**Source: Lenovo, Motorola Mobility – Prateek (pmallick@lenovo.com)**

**Title:****Details of Solution Direction Option 4**

**Document for:** **Discussion and Decision**

# **Introduction**

RAN2 has initiated the following long email discussion.

* [Post114-e][251][Slicing] Solution direction details for slice priorities in cell reselection (Lenovo)

      Scope: Discuss technical details for solution directions identified as part of [AT114-e][250] and identify their pros and cons. Can ask questions on how the solutions work, can discuss combined solutions etc.

      Intended outcome: Discussion report (may include also draft CRs if there is enough convergence)

      Deadline:  Long

Following are the agreements from the RAN2#114e:

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

Note: Signaling optimizations are not excluded.Note: "slice may also mean "slice group"* 1b: Frequency priority mapping for each of the slice (slice -> frequency(ies) -> absolute priority of each of the frequency) is part of the “slice info” agreed to be provided to the UE using both broadcast and dedicated signaling.
* 2: RAN2 kindly allow one more meeting cycle for understanding the necessity of Slice priority along with the following shortlisted solution directions for Idle mode mobility:

a) Option 4): Slice priority first looping over slice-frequency combinationb) Option 5): Maximize slice supportc) Option 6): Frequency priority of highest priority slice with adjustment based on actually supported slice(s) in best ranked cell, without multiple iterations of cell reselectiond) Option 7): Perform legacy cell reselection mechanism based on slice specific frequency priority* 3: RAN2 consider a scenario in its work for slice specific cell (re)selection where it is possible that (Suitable) cells on the same frequency belonging to different TAs support different Slice(s).
* 4: Working assumption: The Best cell principle according to absolute priority reselection criteria specified in clause 5.2.4.5 of TS38.304 needs to be met also for slice specific cell (re)selection.
* 6: In addition to proposal 2, following aspects are FFS:

a) Content of “Slice Info” – to what extent the information needs to be and should be provided to support the Principle in proposal 5b) If used, who provides the “Slice priority” (NAS/ AS, UE/ Network)c) Can RAN2 continue to use “intended” slice for initial registration and idle-mode mobilityd) How UE in each of the solutions from proposal 2 uses slice info for cell reselection if both slice info and existing cell reselection priority is signaled (in the SIB and/ or dedicated signaling) |

This email discussion will be carried in 3 phases:

Phase 1: Development of Solution directions to one well defined solution

Phase 2: Comparison among solutions out of Phase 1 and selecting the most reasonable one

Phase 3: Coming up with an acceptable draft CR for the selected solution if time and situation permits – depending on the outcome of Phase 2.

# **Phase 1**

## How does Solution Direction (Option 4) work?

The UE Idle mode behavior for slice priorities can be described in following sequence of operation:

Step 1: List Slices in the priority order starting with highest priority slice.

Step 2: Select the first (or next if from Step 7) slice in the list

Step 3: Assign the priorities to frequencies according to the priorities provided to the selected slice

Step 4: Perform cell search according to the legacy procedure using the priorities assigned in step 3

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

Step 6: If there are remaining cell frequencies then go back to step 3.

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

Step 8: Perform legacy cell reselection (using non-slice-based priorities i.e. for frequencies not corresponding to any slice support)

You may now share your understanding and comments in below table:

|  |  |
| --- | --- |
| Company Name | Comment |
| Nokia | 1) We see two variants of the procedure depending whether the checking of the RA of the UE is performed in step 5, i.e. step 5 can be the following:Step 5: If the highest ranked cell is suitable (as defined in 38.304) then camp on the cell and exit this sequence of operation2) If the TAC is used as slice group identifier then instead of the RA the UE may also check the TAC if the highest ranked cell supports the slice group that was used for cell reselection.3) An important disclaimer for the procedure is that the UE can re-use the measurements on a frequency when the cell reselection with new priorities are repeated.4) We also have a couple of editorial commentsa) We think that it would be clearer if we revise step 7 in the following way:Step 7: If the end of the slice list has not been reached go back to step 2b) We may simplify the description of step 4-6 to emphasize the similarities to legacy procedure in the following way:Step 4: Perform cell reselection according to the legacy procedure using the priorities assigned in step 3Step 5: If a suitable cell is found and belongs to the UE’s RA then camp on the cell and exit this sequence of operation. If no suitable cell is found go to step 7.Step 6: Exclude the frequency of the suitable cell that does not belong to the UE’s RA and go back to step 4c) In the variant when checking of RA is not performed the description can be the following:Step 4: Perform cell reselection according to the legacy procedure using the priorities assigned in step 3Step 5: If a suitable cell is found then camp on the cell and exit this sequence of operation. If no suitable cell is found go to step 7.Step 6: Void |
| Xiaomi | In our understanding,in step 5, the intention of RA or TAC checking or some other parameters checking is to check whether the reselected cell supports the intended slice, we agree on this intention and think it is necessary for UE to avoid reselecting a cell not supporting the intended slice. However, we disagree on the reselected cell limited into RA. If the intended slice is requested NSSAI outscope of allowed NSSAI, the reselected cell maybe out of RA which is possible and allowed in current spec. Thus we prefer to just express the intended to reselect a cell supporting the intended slice without any technical detail on how to check in this solution direction.Step 5: If the highest ranked cell is suitable (as defined in 38.304) and supports intended slice then camp on the cell and exit this sequence of operationAs we agreed last meeting that not all cells of the same freq can support the same slices, in this case the highest ranked cell just according to the radio condition may not support the intended slice. Thus we think the cell ranking should also consider the supported slice and it is more important. Step 1: List Slices in the priority order starting with highest priority slice.Step 2: Select the first (or next if from Step 7) slice in the listStep 3: Assign the priorities to frequencies according to the priorities provided to the selected sliceStep 4: Perform cell search according to the legacy procedure using the priorities assigned in step 3Step 5a : The UE shall perform ranking of all cells supporting the intended slice.Or Step 5b: UE shall perform cell reselection to the cell above the configured threshold and support the intended slice. If there are multiple such cells, UE shall perform cell reselection to the highest ranked cell among them.Otherwise(i.e. no cell above the threshold and supports intended slice), UE perform cell reseletion to the highest ranked cell.Step 6: If the highest ranked cell is suitable (as defined in 38.304) then camp on the cell and exit this sequence of operationStep 7: If there are remaining cell frequencies then go back to step 3.Step 8: If the slice list is not empty go back to step 2Step 9: Perform legacy cell reselection (using non-slice-based priorities i.e. for frequencies not corresponding to any slice support) |
| OPPO | 1. If we understand correctly, the checking “and belongs to the UE’s RA” in step 5 is used to exclude the cell that does not support the intended slice, but this description may block UE reselecting the cell that supports the intended slice but is not in UE RA. In addition, we do not expect the RA information is delivered and used in UE AS for cell reselection, which is an enhancement to current spec. A general description for step 5 should be:

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 1. For step 7, we think the procedure of slice looping will introduce the huge latency for the cell reselection/camping, especially when there are multiple intended slices existing (e.g. 8 intended slices). Thus, one variant of the whole procedure is to avoid step 7, i.e. if there is no suitable cell found for the highest priority slice, UE can fall back to legacy cell reselection directly.
2. We also suggest to simplify the description of step 4-6 to match current cell reselection procedure:

Step 4: Perform cell reselection according to the legacy procedure using the priorities assigned in step 3Step 5: If a suitable cell is found which supports the selected slice in step 2 then camp on the cell and exit this sequence of operation. |
| Qualcomm | 1. Same view as Nokia and OPPO, we prefer to remove the checking “and belongs to the UE’s RA” in step 5. “RA” is a higher layer concept which should not be used in cell reselection procedure. OPPO’s suggested change looks good to us:

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 operation1. For Step 7, we have same view as OPPO that the multiple iteration for each slice will introduce extra big latency of cell reselection. This is conflicted with the intention to introduce “quick” slice specific cell reselection. If disagree, please explain why it is quicker than legacy cell reselection? Thus, we prefer no fallback, i.e. the step 7 can be removed.

In summary, our suggested changes are:Step 1: List Slices in the priority order starting with highest priority slice.Step 2: Select the first (or next if from Step 7) slice in the listStep 3: Assign the priorities to frequencies according to the priorities provided to the selected sliceStep 4: Perform cell search according to the legacy procedure using the priorities assigned in step 3Step 5: If the highest ranked cell is suitable (as defined in 38.304) and ~~belongs to the UE’s RA~~ supports the selected slice in step 2 then camp on the cell and exit this sequence of operationStep 6: If there are remaining cell frequencies then go back to step 3.~~Step 7: If the slice list is not empty go back to step 2~~PB) We discussed this with Oppo and our response is:If we delete this step then only the most important slice is considered and other slices do not play any role. In practice there will not be many frequencies in a geo and as Nokia suggested, “that the UE can re-use the measurements on a frequency when the cell reselection with new priorities are repeated”. I think total number of frequency availability (carrier deployment) will not change due to RAN Slice enhancements – and like legacy, different solution directions (not just SD 4) will need to scroll through the frequencies starting with the highest priority one to find a suitable cell. Network has still full control i.e. how much (and if at all) SliceInfo it wishes to provide, it can control that. The RAN slicing feature specification should cater to a more generalized slice support not just limiting to the most important Slice.Step 8: Perform legacy cell reselection (using non-slice-based priorities i.e. for frequencies not corresponding to any slice support) |
| Huawei, HiSilicon | Agree with OPPO comment (1) and (2).For step 7, no matter intended slices or slice groups are considered for slice looping, extra delay may be introduced and it depends on the number of intended slices/slice groups, so we agree to avoid multiple iteration for slices. |
| Intel | 1. The checking of RA for the highest ranked cell in Step-5 limits the UE to just the allowed slices which may not be the intention of the UE. Hence we also agree with Nokia, OPPO and QC that this can be removed. Also, as mentioned by OPPO and QC, it would also require the UE to read the SIB of the highest rank cell which is currently not needed by the UE.
2. In Step-1, there is the list of slices. What is this list? Allowed slices?
3. In Step-5, some companies (OPPO and QC) modify the checking to whether the highest ranked cell supports the selected slice in Step-2.  Is the slice availability of the neighbour frequency/cell provided by the serving cell in the SIB or the UE has to read the SIB of the neighbour cell?
4. What information is broadcast as slice availability for each frequency in SIB?
 |
| ZTE | Agree with OPPO’s comment 1 and 2.For step 7, we share the same understanding with OPPO and QC that the procedure of slice looping will introduce the huge latency for the cell reselection/camping, especially when there are multiple intended slices existing . We understand the cell reselection according to the allowed S-NSSAI is a best effort enhancement as UE may initiate MO data on any slices in the allowed list, not exactly the slice associated with slice specific priority it has used during reselection. For example, assuming that we have slice#1/2/3 in the allowed list and UE end up in a cell supporting slice#2 with the loop, it is still possible UE tries to initiate MO data on slice#3 or slice#1 afterwards. With the slice specific reselection priority, we just increase the probability of the right choice but not ensure UE will reselect to a cell supporting a slice UE will initiate MO service on.Thus, we understand it makes not much difference with the loop or without, considering the highest priority slice would be sufficient. This option 4 would be cleaner and simpler without this step 7. |
| NEC | See below suggested wording on this solution based on our understanding and preference, reasons of change are inserted in lines:Step 0: list all cell frequencies that UE should consider for cell reselection as the remaining cell frequencies (i. e. intra-frequency and inter-frequencies indicated by system information or RRC Release message)Step 1: List Slices in the priority order starting with highest priority slice.Step 2: Select the first (or next if from Step 7) slice in the listStep 3: Selects the cell frequencies supporting the selected slice from the remaining cell frequencies list, and Assign the priorities to frequencies according to the priorities provided to the selected slice[Reason of changes: to clarify that only frequencies supporting the selected slice is considered in step3, therefore there may have remaining frequencies as indicated in step 6; alternatively, delete step6, and clarify how to assign priority to a frequency which does not support the selected slice and does not provide priority corresponding to the selected slice]Step 4: Perform cell search according to the legacy procedure using the priorities assigned in step 3 among the selected frequenciesStep 5: If the highest ranked cell is suitable (as defined in 38.304then camp on the cell and exit this sequence of operation, if no suitable cell is found, exclude these selected frequencies from remaining cell frequencies[Reason of deleting the text: for simplicity, we prefer not to further check whether the best ranked cell support the UE’s intended/selected slice. As indicated by ZTE, cell reselection according to the allowed S-NSSAI is a best effort enhancement, no need to be perfect. Using cell-level service information to influent the result is complicate, and question #3 asked by intel will needs be addressed]Step 6: If there are remaining cell frequencies then go back to step 3.Step 7: If the end of the slice list has not been reached go back to step 2Step 8: Perform legacy cell reselection (using non-slice-based priorities i.e., for frequencies not corresponding to any slice support)We prefer solution 4 or solution 5 which are relatively simply and serve the purpose in most of time. However, we notice that no solution can work perfectly, but we should be able to live with it:* With solution 4, UE may prioritize/select a frequency supporting UE’s most important slice but not the frequency supporting all UE’s intended slices
* On the opposite, with solution5, UE may select a frequency supporting more UE intended slices but not the most important slice.
 |

## What is the content of “Slice Info” when provided using Broadcast and dedicated signaling?

Without attempting to define stage-2 ASN.1 coding (and rather just for understanding purposes), Slice-Info could look like:

(removed the ASN.1 like structuring based on company feedback and replaced this with the following table)

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

|  |
| --- |
| Slice info |
| For the serving frequency |
|  | Slice id-1/Slice Group Id-1 | Slice specific Freq-x-priority (Optional) |
| Slice id-2/Slice Group Id-2 | Slice specific Freq-x-priority (Optional) |
| .... |  |
| For inter-frequency |
| Frequency 1 | Slice id-1/Slice Group Id-1 | Slice specific Freq-x-priority (Optional) |
| Slice id-2/Slice Group Id-2 | Slice specific Freq-x-priority (Optional) |
| ... | ... |
| Frequency 2 | Slice id-1/Slice Group Id-1 | Slice specific Freq-x-priority (Optional) |
| Slice id-2/Slice Group Id-2 | Slice specific Freq-x-priority (Optional) |
| ... | ... |
| ... |

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

AS receives the Slice Priority from NAS and how NAS receives it is left for SA2/ CT1 to solve.

## Can “intended” slice as defined in TR38.832 be used “as is” for in this Solution Direction?

 “Yes”. The content of “intended slice” i.e. which slice is signalled by NAS as part of “intended slice” is left to NAS. For mobility related reselections, the AS uses the “intended slice(s)” last received from NAS.

# **Annex**

*Somewhat* in line with the TR 38.832 following geographies are depicted – only as a checkpoint to see how your solution works here. Only “slice” is mentioned but it can also mean “slice group”. A general term of “desired slice” is used to intentionally avoid using the term “intended slice”. A “desired slice” for one solution may mean higher priority slice (if a slice priority exists) or, for another solution may just point to the slice corresponding to the highest absolute priority for a supporting frequency.



Q1: Best Cell (Cell 1) on a high priority frequency (F1) does not support the-most-desired Slice (Slice 2). Where should the UE camp (or reselect)? Only one of TA1 or TA2 is part of UE’s RA.

UE behavior from this option: The UE camps on Cell 1, based on the best cell principle.



Q2: Best Cell (Cell 4) on a high priority frequency (F1) does not support UE’s only desired Slice (Slice 1). Where should the UE camp (or reselect)? Only TA1 is part of UE’s RA.

UE behavior from this option: On Cell 5 to be able to use Slice 1.



Q3: Only TA1 is part of UEs Registration area. All Slices (1, 2, 3 and 4) are part of UEs Slice list. From radio quality Cell 6 is the best cell on F1. Where should the UE camp (or reselect) if

1. Slice 1 is most desired
2. Slice 4 is most desired

UE behavior from this option: In both cases the UE selects cell 6, the best radio cell.



Q4: F1 has the highest absolute frequency priority according to the *cellReselectionPriorities* provided to the UE but none of the UE desired slices prefer F1 (as configured in the Slice-Info) and cell 8 does not broadcast any Slice support indication. Slice 1 is the only desired slice for the UE and UE’s RA consist of:

1. Both TA1 and TA2 (assuming this is not violating “homogeneous principle in the UE’s RA since cell 11 - TA1 does not prohibit use of any particular slice)

UE behavior from this option: UE selects cell 8 due to F1 being the highest priority. Here we assume that Cell 8 has not been upgraded for RAN slicing yet but that does not necessarily mean that the UE’s required QoS will not be fulfilled here. And, if required cell 8 can handover the UE to cell 9 when data from an application arrives that is not better served in cell 8.

1. Only TA1

UE behavior from this option: Same behavior as above.

1. Only TA2

UE behavior from this option: UE selects cell 9.



Q5: F1 has the highest absolute frequency priority according to the *cellReselectionPriorities* provided to the UE but none of the UE desired slices prefer F1 (as configured in the Slice-Info). Cell 10 supports only Slice 2 but Slice 1 is the only desired slice for the UE. UE’s RA consist of:

1. Only TA1

UE behavior from this option: UE camps on Cell 11 since Slice 1 can be used – UE will need to perform a RAU/ TAU.

1. Only TA2

UE behavior from this option: Same procedure as above but without a RAU/ TAU.

# **Annex-2**

List of companies contributing to this option

|  |  |  |
| --- | --- | --- |
| Company Name | Delegate Name | Email Address |
| Nokia | Gyuri Wolfner | gyorgy.wolfner@nokia.com |
| Xiaomi | Xiaofei Liu | liuxiaofei@xiaomi.com |
| OPPO | Zhe Fu | fuzhe@OPPO.com |
| Qualcomm | Peng Cheng | chengp@qti.qualcomm.com |
| Huawei, HiSilicon | Jun Chen | jun.chen@huawei.com |
| Intel | Seau Sian Lim | Seau.s.lim@intel.com |
| ZTE | Yuan Gao | gao.yuan66@zte.com.cn |
| NEC  | Yuhua Chen | Yuhua.chen@emea.nec.com |