**3GPP TSG-RAN** **WG2 Meeting #114 electronic R2-210xxxx**

**Online, 19 – 27 May, 2021**

**Source: Samsung**

**Title: Summary of email discussion [Post113bis-e][061][feMIMO] InterCell mTRP and L1L2 mobility (Samsung)**

**Document for: Discussion and Decision**

**Agenda Item: x.xx**

# Introduction

This document summarizes the following email discussion.

* [Post113bis-e][061][feMIMO] InterCell mTRP and L1L2 mobility (Samsung)

 Scope: Based on R1 LS and discussion at R2 113bis-e, achieve better understanding of impact in R2, pave the way for potential high level decisions, pave the way for decisions needed to reply to R1 LS, identify questions that R2 shold ask R1, if any (can e.g. apply P3 from R2-2104632). Intention to provide a reply to R1 from next meeting.

 Intended outcome: Report

 Deadline: Long

In RAN2#113bis-e meeting, RAN2 intensively discussed the L1/L2 centric mobility based on RAN1 LSes [1][2] and RAN2 tried to share the understanding on this issue. As results of the offline discussion [3], RAN2 progress some aspects to support L1/L2 centric inter-cell mobility but the main use cases what RAN1 intended are stil unclear i.e. companies have different understanding the scope of this issue.

[R2-2104632](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_113bis-e%5CDocs%5CR2-2104632.zip) Summary of email discussion [AT113bis-e][035][feMIMO] L1L2 Centric Mobility Samsung

DISCUSSION

P1

- Nokia think the intent is that we indicate something to R1, extra-cell?

- ZTE think indeed the term is strange.

- Chair wonder what is the L1 difference of non-serving cell? SS and ZTE think the only difference is PCI otherwise nothing?

P2

- Chair think it would be good to understand the m-TRP model in order to understand to what extent HO model is needed and how it can work.

- replying to Q from Intel. Samsung think RAN2 can provide understanding for both cases.

- Ericsson think the LS is about two separate questions, mTRP and HO and both are supported from R1 perspective, both Scenario 1` and 2 are applicable and included.

- vivo has similar understanding as Ericsson, need to assume both. Not sure there is enough Tus in R2, can discuss more on common parts between these cases.

- Oppo think mTRP is scenario 1 and HO is scenario 2. Confusion seems to apply for scenario 2. RAN1 hasn’t finished their job so we can focus on Secnario 1 and possibly HO for scenario 2.

- MTK think the scenarios are different and think that in scenario 2 Pcell is changed, can ficus on scenario 1.

- Xiaomi think we should first focus on scenario 1. For Scenario 2 we’d anyway need to send an LS.

- Huawei think the key difference between 1 and 2 is if the serving cell shall be changed. Think we can just agree P2. Also see some commonality between the scenarios.

- Apple think we should cover scenario 1 and 2, not sure what is the new issue of scenario 1.

- QC think the two WI objectives are separate in R1 and this LS is ony about L1 L2 mobility and changing the cell.

- FW also think the amin difference between scenarios is wheher we need to change the Pcell, need to start with Scenario 1 to see impact of L2 procedures for mobility etc.

- LG think it is easy to support mTRP objective but not the mobility objective and think due to TU we should focus on the first.

- Nokia think we can ask R1 about the intentions.

- Samsung think that scenario 1 and 2 are different and 2 brings much more R2 impact, we can focus on scenario 1 now.

P4

- Nokia think the plural of candidate cell(s) should be removed.

- intel wonder whether this proposal is intended to address both HO and mTRP. SS think this is only for mTRP. ZTE think that if this is just for mTRP then this is invisible to the UE. ZTE think this applies to HO

- Chair: it seems this is widely supported but unclear what problem is addressed.

P6

- Huawei wonder how different C-RNTI will work, it may impact ID handling for the RACH procedure.

* The term “non-serving cell(s)” seems to cause confusion, and should be changed (to be consistent with the current RAN2 definitions).
* RAN2 further study the impact on L1/L2 centric mobility for inter-cell multi-TRP-like model and inter-cell HO-like model.
* Chair: while unclear, there seems to be support for: RRC provides the pre-configured configuration of “the candidate cell for L1/L2 centric mobility” (FFS if > 1), and L1/L2 signaling can be used/feasible for the dynamic switching of the pre-configured value.

Chairman: For now, Work on both mTRP and Mobility scenarios.

* Continue by long email discussion, to better understand impact in R2, pave the way for potential high level decisions, and get replies and Q to R1 LS

In this offline discussion, RAN2 tried to get better understanding of the RAN2 impact on both inter-cell multi-TRP-like model and inter-cell HO-like model as chariman suggested. Based on the RAN2 impact on both scenario, RAN2 will be able to provide the reply LS with the answers for the questions in RAN1 LS [2].

# Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

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| --- | --- | --- |
| Company | Name | Email Address |
| Samsung | Seungri Jin | seungri.jin@samsung.com |
| Nokia | Tero Henttonen | tero.henttonen@nokia.com |
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# Discussion:

## RAN2 impacts on L1/L2-centric inter-cell mobility

In R2-2102625 (LS on Agreements Pertaining to L1/L2-Centric Inter-Cell Mobility)[1], all agreements on L1/L2 centric inter-cell mobility issue are included. First, it is very important RAN2 know what is the scope of this WI especially for support L1/L2 Centric Inter-Cell Mobility. One hint based on the RAN1 agreements in [1] is that RAN1 initially assumed that this feature potentially can extend the Rel-16 mobility mechanism but the main outcome seems to be dynamic TCI state update using the TCI framework for inter-cell case (i.e. to extend Rel-15/16 mTRP operation for intra-cell to inter-cell), see below yellow highlight.

The detail functionalities to support the TCI state update (beam indication) for DL reception from and UL transmission to non-serving cell(s) – at least on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH are also listed as green highlight below. According to this required functionalities,

1. UE receives from serving cell, configuration of SSBs/CSI-RSs of non serving cell for beam measurement.
2. UE performs beam measurement for non-serving cell and report it to serving cell.
3. Based on the above reports, TCI state of non-serving cell is activated from the serving cell (by L1/L2 signaling).
4. Prior to and upon activation of TCI state of non-serving cell, actions performed by UE are unclear and needs discussion.
	* UE starts receiving UE-dedicated PDSCH, PDCCH from non serving cell
	* UE starts transmitting UE-dedicated PUSCH, and PUCCH to non serving cell

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| * [Issue 2] For Rel.17 NR FeMIMO, on L1/L2-centric inter-cell mobility:
	1. In RAN1#103-e, finalize scope and use cases for L1/L2-centric inter-cell mobility, including:
		+ Applicability in various non-CA and CA setups such as intra-band and inter-band CA
		+ Use cases in comparison to Rel.15 L3-based handover (HO) taking into account potential extension of DAPS-based Rel.16 mobility enhancement to FR2-FR2 HO
		+ The extent of RAN2 impact (MAC CE, RRC, user plane protocols)
		+ Network architecture, e.g. NSA vs. SA, inter-RAT scenarios
	2. In RAN1#103-e, depending on the outcome of 2a), further identify additional components –along with the associated alternatives –required for supporting inter-cell mobility based on the same unified TCI framework as that for intra-cell mobility (including dynamic TCI state update signaling), including
		+ Method(s) for incorporating non-serving cell information associated with TCI
		+ Method(s) for DL measurements and UE reporting (e.g. L1-RSRP) associated with non-serving cell(s)
		+ UE behavior for reception of signals and non-UE-specific control and data channels associated with non-serving cell(s)
		+ UL-related enhancements, e.g. related to RA procedure including TA
		+ Beam-level event-driven mechanism for L1/L2-centric inter-cell mobility
* FFS: The following enhancement scope is assumed by RAN1:
	1. Whether RRC reconfiguration signaling is needed or not when a TCI associated with non-serving cell RS is indicated
		+ A non-serving cell RS is an RS that is or has an SSB of a non-serving cell as direct or indirect QCL source
		+ This implies no C-RNTI update when UE receives DL channel RS associated to non-serving cell RS as QCL source.
		+ FFS whether TCI associated with non-serving cell can be indicated to or are applicable for all channels.
	2. Whether some RRC parameters need to be updated without additional RRC signaling, e.g. some RRC parameters are pre-configured, which are associated with TCI states with neighbor cell RS as QCL source
	3. Whether UE needs/can change serving cell during L1/L2-centric inter-cell mobility.
	4. The above assumption to be verified by RAN2
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However, RAN1 also indicated whether the serving cell change could be possible in cyan highlight above, it seems RAN1 tried to introduce the inter-cell mobility by L1 signaling e.g. L1 triggered L3 HO.

Since RAN1 asked if UE need to change a serving cell for DL reception from or UL transmission to another (non-serving) cell, at least on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH. If the answer is yes, RAN2 needs to provides more information as requested by RAN1 e.g. how the configuration is provided, how TCI states associated, system information impact, RACH and PUCCH-related impact, etc.

In below questions, it is requested to gather the expected RAN2 impact on each scenarios to pave the way for potential high level decisions.

* Scenario 1: Inter-cell multi-TRP-like model (i.e. without serving cell change)
* Scenario 2: Inter-cell HO-like model (i.e. with serving cell change)

**Q1: What is the expected RAN2 impact for inter-cell multi-TRP-like model (i.e. Scenario 1)?**

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| **Company name** | **Comments** |
| Nokia, Nokia Shanghai Bell | The basic requirement is to allow linking a TCI state or CORESET pool to utilize SSB that uses different PCI than the serving cell PCI. Then the exact changes depend on how RAN1 decides this is done, but require at least the following:* Addition/release/modification of inter-cell multi-TRP (i.e. PxxCH configuration with different TCI states linked to a different PCI than serving cell PCI)
* Measurements and procedures to use the inter-cell multi-TRP (e.g. activation/deactivation via MAC CE, measurement reporting configuration)
* TCI state linkage for inter-cell multi-TRP (e.g. does the current TCI state definition require modifications)
* Inter-cell multi-TRP interaction with (L3) handovers and RRM measurements
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**Q2: What is the expected RAN2 impact for inter-cell HO-like model (i.e. Scenario 2)?**

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| **Company name** | **Comments** |
| Nokia, Nokia Shanghai Bell | The basic requirement for the inter-cell HO-like model is to allow network to use L1/L2-signalling to trigger serving cell change. We will call this as **L1 mobility** from now on. This further requires at least the following:* Addition/modification/release of L1 mobility configurations (including the content of what can and needs to be pre-configured)
* How to ensure L1 mobility reliability and prevent configuration mismatches (e.g. how to ensure the signalling triggering L1 mobility is secure and robust enough, and what happens on failure)
* Analysis of security of L1 mobility (i.e. to avoid attacks causing unnecessary cell changes, which may require SA3 consultation)
* L1 mobility interaction with other features (e.g. HO, CHO, DAPS, multi-TRP, CA, DC, etc.)
* User plane impacts (e.g. how does MAC/RLC/PDCP/SDAP work during L1 mobility)
* Dynamic switching between stored L1 mobility configurations (if more than one configuration is supported)
* Measurement reporting for L1 mobility (e.g. how do RRM/RLM measurements work with L1 mobility, is additional event-triggered reporting needed, etc.)
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We think it would be better RAN2 provides the preference on the scope of L1/L2 centric mobility based on RAN2 impact

**Q3: Which Scenario could be the scope of the L1/L2 centric mobility in Rel-17?**

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| **Company name** | **Scenario** | **Comments** |
| Nokia, Nokia Shanghai Bell | Scenario 1 but... | We think scenario 1 is simpler but it would be preferable to consider what is the intent of the WI: It seems to us that scenario 1 is the pre-requisite to scenario 2 (as UE needs to be configured with the inter-cell resources before it can switch between them), but if the scenario 2 allows for faster mobility performance (compared to L3 mobility), that may be beneficial. Ultimately this is RANP decision and RAN2 should just consider what is possible within Rel-17 as **even** scenario 1 likely requires considerable amount of work from RAN12345. |
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| **Question 2**: In regard of RRC configuration, RAN1 is discussing whether to allow a UE to be configured for DL reception from or UL transmission to a non-serving cell on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH. From RAN2 perspective1. Depending on the answer to question 1-1, what would be the impact of allowing the UE to transmit and/or receive on some or all of those channels and which RRC parameter(s) would need to be reconfigured for the UE?
2. Is it feasible to update some of the above RRC parameter(s) via dynamic signaling (e.g. MAC CE and/or DCI, potentially selecting pre-configured values) without any additional RRC reconfiguration signaling?
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For above questions, RAN2 impact especially for configuration aspect to support L1/L2 centric mobility was discussed during the RAN2#113bis-e meeing, in general RAN2 uses RRC configuration to configure UE-dedicated configuration and it is clear that new RRC configuration for non-serving cell is required. In addition, dynamic signaling (MAC CE and/or DCI, potentially selecting pre-configured values) could be possible so it can be introduced if needed.

Following proposal was made in RAN2#113bis-e meeing:

**Proposal A: RRC provides the pre-configured configuration of “the cells for L1/L2 centric mobility”, and L1/L2 signaling can be used/feasible for the dynamic switching of the pre-configured value.**

**Q4: Do companies agree the above proposal (i.e. Proposal A), if yes, which scenario this proposal could be applied?**

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| **Company name** | **Yes/No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Depends on interpretation | It's impossible to answer this before the details are understood: We don't even know what the "L1/L2-centric mobility" means yet (see scenario discussion above). It's certainly feasible to allow L1/L2 signalling to impact used UE configuration (that's how BWP switching works), but whether such switching provides any performance gain requires further studies. Hence, the "feasibility" should also consider the gains achievable from the feature and the impacts to RAN WG workload. |
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For the number of cells for L1/L2 centric mobility to be configured by RRC, companies had different understanding so below propsoal was made.

**Proposal B: RAN2 prefer minimizing the RRC signaling overload for the pre-configuration part in Rel-17.**

* **FFS: the number of candidate cells for L1/L2 centric mobility, contents of common configurations**

It seems too early to decide the detail configuration but if companies reached the common view on this aspect it would be better to determine how many configurations configured by RRC.

**Q5: What would be the preferred number of pre-configuration part for cells for L1/L2 centric mobility in Rel-17?**

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| **Company name** | **Answer** | **Comments** |
| Nokia, Nokia Shanghai Bell | 1 (see answer) | One seems like the minimum number to start with to minimize complexity and thus, required time. Then later releases can consider optimizations. |
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For C-RNTI handling, it's also not at all clear what is the motivation of taking away the per-cell C-RNTI assignment: C-RNTI is just the identifier used to address UE via PDCCH. In addition, it is also clear that each cell can have a C-RNTI i.e. C-RNTI for non-serving cell may be different to serving cell, but it can be assigned the same value by implementation.

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| **Question 3**: In regard of C-RNTI:1. Is there a need to assign a UE a separate C-RNTI for DL reception from and UL transmission to a non-serving cell, or can the same C-RNTI from the serving cell be reused, at least for transmission and reception on UE-dedicated PDSCH, PDCCH, PUSCH, and PUCCH?
2. In restricting the use of the same C-RNTI for serving and non-serving cells, what would be the impact in applicable use cases and/or required specification support, if any?
3. If separate C-RNTIs are considered necessary in some cases, for serving and non-serving cells, how would this be configured for UE, i.e. is RRC reconfiguration signaling or some other (dynamic) signaling needed for configuring the separate C-RNTI(s)?
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As results of the offline discussion, below proposal was made but some companies have concerns on the meaning of below text i.e. some companies think C-RNTI between serving cell and non-serving cell should be aligned by NW implementation to support L1/L2 centric mobility.

**Proposal C: RAN2 confirms that each cell may use different C-RNTIs: Same C-RNTI is allowed but network shall not be required to use the same C-RNTI in different cells.**

**Q5: Do companies agree the above proposal (i.e. Proposal C)?**

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| **Company name** | **Yes/No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Yes | Since each cell assigns its own configuration, the basic assumption should be separate C-RNTIs unless there is a reason this doesn't work. |
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It also seems reasonable to assume that, just like currently, UE would obtain the non-serving cell C-RNTI via either 1) random access (i.e. similar to initial connection setup) or 2) RRC configuration (i.e. similar to handover). While the RRC configuration option would seem most suitable here, it's still not clear what would be required for UE to access the non-serving cell, so the first option might also be feasible if UE would have both UL and DL towards the non-serving cell. But using RRC configuration (from target cell) should be the baseline. Therefore below proposal was made in RAN2#113bis meeting.

**Proposal D: RRC configurations of non-serving cell, including C-RNTI, are configured by RRC.**

**Q6: Do companies agree that RRC configuration (from target cell) should be the baseline for configuring the C-RNTI for non-serving cell?**

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| **Company name** | **Yes/No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Yes | Since RRC configuration is anyway needed, C-RNTI should also be given via RRC.  |
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For CU/DU split question, it is related to we restrict the L1/L2 centric mobility for some cases (e.g. intra-DU deployment). Some companies proposed to restrict this feature only for intra-DU case in order to reduce the complexity of the Rel-17 work. Meanwhile, other companies proposed to apply this feature for general deployment scenarios including inter-DU deployment because complexity is not the critical reason to object the general support of the feature.

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| **Question 4**: In regard of CU-DU split, from RAN2/3 perspective, is there any difference between supporting intra-DU only and supporting inter- in addition to intra-DU, in terms of the following? 1. The associated RAN2 specification impact,
2. Applicable use cases (e.g. deployment scenarios), and
3. Network inter-operability (e.g. across different gNB vendors)
 |

As results of the offline discussion in RAN2#113bis meeting, below proposal was made.

**Proposal E: RAN2 prefer to restrict the scope only for intra-DU case in Rel-17 .**

**Q7: Do companies agree that restriction of deployment scenario only for intra-DU is needed?**

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| **Company name** | **Yes/No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Yes but... | We expect RAN3 can give better answer to this but from RAN2 side, intra-DU is simpler than inter-DU.  |
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According to the companies contributions, companies think the RAN2 impact on CA and RF impacts of L1/L2 mobility is quite limited i.e. only UE capability issues will be expected. RAN1 seem to support intra-frequency scenarios (i.e. serving and non-serving cells share the same SSB frequency) but inter-frequency cases (i.e. serving and non-serving cells have different SSB frequency) bring some more issues (e.g. measurement gaps, UE capabilities, etc). In addition, many companies provided the comments that the decision/answer to support intra- and inter- frequency is up to RAN4.

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| **Question 5**: In regard of CA issues, RAN1 is discussing whether the operation is supported only for intra-band CA scenario (i.e. UE is configured to operate with serving and non-serving cells that belong to the same frequency band) or for both intra-band CA and inter-band CA scenarios. Note that one common TCI state ID associated with a non-serving cell, if supported, may be optionally applied for CCs in a band.1. Are there specific RAN2/4 issues (including higher-layer impact) that need to be considered for deciding between the two alternatives?

**Question 6**: In regard of inter-frequency issues, from RAN2/4 perspective, what would be the higher-layer and RRM impact assuming inter-frequency scenarios as opposed to intra-frequency scenarios? For intra-frequency scenario, it is assumed that SSBs of non-serving cells have the same center frequency and SCS as the SSBs of the serving cell.* Note: RAN1 has agreed to support intra-frequency scenarios, whereas the support for inter-frequency scenarios is still for further study.
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As results of the offline discussion in RAN2#113bis meeting, below proposal was made.

**Proposal F: RAN2 prioritize intra-frequency case in Rel-17, but RAN2 follows the RAN4 decision to support inter-frequency case.**

**Q8: Do companies agree the proposal above (i.e. Proposal F)?**

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| **Company name** | **Yes/No** | **Comments** |
| Nokia, Nokia Shanghai Bell | Yes | Intra-frequency seems most relevant for both scenario 1 and 2, so it makes sense to focus on that if RAN4 confirms it makes sense and is feasible. |
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**Q9: Do companies have any further issues to be discussed here?**

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| **Company name** | **Comments** |
| Nokia, Nokia Shanghai Bell | Once it's understood what L1/L2-centric mobility is, measurement reporting needs to be discussed as RRM measurements are currently only sent to CU (and DU need not even comprehend them). This may also open up some issues with security and consultation with SA3 may be needed. |
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# Conclusion

**TBD**

# Reference

1. R2-2102625 LS on Agreements Pertaining to L1/L2-Centric Inter-Cell Mobility (R1-2102209; contact: Samsung) RAN1 LS in Rel-17 NR\_feMIMO-Core To:RAN2 Cc:RAN3, RAN4
2. R2-2102627 LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility (R1-2102248; contact: Samsung) RAN1 LS in Rel-16 NR\_feMIMO-Core To:RAN2, RAN3, RAN4 Cc:RAN
3. R2-2104632 Summary of email discussion [AT113bis-e][035][feMIMO] L1L2 Centric Mobility Samsung DISCUSSION
4. R2-2103330 Considerations on L1/L2 centric inter-cell mobility Samsung discussion Rel-17 TEI17 DISCUSSION
5. R2-2102855 Discussion on L1 L2-Centric Inter-Cell Mobility vivo discussion Rel-17 NR\_feMIMO-Core
6. R2-2102870 Discussion on L1/L2-Centric Inter-Cell Mobility Intel Corporation discussion Rel-17 NR\_feMIMO-Core
7. R2-2103079 Discussion on L1/L2 Mobility Qualcomm Incorporated discussion
8. R2-2103260 RAN2 Impacts of L1L2-Centric Inter-Cell Mobility MediaTek Inc. discussion
9. R2-2103639 Discussion on RAN1 LS for L1/L2-Centric Inter-Cell Mobility Nokia, Nokia Shanghai Bell discussion Rel-17 NR\_feMIMO-Core
10. R2-2103823 On RAN1 LS (R2-21xxxxx) for L1/L2 centric inter-cell mobility Ericsson discussion
11. R2-2103866 L1/L2-centric inter-cell mobility Apple discussion Rel-17 NR\_feMIMO-Core
12. R2-2104116 RAN2 impact of L1/L2 centric mobility and inter-cell multi-TRP Huawei, HiSilicon discussion
13. R2-2103341 DRAFT LS Reply on TCI State Update for L1/L2-Centric Inter-Cell Mobility Samsung LS out Rel-17 TEI17 To:RAN1 Cc:RAN3, RAN4
14. R2-2103673 Draft Reply LS on TCI State Update for L1/L2-Centric Inter-Cell Mobility Nokia, Nokia Shanghai Bell LS out Rel-17 NR\_feMIMO-Core To:RAN1 Cc:RAN3, RAN4, RAN