 2), according to TS 38.304, the suitable cell and inter-frequency reselection criteria are independent, we understand when the highest ranked cell is suitable and satisfies the inter-frequency reselection criteria, the cell reselection to this highest ranked cell shall be performed.For 3), similar answer with issue 1) listed above. |
| NEC | Yes | We would like to keep idle mode mobility simple if possible.Hence, we should just restrict the cell to provide slice-specific priority for all listed NR frequencies, for a given slice-group appears in SliceInfoList. In this way, slice-specific frequency priority would be all under network control, UE sort one slice group and use corresponding slice-specific frequency priority for cell reselection, no more fall back or extra loops with another slice group.  |
| Apple | Yes | We are thinking to have a text for UE to generate a frequency pool with priority at first which has the same outcome as Annex B. The serving frequency should be also considered here. Then the RRM would not be touched.An example is below:In slice based frequency configuration:F1: supports slice 1 (priority 8), slice 2 (priority 7)F2: support slice 1 (priority 7)F3: support slice 2 (priority 8)In legacy frequency configuration for legacy UE: F1: priority 8 F2: priority 7UE1: intended slices 1 and 2, with slice 1 as the highest priority. For UE1, the frequency ranking would be as below.{ {F1}, {F3(priority 8), F1 (priority 7), F2(priority 7)}, {F1, F2} }{}: frequency rank associated with highest slice (slice 1){}: frequency rank associated with the second highest slice (slice 2) (Note that F1 is put with higher priority than F2 since F1 supports more intended slices){}: frequency rank associated with legacy frequenciesNote that serving frequency should be also put into the ranking, so that UE would have a clear understanding which frequency is with higher priority and which frequency is with lower priority. |

 **Summary Q2-Q3:**

On the discussion of Q2 and Q3, the Rapporteur understands that

* Companies agreed on the issues raised on existing TP.
	+ Several companies assumed these issues with existing TP can be fixed, and some ways forwards were proposed in some cases.
	+ Other companies assumed those issues are resoved with alternative TP (TP B)
* Additional issues where raised by one company
	+ Some companies proposed way forward to fix them

### 2.2.3 Alternative TP (See Annex B)

In [1], Ericsson presented TP that aims to avoid the issues raised with the existing TP.

By calculating (new) reselection priorities for frequencies that have slice-specific priorities, all frequencies (with and without slice-specific priorities) are considered with the existing cell reselection principles. Existing specification text are retained without impact

This method ensures the original/complete solution 4 is used, i.e. also taking also lower priority slices into account.

**Q4: Do you agree that alternative TP in Annex B covers original/complete solution 4 (B)?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | Yes, but | Additional specification is needed in 5.2.4.5 to specify the case when the "best" cell on a band does not support the slice (group) used to select the band |
| Qualcomm | See comments | In high level, we agree that the method ensures the original/complete solution 4 is used, i.e. also taking also lower priority slices into account. However, the current TP is not acceptable to us (see our comments in Q5).  |
| Huawei, HiSilicon | No | In table 1, it is listed all possible UE camping behaviours, and we wonder whether both solutions will lead to the same UE behaviours. More justifications are needed.In addition, as we stated in the email report R2-2111566, lots of issues would be introduced and it will take RAN2 more time to check the new issues, e.g. the new formular and relevant UE/NW behaviours. |
| Intel | Yes, in principle | We agree with the general approach of Annex B as it integrates the slice based cell reselection into the existing cell reselection mechanism. That is all of the existing cell reselection procedures and interactions with regard to Clauses 5.2.4.2 [Measurement rules], 5.2.4.3 [Mobility States], 5.2.4.4 [Cell restriction], 5.2.5.5 [priority cell reselection criteria], 5.2.4.6 [cell ranking], 5.2.4.8 [Inter-RAT cell reselection in RRC\_Inactive state] and 5.2.4.9 [Relax measurement] are all applied also for slice based cell reselection and the only difference is the assignment of the frequency priority for a carrier.The formula captured in Annex B is one mechanism of assigning the priorities for the frequencies corresponding to that of the highest priority slice available on that frequency. We are open to other ways of achieving this as well.We also note that both Annex A and Annex B solutions require the UE to be explicitly provided with slice priorities by NAS. If slice priority is not provided by NAS and is left to UE implementation, both TPs (Annex A or B) only provides part of a solution and will not result in a known and specified or network controlled outcome in terms of which frequency will be prioritised by the UE. For Annex B, if slice priority is left to UE implementation, one way is that we can consider that the slice priority is set to 0 and the frequency priority of a frequency is then based on the slice based frequency priority broadcast or via dedicated signalling, i.e.SliceBasedReselectionPriority = SliceReselectionPriority,Hence if slice priority is not provided by NAS, RAN2 will need to consider other AS procedure or some implicit mechanism for assigning frequency priority for slice based cell reselection that also considers slice priority.  |
| Xiaomi | No | In our understanding, the intention of the new approach is to determine slice based cell reselection priorities considering both the priority and the number of the slice supported on a frequency and to integrate slice priorities with legacy priorities to avoid fallback between two procedure. However, we think these enhancements can be resolved by NW configuration and minor change on running CR of solution4.As the new approach and associated running CR lacks of enough analysis, we think it needs more time to complete than the original one. |
| BT | No | The number of slices supported by each frequency was never agreed as part of the procedure, but it is taking into account to prioritize the slices. |
| OPPO | See comment | There is no whole picture on how this TP works, since there are many details to be discussed. Just compared what we can see from the text in Annex B and A:* Annex B always considers the next priority slices for slice-specific cell reselection, which is FFS in Option 4.
* Annex B uses the exact slice priority value to determine slice-specific frequency priority, which is different from Option 4.
 |
| LGE | See comments | More contents need to be specified in Annex B to understand the overall procedure and also detailed cell reselection operations.  |
| CATT | See comments | In general, we agree the algorithm can cover the original/complete. We think this approach is the optimization of the current solution with iteration. But the benefit is limitation when choose the solution without iteration. So we prefer to focus on the current solution.  |
| Spreadtrum  | See comments | By applying the new approach in Annex B, UE may get the similar result as using the solution 4. But the actual behavior of UE is quite different. From our side, the new approach need more time to be carefully checked. |
| Lenovo, MotM | Comments | The idea of the alternative TP is very good but implementation lags behind.The Annex B will not lead to “Idea behavior” since there’s no summation of calculated values across slices.It mixes up with cell reselection priorities – we think slice priorities and legacy CRPs are Apples and Oranges and can’t mean a priority of say ‘7’ to have the same meaning.Also, TP is not complete, e.g., no mention of the cases when a slice support of the best cell is different from the slice support of the frequency (both success and failure cases need to be considered here). |
| Samsung  | No |  |
| CMCC | See comments | We understand the intention of the new algorithm in Annex B, but we think there are still many details to be discussed. |
| NEC | Yes |  |
| Apple | No | We prefer using text rather than formula. But we do agree with the intention to have a unified priority order for all frequencies. |

**Summary:**

See summary after Q7.

**Q5: Do you see any issues with this TP?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | Yes | Additional specification is needed in 5.2.4.5 to specify the case when the “best” cell on a band does not support the slice (group) used to select the band, see Q6 |
| Qualcomm | Yes | We do not agree to use the below formular in Section 5.4.2.x of Annex B to calculate slice specific frequency priority: *SliceBasedReselectionPriority = SlicePriority \* MaxReselectionPriorityValue + SliceReselectionPriority** First, we do not prefer to use a formular in TS 38.304. If necessary, one description is sufficient. Note that there is not any formular captured in TS 38.304 up to now, and we don’t think RAN2 should open the door for it due to a small feature.
* Secondly, it is possible that SA2 will agree *SlicePriority* (i.e. priority among intended slice) is left to UE implementation. Then, it doesn’t make sense to use it to calculate slice specific frequency priority.
* Thirdly, the main intention of the formular is to ensure frequency priority of a high priority slice is larger than frequency priority of a low priority slice. However, we believe Network implementation can ensure it (i.e., NW assigns a higher frequency priority for a slice with higher priority). Thus, we believe this formular is not necessary.

Thus, we suggest to remove the formular and not explicitly couple slice specific frequency priority with *SlicePriority.* |
| Huawei, HiSilicon | Yes | Share similar views as Qualcomm. |
| Intel | No | The only issue is if it is found that the behavior cell support slices that are different to the frequency level. Our understanding is that this is to be discussed in Section 2.3 |
| Xiaomi | Yes | Share similar views as Qualcomm. |
| BT | Yes | The behavior of the formula was never agreed so it is something that we cannot accept.We don’t agree with second bullet of QC inputs. RAN2#115e agreed “Step 0: NAS layer at UE provides slice information to AS layer at UE, including slice priorities”. RAN2 must work based on our own agreements and not based on hypothetical agreements on other groups. Even we don’t agree with the formula, we don’t see any valid reason to remove *SlicePriority* from it |
| OPPO | Yes | Using such a formula is unacceptable to us, we agree with the first two reasons mentioned by Qualcomm.In addition, the TP does not mention the slice availability check for the highest ranked and suitable cell of a specific frequency, and there is no clear view on whether/how to handle this issue.  |
| LGE | See comments | We’d like to further discuss the formular. After RAN2 decides whether the formular is accepted, we can work on TP. |
| Spreadtrum  | Yes  | Agree with QC |
| Lenovo, MotM | Yes | As mentioned as a response to previous question. |
| Samsung  | Yes | we share other companies view on the formula to calculate slice specific frequency priority.  |
| CMCC | Yes | Share similar views as Qualcomm. |
| NEC | Yes | Same as Qualcomm we prefer not to couple the priority with SlicePriority, slice priority order may not be so important, and we feel the solution over weight it |
| Apple | Yes | Though we agree with the intention, we can not accept with a formula. We suggest to introduce some general text to enable the same function. |

 **Summary:**

See summary after Q7

**Q7: Do you have any change proposals for the TP? (Can also propose new/draft text proposal inline in Word comments in Annex A)**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  | Text proposal for clause 5.2.4.5 can be based on text proposal of [R2-2111566](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs/R2-2111566.zip):Otherwise, cell reselection to a cell on a lower priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if:- The serving cell fulfils Srxlev < ThreshServing, LowP and a cell of a lower priority RAT/ frequency fulfils Srxlev > ThreshX, LowP during a time interval TreselectionRAT; and- More than 1 second has elapsed since the UE camped on the current serving cell.If one or more cells fulfil the above criteria for cell reselection with reselection priority values larger than [10] calculated as defined in 5.2.4.x, the UE shall validate whether sliceFrequencyPriority applies for the cell(s). If sliceFrequencyPriority does not apply for a validated cell, the UE shall use the c*ellReselectionPriority* for that frequency if any, and the UE shall not use sliceFrequencyPriority for this frequency for 300 seconds or until new slice priorities is received from NAS.NOTE: If there is no cellReselectionPriority for the frequency, or a cell with the cellReselectionPriority of the frequency does not fulfil the above criteria for cell reselection, the UE will not consider this cell as a candidate for cell reselection.Cell reselection to a higher priority RAT/frequency shall take precedence over a lower priority RAT/frequency if multiple cells of different priorities fulfil the cell reselection criteria. |
| Qualcomm | We have strong concern on the formular in Section 5.4.2.x. Thus, we propose to change it to below text:“For frequencies with a slice specific frequency priority for at least one slice in the slice list, the SliceBasedReselectionPriority is the slice priority frequency of the highest prioritized slice supported by the UE on the frequency ~~calculated by the formula:~~ ~~SliceBasedReselectionPriority = SlicePriority \* MaxReselectionPriorityValue + SliceReselectionPriority,~~~~where SlicePriority is the priority of the highest prioritized slice for which the UE have received~~ *~~SliceSpecificFrequencyPriority~~* ~~on the frequency. MaxReselectionPriorityValue is a constant which is higher than the maximum reselection priority, and SliceReselectionPriority is the~~ *~~SliceSpecificReselectionPriority~~* ~~of the highest prioritized slice on the frequency.”~~ In addition, we suggested below changes on some detailed issues:1. On ”the UE shall not use sliceFrequencyPriority for this frequency until the highest ranked cell changes on the frequency or until new slice priorities is received from NAS.”

We think the current CR just list two conditions to apply sliceFrequencyPriority: 1) the highest ranked cell changes on the frequency; 2) new slice priorities is received from NAS. However, we think one more condition is missing: 3) sliceFrequencyPriority is changed (e.g. the UE camps in a new cell, or sliceFrequencyPriority is changed in SIB, or gNB send new sliceFrequencyPriority via RRC release)1. One related issue is that if the UE uses c*ellReselectionPriority* because sliceFrequencyPriority does not apply, the UE may need to re-evaluate criteria of inter-frequency reselection criteria (below) because it depends on priority value of serving frequency and target frequency. Since the UE changed priority value of target frequency, one cell satisfying criteria (under high priority value) may not satisfy the criteria any more (under the legacy priority).

If *threshServingLowQ* is broadcast in system information and more than 1 second has elapsed since the UE camped on the current serving cell, cell reselection to a cell on a lower priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if:-    The serving cell fulfils Squal < ThreshServing, LowQ and a cell of a lower priority NR or E-UTRAN RAT/ frequency fulfils Squal > ThreshX, LowQ during a time interval TreselectionRAT.Otherwise, cell reselection to a cell on a lower priority NR frequency or inter-RAT frequency than the serving frequency shall be performed if:-    The serving cell fulfils Srxlev < ThreshServing, LowP and a cell of a lower priority RAT/ frequency fulfils Srxlev > ThreshX, LowP during a time interval TreselectionRAT; and |
| Huawei, HiSilicon | Prefer to use Annex A for more discussions. |
| Xiaomi | Prefer to use Annex A for more discussions. |
| BT | We prefer to use Annex A. |
| LGE | Prefer to use Annex A |
| Spreadtrum | Prefer to use Annex A for more discussions. |
| Lenovo, MotM | Prefer to use the next version (a more complete) version of Annex A. |
| Samsung  | We prefer to use Annex A for more discussion. |
| Apple | We prefer introducing a text for the same intention of Annex B. |

**Summary:**

In the discussion on Q5-Q7, the Rapporteur understands:

* Several companies considers the alternative TP in Annex B integrates the slice based cell reselection into the existing cell reselection mechanism, but the TP is not complete
* Several companies see issues with the TP. Some are common with the TP in Appendix A, but some are specific for this alternative, and have not been explicitly discussed in AN2.

In summary, we ask companies to indicate their preference whether to use/evolve the existing TP (Appendix A) or use the Alternative TP (Appendix B)

**Q8. Which specification approach to you prefer**

1. **Use TP according to Appendix A**
2. **Use TP according to Appendix B**

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B** | **Comments** |
| Nokia | B |  |
| Qualcomm | A removing FFS or B removing formular  | Our preference is: A removing FFS on slice looping > B removing formula in Section 5.4.2.x (as we suggested in Q5). |
| Huawei, HiSilicon | A |  |
| Intel | B |  |
| Xiaomi | A |  |
| BT | A |  |
| OPPO | A |  |
| LGE | A |  |
| CATT | A |  |
| Spreadtrum | A |  |
| Lenovo, MotM | A |  |
| Samsung  | A |  |
| CMCC | A |  |
| NEC |  | TP can be fixed after we conclude the principle, at the same time, both A and B can be refereed. Too earlier to choose one of them, since A needs improvement, principle in B is not agreed yet  |
| Apple | Modification to A |  |

**Summary Q8:**

Rapporteur realizes there is preference for using TP A, although some companies prefer the alternative TP B.

Rapporteur proposes the following:

1. Both Existing TP (TP in Annex A) and alternative TP (TP in Annex B) have issues and can be enhanced, based on company contributions. Should resolve the issues and comments raised in this email discussion (in 2.2.2 and 2.2.3).

## 2.3 Actions if wanted/prioritised slice is not supported in highest ranked cell on target frequency

### 2.3.1 Introduction

In [1], we (Ericsson) provided a TP for section 5.2.4.5 in 38.304, as well as a new section describing the UE’s actions when UE detects that the wanted/prioritised slice is not supported on the cell of the target frequency. Several companies had comments and other proposals on how to solve the issue.

Before discussing details in the TP’s, we think the wanted behaviour should be discussed. In short, this is the Ericsson proposal:

1. Recalculate the frequency priority based on slices supported in current cell.
2. Re-evaluate if the cell fulfills the cell re-selection criteria.
	1. Yes - > Reselect Cell
	2. No - > Continue cell re-selection procedure, using the recalculated frequency priority for this frequency until the highest ranked cell changes on the frequency.

**Q9: Do you agree with the main outline of the solution (Y/N)? (If not, provide alternative.)**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Nokia | No | 1) We prefer the use of legacy (non-slice aware) frequency priorities (option B of Q8) for this case.2) As the UE may never need to make any measurements on the frequency after not selecting the cell due to unsupported slices (e.g., the frequency has no other priority) a timer-based solution looks simpler (Option B of Q9) |
| Qualcomm  | Yes |  |
| Intel | Yes (with comments) | In principle we agree with this approach. Step 1 is needed if we are to consider the slice availability at a cell level as was agreed by RAN2. However, in our understanding, this “recalculation” of priority is for the neighbouring cell (note that by “cell” here, the calculation is done for the highest ranked cell but we will work with priorities per frequency) rather than current cell (we don’t think this is really a “recalculation” as such as the priority of that particular cell was not directly calculated before). For example, while the UE is in cell A, and cell B is the highest rank cell, then “recalculate” the priority of frequency of cell B based on the slices available in cell B (that is, this recalculation is done while the UE is still in Cell A). The step 2 in our understanding is part of the normal reselection procedure after the re-assignment of the priority for the cell B.  |
| BT | No | It is not clear why in point 1) it is required to recalculate the frequency priority. In the agreed procedure, “Step 1: AS sorts slices in priority order starting with highest priority slice”, slice prioritization is already done.In general, the question is formulated in a way that it refers to a single slice or a single slice group while step 7 is still FFS “Step 7: If the end of the slice list has not been reached go back to step 2”.We prefer a simple solution where step 7 is accepted. Then, if the UE reaches the end of the prioritized slices, it performs legacy cell reselection as captured in step 8. |
| Huawei, HiSilicon | Yes |  |
| OPPO | No | We wonder whether the frequency resetting is needed. It may introduce a consequent frequency priority resetting, which may complicate the UE behavior. If the need is justified, we prefer to use the legacy frequency priority for this case. |
| LGE | No | We prefer simpler operations and prefer to use frequency priorities provided by the network considering network slices.  |
| Spreadtrum | No | We can’t understand that why frequency priority should be recalculated based on slices supported in current cell. Based on the agreement of the step 4 and the step 6 in the solution 4:* Step 4: Starting with the highest priority frequency, perform measurements (same as legacy).
* Step 6: If there are remaining frequencies then go back to step 4.

In our understanding, if the wanted/prioritised slice is not supported in highest ranked cell on target frequency, and if there are remaining frequencies, it should re-execute the step 4, to perform measurements on second highest priority frequency. If the frequency list is empty, UE should use legacy frequency priority. |
| Lenovo, MotM | No | UE could end up on a cell that does not support any of its slices even if there was another frequency that supports its highest priority slice. |
| Samsung  | No  | we also prefer 1) the use of legacy (non-slice aware) frequency priorities (option B of Q8) for this case. |
| CMCC | Yes |  |
| NEC | No | We want to avoid recalculate the priority |
| Apple |  | There is no need to recalculate the priority. UE just goes to next frequency for cell evaluation. |

 **Summary:**

See summary after Q11.

### 2.3.2 Frequency priority when wanted/prioritised slice is not supported in highest ranked cell on target frequency

In Ericsson proposal in [1], the frequency priority is re-calculated the frequency priority for solution 4. It has also been proposed that the UE should use legacy priorities (to simplify).

In the following example, we show the difference between the two methods. In Figure 2, a network configuration is shown.

**Broadcasted Frequency Priorities**

Legacy priorities are used for the slice C (default), while there are specific priorities for slice A & B.

|  |  |  |  |
| --- | --- | --- | --- |
|  | Cell 1 | Cell 21 | Cell 21 |
|  | F1 | F2 | F1 | F2 | F1 | F2 |
| Slice A | - | 1 | - | 1 | - | - |
| Slice B | - | 1 | - | 1 | - | 1 |
| Legacy | 2 | 1 | 2 | 1 | 2 | 1 |

Figure 2 Example NW configuration

Frequency band F2

Frequency band F1

Example:

The prioritized slices of a UE are A and B, in priority order. The UE is in IDLE mode with ongoing services in slice A and B, and is camping in Cell 21. UE moves into the coverage area of cell 22.

This is the UE’s actions for cell re-selection if the frequency priorities are re-calculated:

1. Based on slice specific broadcast from cell 21, the frequency priority of F2 is highest. Cell 22 is highest ranked cell on the frequency.
2. Evaluate slice support on cell 22 -> Slice A is not supported.
3. Re-calculate slice priority for the frequency, (still using parameters broadcasted in cell 21, but assuming slice A is not supported): F2 have still highest priority, since slice B is supported in cell 22.
4. UE camps in cell 22
5. Register in cell 22, since new RA. -> PDU session on slice A closed, but continue using slice B.

If legacy priorities are used instead of re-calculated priorities, the UE’s cell re-selection will follow the steps:

1. Based on slice specific broadcast from cell 21, the frequency priority of F2 is highest. Cell 22 is highest ranked cell on the frequency.
2. Evaluate slice support on cell 22 -> Slice A is not supported.
3. Use legacy frequency priorities -> F1 is highest prio.
4. UE camps in cell 1
5. Register in cell 1, since new RA. -> PDU sessions on slice A and B closed.
6. AMF signals a Target NSSAI with slice A and B, and a RFSP with frequency F2 prioritized.
7. Cell 1 signals dedicated frequency priorities to UE with F2 prioritized.
8. UE camps in cell 22
9. Register in cell 22, since new RA. ->UE may start new PDU session on slice B.

It can be noted that this example is just a special case, and in many other scenarios, the legacy priorities will work just as good as re-calculated priorities. However, the re-calculated priorities will ensure that the UE directly camps on the frequency prioritized by solution 4.

**Q10: What frequency priorities should UE use to re-evaluate cell reselection?**

1. **Re-calculated frequency priorities**
2. **Legacy frequency priorities**

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B** | **Comments** |
| Nokia | B | Re-calculating frequency priorities may have some advantages in some cases, but makes the procedure much more complex, as e.g., the priority for a frequency may need to recalculate several times. |
| Qualcomm | A | We agree A can take low priority slice into consideration without introducing extra slice looping. Thus, we prefer to use Option A. But Option B is acceptable to us if majority prefer. |
| Intel | A | Please also see our response to Q7 for more details.However, we are also open to other solutions on how to capture the recalculation of frequency priorities  |
| Huawei, HiSilicon | B | We think that there are two ways for the UE to handle the supported cells in the slice info (i.e. a list of PCIs):* (1) UE only performs measurements based on the supported cells for the slice group, and it will select a best cell on a specific frequency
* (2) UE firstly performs measurements according to the broadcast frequency priorities, and then it will evaluate the highest ranked cell first

For (1), UE can get the PCI of SSB when it performs measurements, so it will exclude cells whose PCIs are not provided in the supported slice/slice groups of neighbor cells when evaluating the highest ranked cell, and thus the step 2) above won’t happen at all. For (2), it is related to Q8, and if it happens, we think B can work well so there is no need for UE to re-calculated frequency priorities. |
| OPPO | B |  |
| LGE | B |  |
| Spreadtrum  | B |  |
| Lenovo, MotM |  | The UE goes to the next frequency to see if the “selected” slice can be attained there.  |
| Samsung  | B |  |
| CMCC | A/B | We have no strong view on this issue, and option A or B is acceptable to us. |
| NEC | None of this | Simply UE just need to prioritize the best ranked cell supporting the selected slide if any, otherwise, follow the legacy procedure, i.e., best ranked cell supporting the selected slice will take the precedence. |

**Summary:**

See summary after Q11.

### 2.2.3 UE trigger to return to slice-based frequency priority

In Ericsson proposal [1], the UE is using the modified frequency priority until the highest ranked cell changes. A similar method is also used in the beginning of TS38.304 section 5.2.4.4:

*For the highest ranked cell (including serving cell) according to cell reselection criteria specified in clause 5.2.4.6, for the best cell according to absolute priority reselection criteria specified in clause 5.2.4.5, the UE shall check if the access is restricted according to the rules in clause 5.3.1.*

*If that cell and other cells have to be excluded from the candidate list, as stated in clause 5.3.1, the UE shall not consider these as candidates for cell reselection. This limitation shall be removed when the highest ranked cell changes.*

Other UE actions used in TS38.304 section 5.2.4.4 of the spec are:

*the UE may consider this frequency to be the lowest priority for a maximum of 300 seconds*

the UE shall not consider this cell and other cells on the same frequency as candidates for reselection for a maximum of 300 seconds.

We note that the rule of 300 ms is used in order to ensure that UE is not required to read SIB1 repeatedly when not able to find a suitable cell on a frequency. Since it will not be required that the UE shall read the SIB in order to evaluate slice support, we think the rule of “until highest cell changes” is more suitable.

**Q11: For how long should the re-calculated priorities be used?**

1. **Until highest ranked cell on the target frequency changes.**
2. **300 s.**
3. **Other.**

|  |  |  |
| --- | --- | --- |
| **Company** | **A/B/C** | **Comments** |
| Nokia | B, but | We do not support the proposal of priority recalculation, as we think that the use of legacy priority of the band (option B of Q8) is much simpler. Even in that case the UE may start using again the sliced-based priority for that frequency after a time (option B).  |
| Qualcomm | A | We agree with Rapporteur’s analysis. Slice specific cell reselection is one best-efforts enhancement. It is not necessary to bar the frequency for 300s just because of slice availability on best ranked cell. It is an overkill. |
| Intel | A | In general, barring or not considering the serving frequency for 300s does not seem the right approach when considering cell level priority based on slices supported in that particular cell. In the particular example above, just because when cell 22 is the highest ranked cell, entire frequency F2 should not be barred/not considered for cell reselection for 300s. After cell reselection, when cell 22 is no longer the highest ranked cell, frequency F2 should be considered again.  |
| LGE | A | If the re-calculation is accepted, A is preferred.  |
| Lenovo, MotM | C | We do not see any reason to penalize a frequency since this frequency may re-appear for the next “selected” slice. |

**Summary of Q9-Q11:**

Given the feedback by companies the Rapporteur proposes the following:

1. In case prioritised slice is not supported in the highest ranked cell on the target frequency, the UE uses legacy frequency priority for that frequency, until another cell on the target frequency becomes highest ranked cell on the target frequency changes

## 2.4 Other comments on Running 38.304 CR for RAN slicing

A draft revision (copy of the endorsed Running 38.304 CR for RAN slicing [1]) have been provided in the email discussion folder.

**Q12. Companies are invited to provide comments and modifications on the running CR that are not related to topics discussed in 2.2 and 2.3 (comments may also be inserted directly in the draft CR).**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |
|  |  |
|  |  |

**Summary Q12: -**

# 3 Conclusion

Based on the discussion and comments in this email discussion, the Rapporteur proposes the following.

1. RAN2 to further discuss and agree on UE behaviour for sliced-based priority re-selection
2. Solution 4, all NAS-prioritised slices with frequency priorities as well as legacy frequency priorities are consisdered, without iteration
3. Solution 4, original (UE first uses the frequency priorities of the highest priority slice, and if no cell is found, it will use the priorities of other slices in priority order, and at last it will use legacy priorities)
4. Solution 4, only highest prio slice considered, then legacy priorities considered
5. Both Existing TP (TP in Annex A) and alternative TP (TP in Annex B) have issues and can be enhanced, based on company contributions. Should resolve the issues and comments raised by companies in this email discussion (in 2.2.2 and 2.2.3).
6. In case prioritised slice is not supported in the highest ranked cell on the target frequency, the UE uses legacy frequency priority for that frequency, until another cell on the target frequency becomes highest ranked cell on the target frequency changes

# 4 References

[1] [R2-2110699](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_116-e/Docs/R2-2110699.zip) Slice-based cell re-selection algorithm (Ericsson)

[2] [R2-2110239](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_116-e/Docs/R2-2110239.zip) Running 38.304 CR for RAN slicing (CMCC)

# Annex A

*Start of changes*

5.2.4.1 Reselection priorities handling

Absolute priorities of different NR frequencies or inter-RAT frequencies may be provided to the UE in the system information, in the *RRCRelease* message, or by inheriting from another RAT at inter-RAT cell (re)selection. In the case of system information, an NR frequency or inter-RAT frequency may be listed without providing a priority (i.e. the field *cellReselectionPriority* is absent for that frequency). If priorities are provided in dedicated signalling, the UE shall ignore all the priorities provided in system information, including slice or slice group specific frequency priorities. If UE is in *camped on any cell* state, UE shall only apply the priorities provided by system information from current cell, and the UE preserves priorities provided by dedicated signalling and *deprioritisationReq* received in *RRCRelease* unless specified otherwise. When the UE in camped normally state, has only dedicated priorities other than for the current frequency, the UE shall consider the current frequency to be the lowest priority frequency (i.e. lower than any of the network configured values). If the UE is configured to perform both NR sidelink communication and V2X sidelink communication, the UE may consider the frequency providing both NR sidelink communication configuration and V2X sidelink communication configuration to be the highest priority. If the UE is configured to perform NR sidelink communication and not perform V2X communication, the UE may consider the frequency providing NR sidelink communication configuration to be the highest priority. If the UE is configured to perform V2X sidelink communication and not perform NR sidelink communication, the UE may consider the frequency providing V2X sidelink communication configuration to be the highest priority.

For a UE supporting slice-based cell reselection, if the UE is provided with slice priorities from NAS, and if slice or slice group specific frequency priorities are included in the cell reselection information used by the UE, UE performs slice-based cell reselection as described in clause 5.2.4.x.

…

(Irrelevant text omitted)

…

*New Clause*

5.2.4.X Slice-based cell reselection

The slice-based cell reselection procedure is the following:

- The UE selects the slice group with highest priority slice.

- The UE assigns the slice frequency priority corresponding to the selected slice group for NR frequencies received in *RRCRelease* or in the system information messages.

- The UE performs measurements and selects the highest ranked and suitable cell as candidate for camping according to clauses 5.2.4.2, 5.2.4.3, 5.2.4.4, 5.2.4.5, 5.2.4.6 using the slice group specific NR frequency priorities. - If the highest ranked and suitable cell supports the selected slice, then the UE camps on the cell.

Editor's Note: FFS: How the UE determines whether the highest ranked cell supports the selected slice.

Editor' Note: It is FFS whether the UE should select another slice group and perform cell reselection with the priorities of that slice group if no suitable cell supporting the selected slice group is found.

- If no suitable cell is found using slice group specific frequency priorities, then the UE continues to perform cell reselection according to clause 5.2.4 without considering slice group specific frequency priorities.

*End of changes*

# Annex B

*Start of changes*

5.2.4.1 Reselection priorities handling

Absolute priorities of different NR frequencies or inter-RAT frequencies may be provided to the UE in the system information, in the *RRCRelease* message, or by inheriting from another RAT at inter-RAT cell (re)selection. In the case of system information, an NR frequency or inter-RAT frequency may be listed without providing a priority (i.e. the field *cellReselectionPriority* is absent for that frequency). If priorities are provided in dedicated signalling, the UE shall ignore all the priorities provided in system information, including slice or slice group specific frequency priorities. If UE is in *camped on any cell* state, UE shall only apply the priorities provided by system information from current cell, and the UE preserves priorities provided by dedicated signalling and *deprioritisationReq* received in *RRCRelease* unless specified otherwise. When the UE in camped normally state, has only dedicated priorities other than for the current frequency, the UE shall consider the current frequency to be the lowest priority frequency (i.e. lower than any of the network configured values). If the UE is configured to perform both NR sidelink communication and V2X sidelink communication, the UE may consider the frequency providing both NR sidelink communication configuration and V2X sidelink communication configuration to be the highest priority. If the UE is configured to perform NR sidelink communication and not perform V2X communication, the UE may consider the frequency providing NR sidelink communication configuration to be the highest priority. If the UE is configured to perform V2X sidelink communication and not perform NR sidelink communication, the UE may consider the frequency providing V2X sidelink communication configuration to be the highest priority.

For a UE supporting slice-based cell reselection, if the UE is provided with slice priorities from NAS, and if slice or slice group specific frequency priorities are included in the cell reselection information used by the UE, UE calculates a Slice-Based Reselection Priority for each frequency, as defined in 5.2.4.x, and use these priorities for cell re-selection instead of the priorities in the field *cellReselectionPriority*.

…

(Irrelevant text omitted)

…

*New Clause*

#### 5.2.4.X Calculation of SliceBasedReselectionPriority

For each slice in the slice list received from NAS, the *SliceSpecificFrequencyPriority* is the *sliceSpecificFrequencyPriority* signalled for the slice group of the slice.

For frequencies with a slice specific frequency priority for at least one slice in the slice list, the SliceBasedReselectionPriority is calculated by the formula:

SliceBasedReselectionPriority = SlicePriority \* MaxReselectionPriorityValue + SliceReselectionPriority,

where SlicePriority is the priority of the highest prioritized slice for which the UE have received *SliceSpecificFrequencyPriority* on the frequency. MaxReselectionPriorityValue is a constant which is higher than the maximum reselection priority, and SliceReselectionPriority is the *SliceSpecificReselectionPriority* of the highest prioritized slice on the frequency.

For frequencies with no slice specific frequency priority for any slice included in the slice list received from NAS, the Slice Based Reselection Priority is set to the *CellReselectionPriority* of the frequency.

*End of changes*