**3GPP TSG-RAN WG2 Meeting #115 e R2-21xxxxx**

**E-Meeting, August 09th - 27th  2021**

**Source: Lenovo, Motorola Mobility**

**Title:****Comparison of Solution Options**

**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 combination  b) Option 5): Maximize slice support  c) 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 reselection  d) 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 5  b) 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 mobility  d) 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; currently we are in the second phase:

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.

# **Solution Options**

# **Option 4**

## How does it 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; FFS: How the UE determines whether the highest ranked cell supports the selected slice.

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

**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 (using non-slice-based priorities i.e. for frequencies not corresponding to any slice support)

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

In a tabular form the Slice Info looks like:

|  |  |  |
| --- | --- | --- |
| 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 |
| … | … | … |

## 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?

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.

# **Option 5**

## How does it work?

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

## Who provides the “Slice priority” (NAS/ AS, UE/ Network)

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

# **Option 6**

## How does it work?

Option 6 can be regarded as one enhanced solution on top of Option 4 if slice availability info on neighbor cells are provided to UE. Compared with Option 4, it has below 2 differences:

1. Adjust frequency priority based on actually supported slice(s) in best ranked cell, to avoid wrongly setting a too high frequency priority corresponding to unsupported slice.
   * In Option 4, if highest ranked cell is suitable but doesn’t support the UE’s intended highest priority slice, the frequency is excluded.
2. There is no need for UE to perform multiple iterations of cell reselection (i.e. remove Option 4’s Step 7 which is labelled as FFS)

Please note that when slice availability info on neighbour cells are absent, Option 6 fallbacks to Option 4 (removing slice iteration in Step 7). The detailed procedure is illustrated in Section 2.3.1.1 and an example can be found in Section 2.3.1.2.

In addition, Option 6 is not exclusive-mutual with other Options. It can work with Option 4 and Option 5 together. Its relationship with Option 4 and Option 5 is provided in Section 2.3.1.3.

*2.3.1.1 Procedure step*

Based on companies’ input, the “slice info” are:

* **From SIB/RRC release**: A list of {Slice group ID, list of [frequency, frequency priority value (Optional), slice availability (Optional)]}
  + “slice availability” is a list of neighbor cell PCI(s) which support the slice group.
  + An example is illustrated in Table 2.3.1

|  |  |  |  |
| --- | --- | --- | --- |
| SliceInfo-List | | | |
| Slice-Group Id-1 | Supported-on-Freq-x | Freq-x-priority (Optional) | PCI 1, PCI2, ... (Optional) |
| Supported-on-Freq-y | Freq-y-priority (Optional) | PCI 3, PCI4, ... (Optional) |
| Slice-Group Id-2 | Supported-on-Freq-x | Freq-x-priority (Optional) | PCI 5, PCI6, ... (Optional) |
|  | Supported-on-Freq-z | Freq-z-priority (Optional) | PCI 7, PCI8, ... (Optional) |
| … | … | … |  |

**Table.2.3.1: An example of “slice info” in SIB/RRC release**

* **From NAS**: Slice priority
  + Whether to introduce NAS signaling is left for SA2/ CT1 to solve. If SA2/CT1 don’t agree to introduce new NAS signaling, it is up to UE implementation.

Option 6 works when both per-slice frequency priority and slice availability are present in SIB/RRCRelease. The procedure step can be described in following sequence of operation **on top of option 4** with different steps highlighted (i.e. add Step 5-a/5-b, remove Step 7):

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

**Step 2**: Select the first 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 5-a**: Else if the highest ranked cell is suitable (as defined in 38.304) but **doesn’t support** the selected slice in step 2, then the priority value of this frequency is changed to the priority value of the highest priority slice supported by both UE and the highest ranked cell (i.e. intersection slice set).

**Step 5-b**: With updated frequency priority, if legacy inter-frequency cell reselection criteria (as illustrated below) is met, camp on the cell and exit this sequence of operation.

* If priority of target frequency is **higher than** serving frequency, Srxlev > ThreshX, HighP during a time interval
* If priority of target frequency is **lower than** serving frequency, Srxlev < ThreshServing, LowP and Srxlev > ThreshX, LowP during a time interval

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

**~~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 (using non-slice-based priorities i.e. for frequencies not corresponding to any slice support)

*2.3.1.2 Example*

One example is illustrated in Figure2.3.1.



**Figure.2.3.1 Example scenario**

Then, the UE performs below cell reselection procedure:

UE is provided below “slice info”:

* Cell 3’s SIB provides:
  + List 1: {eMBB, F1, priority 2, (Cell 1, Cell2}}
  + List 2: {eMBB, F2, priority 3, (Cell3)}
  + List 3: {URLLC, F1, priority 8, (Cell 1)}
  + List 4: {URLLC, F2, priority 7, (Cell 3)}
* UE’s slice priority: URLLC > eMBB (from NAS)
* Step 1: List slice in priority order: {URLLC, eMBB}
* Step 2: Select 1st slice (i.e. URLLC)
* Step 3: The UE derives frequency priority value of F1 is 8 and F2 is 7 (i.e. priority of F1 is taken from List 3 and priority of F2 is taken List 4)
* Step 4: Assuming priority of F1 is 8, the UE performs IDLE measurements for cell 1 and cell 2
* Step 5: Both Cell 1 and 2 are suitable. Cell 2 is best ranked cell due to it being close to UE (-82dBm>-92dBm).
* Step 5-a: Because only eMBB is supported in Cell 2, UE decreases priority value of F1 from 8 to 2 (value 2 is from List 1 for eMBB).
* Step 5-b: Because priority value of F1 (value 2) is lower than serving frequency F1 (value 7), the UE checks whether condition of reselection to Cell 2 is fulfilled, i.e. whether cell 3 fulfils Srxlev < ThreshServing, LowP and cell 2 fulfils Srxlev > ThreshX, LowP. The condition is not satisfied because RSRP of serving cell (cell 3) is larger than ThreshServing, LowP. Thus, the UE stay in Cell 3.
  + Please Note if without priority adjustment for F1 in Step 5-a, the UE will regard priority value of F1 is 8 (higher than serving frequency). Then, the UE just need to check whether Srxlev > ThreshX, HighP, the condition of reselection to Cell 2 is fulfilled. So, the UE will reselect to Cell 2 supporting only eMBB, which is not intended behavior.
* Step 6 and 8 are skipped because no remaining frequencies are left

*2.3.1.3 Relationship with Option4 and Option 5*

Option 6 is not exclusive-mutual with other Options:

* It can be regarded as one enhanced solution on top of Option 4 if slice availability info on neighbor cells are provided to UE (besides per-slice frequency priority required by Option 4).
* When slice availability info is absent but per-slice frequency priority is present, it fallbacks to Option 4 (removing slice iteration in Step 7).
* When per-slice frequency priority is absent, the UE performs Option 5 with the assumption that all slices are same priority.

It is illustrated in Table 2.3.2:

|  |  |  |
| --- | --- | --- |
| Slice availability of neighbor cell  Per-slice frequency priority | Absent | Present |
| Absent | Option 5 | Option 5 |
| Present | Option 4 removing slice iteration Step 7 | Option 6 (i.e. Option 4 + Step 5-a/5-b) |

**Table.2.3.2: Relationship of Option 6 with Option 4/5**

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

In a tabular form the Slice Info looks like:

|  |  |  |  |
| --- | --- | --- | --- |
| SliceInfo-List | | | |
| Slice-Group Id-1 | Supported-on-Freq-x | Freq-x-priority (Optional) | PCI 1, PCI2, ... (Optional) |
| Supported-on-Freq-y | Freq-y-priority (Optional) | PCI 3, PCI4, ... (Optional) |
| Slice-Group Id-2 | Supported-on-Freq-x | Freq-x-priority (Optional) | PCI 5, PCI6, ... (Optional) |
|  | Supported-on-Freq-z | Freq-z-priority (Optional) | PCI 7, PCI8, ... (Optional) |
| … | … | … |  |

* Option 6 is applied when both per-slice frequency priority and Slice availability on neighbor cell are present.
* When slice availability info is absent but per-slice frequency priority is present, it fallbacks to Option 4 (removing slice iteration in Step 7).
* When per-slice frequency priority is absent, the UE performs Option 5 with the assumption that all slices are same priority.

## Who provides the “Slice priority” (NAS/ AS, UE/ Network)

UE’s AS receives the Slice Priority from NAS. Whether to introduce NAS signaling is left for SA2/ CT1 to solve. If SA2/CT1 don’t agree to introduce new NAS signaling for slice priority, it is up to UE implementation.

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

Yes, “intended slice” is signaled by NAS. The signaling details can be discussed further (e.g. left to SA2/CT1 to decide).

# **Option 7**

## How does it work?

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

## Who provides the “Slice priority” (NAS/ AS, UE/ Network)

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

# **Behaviours in different scenarios**



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.

Option 4: The UE camps on Cell 1, based on the best cell principle.

Option 5:

Option 6: The UE camps on Cell 1, based on the best cell principle.

Option 7:



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.

Option 4: UE behavior from option 4: On Cell 5 to be able to use Slice 1.

Option 5:

Option 6: Because best Cell in F1 (Cell 4) doesn’t support Slice 1, UE will decrease priority of F1 and thereby stay in Cell 5 to use Slice 1 (i.e. not reselection to F1 as inter-frequency cell reselection criteria is not met)

Option 7:



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

Option 4: UE behavior from option 4: In both cases the UE selects cell 6, the best radio cell.

Option 5:

Option 6: In both cases the UE selects cell 6, the best radio cell.

Option 7:



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)

Option 4: UE selects cell 9 on F2 since F1 does not explicitly support Slice 1.

Option 5:

Option 6: As no slice availability info, Option 6 fallback to Option 4, i.e. UE selects cell 9 on F2 since F1 does not explicitly support Slice 1.

Option 7:

1. Only TA1

Option 4: Same behavior as above and UE needs to perform a RAU procedure.

Option 5:

Option 6: As no slice availability info, Option 6 fallback to Option 4, i.e. same behavior as above and UE needs to perform a RAU procedure.

Option 7:

1. Only TA2

Option 4: UE selects cell 9.

Option 5:

Option 6: As no slice availability info, Option 6 fallback to Option 4, i.e. UE selects cell 9.

Option 7:



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

Option 4: UE camps on Cell 11 since Slice 1 can be used – UE will need to perform a RAU/ TAU.

Option 5:

Option 6: Because best Cell in F1 (Cell 10) doesn’t support Slice 1, UE will decrease priority of F1 and thereby this results in priority of F2 becoming higher than F1. The UE finally camps on Cell 11 to use Slice 1. The UE will also need to perform a RAU/TAU as Cell 11 is in different TA.

Option 7:

1. Only TA2

Option 4: Same procedure as above but without a RAU/ TAU.

Option 5:

Option 6: Because best Cell in F1 (Cell 10) doesn’t support Slice 1, UE will decrease priority of F1 and thereby it results in priority of F2 becoming higher than F1. The UE finally camps on Cell 11 to use Slice 1. But the UE will NOT need to perform a RAU/TAU as Cell 11 is in same TA.

Option 7:

# **Comparison of options**

**Q1: Is the solution proposed out of Phase 1 clear enough and covering relevant details?**

|  |  |
| --- | --- |
| **Solution 4** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 5** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 6** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 7** | |
| Company Name | Comments |
|  |  |
|  |  |

**Q2: How well the given solution fulfils relevant Objective set out in the WID [RP:210912] and is in accordance with the intention of the study [TR 38.832]?**

|  |  |
| --- | --- |
| **Solution 4** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 5** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 6** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 7** | |
| Company Name | Comments |
|  |  |
|  |  |

**Q3: How easy/difficult is to implement/ specify the solution?**

|  |  |
| --- | --- |
| **Solution 4** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 5** | |
| Company Name | Comments |
|  |  |
|  |  |

|  |  |
| --- | --- |
| **Solution 6** | |
| Company Name | Comments |
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|  |  |
| --- | --- |
| **Solution 7** | |
| Company Name | Comments |
|  |  |
|  |  |

**Q4: Which Option does your company support?**

|  |  |  |
| --- | --- | --- |
| Company Name | Supported Option | Comments |
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# **Conclusion**

# **Contact list**

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| Company Name | Delegate Name | Email Address |
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