**3GPP TSG-RAN WG4 Meeting # 99 R4-210XXXX**

**Electronic Meeting, 17th – 27th May, 2021**

**Agenda item:** 9.18.2

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [99][235] feMIMO RRM

**Document for:** Information

# Introduction

In RAN4 99bis meeting, an LS from RAN1 (R4-2104455) on TCI state update for L1/L2 centric inter-cell mobility was received. Based on the discussion in previous RAN4 meeting, WF R4-2105838 was agreed. In RAN4 99 meeting, an LS from RAN1 R4-2107614 on timing assumption for inter-cell DL measurement was also received. This e-mail thread summary the RAN4 discussion on the response of these two LS with potential conclusions.

Furthermore, in the latest approved WID for Rel-17 FeMIMO RP-202024, the below objectives have been included, i.e.,

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| The work item aims to specify the further enhancements identified for NR MIMO. The detailed objectives are as follows:   * Extend specification support in the following areas [RAN1]  1. Enhancement on multi-beam operation, mainly targeting FR2 while also applicable to FR1:    1. Identify and specify features to facilitate more efficient (lower latency and overhead) DL/UL beam management to support higher intra- and L1/L2-centric inter-cell mobility and/or a larger number of configured TCI states:       1. Common beam for data and control transmission/reception for DL and UL, especially for intra-band CA       2. Unified TCI framework for DL and UL beam indication       3. Enhancement on signaling mechanisms for the above features to improve latency and efficiency with more usage of dynamic control signaling (as opposed to RRC)    2. Identify and specify features to facilitate UL beam selection for UEs equipped with multiple panels, considering UL coverage loss mitigation due to MPE, based on UL beam indication with the unified TCI framework for UL fast panel selection 2. Enhancement on the support for multi-TRP deployment, targeting both FR1 and FR2:    1. Identify and specify features to improve reliability and robustness for channels other than PDSCH (that is, PDCCH, PUSCH, and PUCCH) using multi-TRP and/or multi-panel, with Rel.16 reliability features as the baseline    2. Identify and specify QCL/TCI-related enhancements to enable inter-cell multi-TRP operations, assuming multi-DCI based multi-PDSCH reception    3. Evaluate and, if needed, specify beam-management-related enhancements for simultaneous multi-TRP transmission with multi-panel reception    4. Enhancement to support HST-SFN deployment scenario:       1. Identify and specify solution(s) on QCL assumption for DMRS, e.g. multiple QCL assumptions for the same DMRS port(s), targeting DL-only transmission       2. Evaluate and, if the benefit over Rel.16 HST enhancement baseline is demonstrated, specify QCL/QCL-like relation (including applicable type(s) and the associated requirement) between DL and UL signal by reusing the unified TCI framework 3. Enhancement on SRS, targeting both FR1 and FR2:    1. Identify and specify enhancements on aperiodic SRS triggering to facilitate more flexible triggering and/or DCI overhead/usage reduction    2. Specify SRS switching for up to 8 antennas (e.g., xTyR, x = {1, 2, 4} and y = {6, 8})    3. Evaluate and, if needed, specify the following mechanism(s) to enhance SRS capacity and/or coverage: SRS time bundling, increased SRS repetition, partial sounding across frequency 4. Enhancement on CSI measurement and reporting:    1. Evaluate and, if needed, specify CSI reporting for DL multi-TRP and/or multi-panel transmission to enable more dynamic channel/interference hypotheses for NCJT, targeting both FR1 and FR2    2. Evaluate and, if needed, specify Type II port selection codebook enhancement (based on Rel.15/16 Type II port selection) where information related to angle(s) and delay(s) are estimated at the gNB based on SRS by utilizing DL/UL reciprocity of angle and delay, and the remaining DL CSI is reported by the UE, mainly targeting FDD FR1 to achieve better trade-off among UE complexity, performance and reporting overhead  * Investigate if the requirements on link recovery procedure is suitable for FR2 serving cells [RAN4] * Specify higher layer support of enhancements listed above [RAN2] * Specify core requirements associated with the items specified by RAN1 [RAN4] |

Based on the approved WID and latest discussion in RAN1 and RAN2, contributions have been submitted to RAN4 91 agenda 9.18.2 to discuss the RRM impact due to introducation of FeMIMO. Also, rapporteur provide the initial workplan for RAN4 RRM core requirements. In this e-mail thread, discussion on the RRM impact is summarized with potential conclusions. View for workplan is also collected for further information.

# Topic #1: Response LS on L1/L2 centric inter-cell mobility

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

Note: Based on RAN4 chairman guideline, companies provide single contributions with proposals for two incoming LS from RAN1 and overall RRM impact. In the below summary, only proposals related to L1/L2 centric inter-cell mobility are listed and proposals for other topics are summarized in other corresponding topics.

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2109360 | Apple | Proposal #1: Discuss further and agree on the implication of inter-band operation for L1/L2 centric mobility and inter-cell mTRP and clarify with RAN1 to provide an appropriate response.  Proposal #2: [Proposed reply for Q6] In order to support measurements on inter-frequency carrier, a measurement gap might be required to support inter-frequency measurement. In addition, the switching delay might need to be accounted for additional time for active TCI state switch delay in case of inter-frequency cell.  Proposal #3: Clarify with RAN1 the expectation on receiving signals from different cells after the switch (TCI state) to new cell for dedicated channels. |
| R4-2109508 | CMCC | Proposal 1: in the Reply LS, it is proposed to inform RAN1 about following impact on inter-frequency L1 measurement:   * For SSB based inter-frequency measurement, measurement gap may be needed * For SSB based inter-frequency measurement without MG, there may be scheduling restriction * For CSI-RS based inter-frequency measurement, measurement gap is needed |
| R4-2109636 | MediaTek | Proposal 1: RAN4 should wait for RAN1 final definition on inter-cell mobility/mTRP operation.  Proposal 2: No need to introduce the inter-frequency scenario for inter-cell mobility/mTRP operation.  Proposal 3: RRC based TCI state should not be applicable for L1/L2-centric inter-cell mobility/inter-cell mTRP operation.  Proposal 4: Not to introduce the TCI state switching with unknown case for L1/L2-centric inter-cell mobility/inter-cell mTRP operation.  Observation 1: For L1/L2-centric inter-cell mobility, the TCI state list for non-serving cell should be preconfigured to UE via serving cell.  Proposal 5: UE is not required to simultaneously receive the signals from serving cell and non-serving cell with the timing difference larger than [CP].  Proposal 6: For colocation assumption in inter-cell mobility/mTRP operation, FFS together with power imbalance and receive timing difference.  Proposal 7: Both intra-band and inter-band can be supported to UE for signals reception/transmission, i.e., up to network deployment, given that reception/transmission is conducted with the same intra-frequency with UE serving cell. |
| R4-2110018 | Nokia | **Observation 10:** The agreements related to CBM and IBM capable UEs needs to be accounted in the LS reply discussion.  **Observation 11:** For intra-band CA, the operations are currently not feasible unless the cells under consideration are collocated. RAN4 would be required to define UE requirements for intra-band CA for non-collocated scenario.  Proposal 10: For intra-band CA, ask RAN1 about clarification on non-collocation scenario and simultaneous operation of SC and NSC under discussion or whether RAN1 is also considering it.  **Observation 12:** For inter-band CA, the operations are currently feasible for a UE supporting independent beam management for the band combination.  **Observation 13:** For inter-band CA, whether the operations are feasible for a UE supporting common beam management will depend on the outcome of the collocation assumption discussion.  **Observation 14:** For inter-frequency operation, inform RAN1 that only collocated scenario is supported. For non-collocated scenario, RAN4 needs further discussion if L1-RSRP measurement for NSC can be properly supported.  **Proposal 11:** RAN4 firstly considers intra-frequency case study under non-co-located cell scenario. FFS for inter-frequency operation. |
| R4-2110037 | Samsung | Observation 1:  RAN4 discuss on the LS with regard to at least these three aspects from RAN4 perspective:   * Measurement on NSC and reporting of the measurement; and * Operations for indicating a TCI state referring to RSs on the NSC; and * Simultaneous transmission schemes for enabling inter-cell multi-TRP operations.   Observation 2: Three aspects could be discussed in RAN4 as above analyzed.  Proposal 1: RAN4 could ask RAN1 what is RAN1’s understanding on “simultaneously transmission for enabling the Multi-TRP operation” before further discussion related issues in FeMIMO WI.  Proposal 2: In order to reply RAN1 in time and help RAN1 make decision, RAN4 could first discuss on a typical scenario for LS reply purpose only; other scenarios would not be precluded and could be discussed in R17 FeMIMO WI.  Proposal 3: Dedicated scenario, for LS reply purpose, considers FR2 operation and non-collocated cells only.  Proposal 4:  RAN4 reply the LS following the basic principles below:   * To Q5: Analyze intra-band and inter-band CA cases, respectively, from current RAN4 understanding, considering UE capacity of IBM; * To Q6: Mention the impact of L1 measurement and TCI state, including MG, SMTC, reference timing, switching delay, etc.; * Ask RAN1 what is RAN1’s understanding of simultaneous transmission for enabling inter-cell multi-TRP operations (may include multiplexing mode). |
| R4-2110067 | OPPO | Proposal 1: From RAN4’s perspective, timing requirement, UE BM capability and Rx beam sweeping should be considered for operation L1/L2 centric inter-cell mobility for CA scenario.  Proposal 2: To Q5, it is more feasible from UE implementation’s perspective that the operation is supported only for intra-band CA scenario.  Proposal 3: To Q6, only define requirement for the case of intra-frequency without measurement gaps for the intra/inter cell mobility. |
| R4-2110305 | Huawei, HiSilicon | Proposal 9: PDSCH, PDCCH, PUSCH and PUSCH shall be on “serving cells”. UE can’t perform data reception and transmission on “non-serving cell”.  Proposal 10: The “CA scenario” and “operation” in the question needs to be clarified.  Proposal 11: If the question refers to inter-cell multi-TRP operation in CA scenario, only intra-band CA is supported.  Proposal 12: We suggest to only consider intra-frequency L1/L2-Centric Inter-Cell Mobility. |
| R4-2110974 | Ericsson | Observation 1: L1-RSRP is to be used as reporting quantity for measurement for L1/L2-centric inter-cell mobility, and at least SS-RSRP is to be supported.  Observation 2: Existing L1-RSRP requirements assume serving cell measurement only. When adding non-serving measurements, increased capability to measure serving and non-serving cells simultaneously may be needed in order to prevent degraded TCI state handling due to increased measurement period.  Observation 3: There is no significant difference between supporting intra-frequency measurements for L1/L2-centric inter-cell mobility for intra-band CA and inter-band CA scenarios, respectively.  Observation 4: Current inter-frequency measurements are based on that inter-frequency carriers are measured one-by-one. This may lead to significantly longer measurement periods for L1-RSRP measured on inter-frequency carriers than for the same measured on intra-frequency carriers, which may have a negative impact on the TCI state handling. Increased capability e.g. by carrying out L1 and L3 simultaneously, when configured, may be considered in order to reduce the measurement period.  Proposal 1: RAN4 replies to Question 5 as follows. From RAN4 perspective, there is no significant difference between measurements on intra-frequency non-serving cell in intra-band and inter-band CA scenarios.  Proposal 2: RAN4 replies to Question 6 as follows. From RAN4 perspective, the main difference is with respect to measurement period for measurements on intra- and inter-frequency carriers. Regardless of whether gaps are used, inter-frequency measurements are based on that carriers are measured one-by-one. This may result in a significantly longer measurement period for inter-frequency than for intra-frequency measurements and thus may impose challenges for the TCI state handling.  Proposal 3: RAN4 provides further input as follows. RAN4 would further like to add that if increase in measurement effort (e.g. from serving cell measurement only, to serving cell and intra-frequency non-serving cell measurements, or from inter-frequency L3 measurements to inter-frequency L1 and L3 measurements) goes unmatched with increase in UE capacity for such measurements, the measurement periods may have to be extended. Further extending the measurement periods compared to baseline may have a negative impact on the TCI state handling. |
| R4-2111268 | vivo | Proposal 3 For Q5, RAN4 reply to RAN1 with the following   * No significant feasibility impact from RRM requirements perspective on the measurement/reporting mechanism and TCI switching mechanism for inter-band CA on top of that for intra-band CA. * RAN4 would ask RAN1 to clarify how to support simultaneous transmission in inter-cell M-TRP from RAN1 perspective, and what are the specific clarification/reply needed. * RAN4 may further discuss whether to provide the current status of discussion on intra-band CA and inter-band CA in FR2.   Proposal 4 For Q6, RAN4 reply to RAN1 with the following   * For measurement/reporting mechanism, RAN4 identified that the measurement gap is needed for inter-frequency case, while the SMTC and reference timing may also be different from that for intra-frequency case. It is up to RAN1 to decide whether inter-frequency case need to be supported in R17. * For TCI state switching mechanism, RAN4 sees no significant feasibility impact on the inter-frequency case on top of that for intra-frequency case, if the TCI state is known. The impact to RRM requirements may need further discussion. RAN4 may also need further discussion on whether there is feasibility impact for the case TCI state is unknown * RAN4 would ask RAN1 to clarify how to support simultaneous transmission in inter-cell M-TRP from RAN1 perspective, and what are the specific clarification/reply needed. Based on RAN1 feedback, RAN4 may further discuss what are the issues on the feasibility to support simultaneous transmission for inter-frequency inter-cell M-TRP transmission. |

## Open issues summary

Based on the submitted contributions, it is observed that some aspects shall be further clarified. Also, companies provide the response for question 5 and 6 respectively

It is Moderator observation that e-mail discussion can focus on these two aspects, i.e., 1) clarification questions to RAN1 and 2) Response to Question 5 and 6. Therefore, sub-topics are arranged as below

* Sub-topic 1-1 Clarification questions
* Sub-topic 1-2 Response to question 5
* Sub-topic 1-3 Response to question 6

For each sub topic, several options based on submitted contributions are listed. In 1st round discussion, further discussion on each option are expected. Based on the discussion, it is expected, RAN4 can reach consensus on which option(s) can be included in the LS. Based on such consensus if any, 2nd round e-mail discussion can focus on the detailed response LS drafting.

### Sub-topic 1-1: Clarification questions

*Sub-topic description:*

List of options can be included in the clarifications to RAN1.

**What shall be included in the response LS for clarification questions**

* Proposals
  + Option1: Meaning of term “CA” and “operation” (Apple, MediaTek, Huawei)
  + Option 2: Clarification on the co-located and non-co-located assumption for intra-band CA operations. (Nokia)
  + Option 3: Simultaneously transmission for enabling the Multi-TRP operation (Samsung, vivo)
  + Option 4: Definition of “non-serving cell” (Huawei, HiSilicon)
* Recommended WF
  + Collect companies’ view (more than 1 Option can be selected)

### Sub-topic 1-2: response to question 5

*Sub-topic description*

List of options can be included in the response to question 5

**What shall be included in the response to question 5**

* Proposals
  + Option 1: RAN4 agreements related to CBM and IBM capable UEs. Feasibility of supporting intra-band and inter-band CA scenarios for different UE capabilities in current RAN4 specifications (Nokia)
  + Option 2: From UE implementation’s perspective that the operation is supported only for intra-band CA scenario (OPPO, Huawei, HiSilicon)
  + Option 3: No significant feasibility impact for inter-band CA on top of that for intra-band CA (Ericsson, vivo)
* Recommended WF
  + Collect companies’ view (more than 1 Option can be selected)

### Sub-topic 1-3: response to question 6

*Sub-topic description*

List of options can be included in the response to question 6

**What shall be included in the response to question 6**

* Proposals
  + Option 2: For inter-frequency operation, inform RAN1 that only collocated scenario is supported (Nokia)
  + Option 3: Impact of L1 measurement and TCI state, including MG, SMTC, reference timing, switching delay for inter-frequency measurement (Apple, Samsung，Ericsson, vivo)
  + Option 4: Suggest RAN1 only consider intra-frequency measurement (OPPO, Huawei, HiSilicon)
  + Option 5: For TCI state switching mechanism, RAN4 sees no significant feasibility impact on the inter-frequency case on top of that for intra-frequency case, if the TCI state is known (vivo)
* Recommended WF
  + Collect companies’ view (more than 1 Option can be selected)

## Companies views’ collection for 1st round

### Open issues

**Sub-topic 1-1: Clarification questions**

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| **Company** | **Comments** |
| Ericsson | Option 1, Option 2, Option 4. |
| Apple | Option 1, 3.  What is inter-band CA in the context of inter-cell mTRP and L1/L2 mobility.  Also, Clarify with RAN1 the expectation on receiving signals from different cells after the switch (TCI state) to new cell for dedicated channels. |
| Qualcomm | Option1 is supported.  As we understand the L1/L2 centric mobility aims for including the TCI state from a non-serving cell with different PCI from that of the serving cell. As such, both cells can be non-colocated. Hope this provide some inputs on option2 and option4.  We observe the intention of the RAN1 LS is for L1/L2 mobility rather than mTRP enhancement. So option3 is less coherent with RRM. |
| Huawei | Option 1 and option 4.  Shall clarify on “CA”: In common understanding, intra-band CA scenario is that the primary serving cell and secondary serving cell(s) belong to the same frequency band, rather than the serving and **non-serving** cells belong to the same frequency band as described in the question.  Shall clarify on “Operation”: “L1/L2-centric inter-cell mobility” or “inter-cell multi-TRP operation”, or both?  We also pointed out the definition of “non serving cell”. In our understanding, PDSCH, PDCCH, PUSCH and PUSCH shall be on “serving cells”. UE can’t perform data reception and transmission on “non-serving cell”. |
| OPPO | Option 1 and 4 are supported.  For option 3, it’s more likely related to RAN2’s current discussion, e.g., inter-cell MTRP-like model or inter-cell HO-like model. |
| MediaTek | Support Option 1 and 4. More clarification can help RAN4 to discuss the corresponding requirement for inter-cell mobility/mTRP on the same page.  For option 2, RAN4 can determine the maximum received timing difference. Not sure about the intention for this clarification.  For option 3, not clear on definition of “Simultaneously transmission”. Are they from gNB or UE? Are they PDSCH/PUSCH or RS? |
| Nokia | In RAN1 discussions, there are still many on-going discussion items, RAN4 starts by firstly selecting items with feasible scenarios and stable operations from RAN1 outcomes.  We don’t object listed clarification questions, here are our observations on a few items :  RAN1 has not have much discussions on inter-cell multi-TRP scenarios. RAN4 does not need to consider variant of inter-cell multi-TRP scenarios seriously. RAN4 can start based on a simple operation scenario such that TRP sets of inter-cell operations (i.e CA) and multi-TRP operations are overlapped.  Depending on the co-located and non-co-located assumption, different UE BM capability and related network signalling are required. The Q5 in LS says *“RAN1 is discussing whether the operation is supported only for intra-band CA scenario”*, it seems intra-band CA scenarios are prioritized in RAN1 discussions. RAN4 can check RAN1 further if a UE BM capability and network signalling are agreed to receive the CA signals “simultaneously” from different directive propagations in the *intra-band CA scenario.*  “Non-serving cell” terms have been used in many discussions and agreements in RAN1. We couldn’t find an agreement for its definition, and we tend to agree that there would have been a better wording. But NSC seems to implicitly imply cells associated with data/control transmission defined by network signalling. Many other agreements explain NSC operations. |

**Sub-topic 1-2 Response to question 5**

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| **Company** | **Comments** |
| Ericsson | Option 3. Intra- or inter-band CA should not matter as long as e.g. pairs of serving and non-serving cells are on same carriers. |
| Apple | We propose not to send a response until further clarification is received from RAN1 |
| Qualcomm | Option3.  Option2 is not agreeable because RAN1 hopefully will assess the complexity thoroughly and it’s early to make the decision.  We are neutral on Option1, but we wonder if we shall expose the RAN4 terms to RAN1 and there are on-going discussion of RAN4 that are not yet concluded. |
| Huawei | RAN4 RRM need to first understand on “CA” and “operation”. We can further discuss the reply after we had a clear understanding of the question.  Option 2 is based on the assumption that the “operation” refers to the inter-cell multi-TRP operation and the CA means two serving cells, question 5 is equivalent to “whether inter-cell multi-TRP operation is supported for intra-band CA scenario or for both intra-band CA and inter-band CA scenarios”, where two inter-cells are all serving cells. To support inter-band inter-cell multi-TRP operation, separate RF chains for CCs on different bands are needed. As each CC has separate baseband process, additional BB is request for inter-cell CC as well. The corresponding UE capability and implementation cost are vastly enhanced. Anyway we can wait for the clarification from RAN1. |
| OPPO | Agree to hold on this until further clarification is received. |
| MediaTek | Share the same view with Apple |
| Nokia | We support option-1 with conditions. Based on the option, we consider answers as   * Both intra-band CA and inter-band CA are feasible to study L1/L2-centric mobility support. * UE capability of independent beam management (IBM) is required to support the mobility between non-collocated cell scenarios.   For RAN4 discussion, CBM and IBM capability definitions are from RAN4 conclusion (not from RAN1), and RAN4 only states about inter-band CA usecase support of the UE capabilities. Therefore RAN4 also needs further discussion :   * if the same capabilities of CBM and IBM can be supported in intra-band CA case (to answer RAN1 LS). * if a UE can support receiver processing on different directive signals simultaneously from non-collocated cells respectively in intra-band CA and inter-band CA scenarios. * FFS, performance impact is expected due to frequency/time sync difference and beam switching etc.   These can be addressed as further issues, and can be included in LS reply as well to discuss together with RAN1. |

**Sub-topic 1-3 Response to question 6**

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| **Company** | **Comments** |
| Ericsson | Option 3. Potentially Option 4 as a consequence of Option 3. |
| Apple | Option 3  Also, RAN4 should provide responses to RAN1 based on their questions rather than suggestions to limit certain scenarios. |
| Qualcomm | Option3.  Option4 is not preferred for the same reason of question5 as we shared. |
| CMCC | In our contribution, we suggest to inform RAN1 the MG impact due to inter-frequency measurement, which is covered by option 3. If there are other impacts due to inter-f measurement which need to inform RAN1, we are also fine. So we are OK with option 3. |
| Huawei | Support both option 3 and option 4.  We suggest to inform RAN1 the both the impact and consequence of inter-frequency scenarios. RAN1 need these information to decide whether inter-frequency is supported or not. From our perspective, as there are multiple potential issues of inter-frequency, option 4 can be informed to RAN1 as a suggestion from RAN4. |
| OPPO | Option 4 is supported. RAN4’s preference can also be suggested in the LS. The impact in option 3 can be for more details. |
| MediaTek | Support option 3 and 4.  MGs is needed for inter-frequency measurement and it will have significant impact on serving cell. Besides, it is RAN4 responsibility to inform RAN1 the problematic scenario from RAN4 perspective. |
| Nokia | We support option-3. Further comments can be considered to reply :   * RAN4 does not preclude inter-frequency scenario for L1/L2 centric mobility support, but relatively large RRM impacts are expected such as RF switching delay and synchronization comparing to intra-frequency scenario. * A simplified inter-frequency scenario such as collocated scenario can be considered.   RAN4 needs further feasibility study with RRM impact analysis on inter-frequency scenario. |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
| **Sub-topic #1-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Sub-topic #1-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Sub-topic #1-3** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

## Discussion on 2nd round (if applicable)

# Topic #2: Response LS on timing assumption for inter-cell DL measurement

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

Note: Based on RAN4 chairman guideline, companies provide single contributions with proposals for two incoming LS from RAN1 and overall RRM impact. In the below summary, only proposals related to timing assumption for inter-cell DL measurement are listed and proposals for other topics are summarized in corresponding topics.

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2108771 | ZTE | Proposal 1: The number of non-serving cell(s) for measurement/reporting should be at least 4.  Proposal 2: Discuss whether or not to introduce a UE capability to indicate the supported number of non-serving cell(s) for measurement/reporting. |
| R4-2109360 | Apple | ***Observation #1:*** *SMTC periodicity could be longer than SSB periodicity of non-serving cell to be measured.*  ***Observation #2:*** *Benefit of limiting L1-RSRP measurements of non-serving cell to SMTC would use the existing framework for L3 neighbor cell measurement.*  ***Observation #3:*** *Allowing for measurements of L1-RSRP of non-serving cell outside SMTC would potentially shorten the measurement time, if measurement is made based on SSB periodicity rather than SMTC.*  **Proposal #4: [Proposed Response to Question 1]**  The SMTC periodicity could be larger than SSB periodicity of non-serving cell to be measured. The benefit of limiting L1-RSRP measurements of non-serving cell to SMTC would use the existing framework for L3 neighbor cell measurement. On the other hand, allowing for measurements of L1-RSRP of non-serving cell outside SMTC would potentially shorten the measurement time, if measurement is made based on SSB periodicity rather than SMTC.  ***Observation #4:*** *In FR1 TDD and FR2 the intra-frequency neighbor cell is assumed to be synchronous and can derive timing from serving cell. For FR1 FDD the intra-frequency cell could be asynchronous and have different receive timing compared to serving cell.*  **Proposal #5: [Proposed Response to Question 2]**  In FR1 TDD and FR2 the intra-frequency neighbor cell is assumed to be synchronous and can derive timing from serving cell. For FR1 FDD the intra-frequency cell could be asynchronous and have different receive timing compared to serving cell. |
| R4-2109636 | MediaTek | Proposal 8: For non-serving cell, the L1-RSRP measurement is depending on frequency range:  In FR1, there is no impact on limiting L1-RSRP measurement within SMTC window.  In FR2, the sharing factor, e.g., Psharing factor defined in TS 38.133, should be considered for non-serving cell.  Proposal 9: For R17 inter-cell mobility/mTRP, UE should receive downlink transmission from multiple TRP within a CP, otherwise UE may not be able to measure and receive the signals simultaneously from multiple TRPs. |
| R4-2110018 | Nokia | **Observation 5:** The RAN1 agreement captured in the LS needs further clarification. Rel-15 SS-RSRP measurements may not be measured equivalently between SC and NSC to support L1/L2 mobility.  **Proposal 8:** Inform RAN1 that SS-RSRP intra-frequency accuracy and SSB-based L1-RSRP accuracy requirements are found differently in TS38.133. It is unclear if SS-RSRP supports *L1/L2-centric inter-cell mobility* properly.  **Observation 6:** the current SMTC window for NSC is used for L3 RSRP measurements and configuration.  **Proposal 9:** RAN4 need to study if the current SMTC window can be properly used for L1-RSRP measurement for NSC and the potential impact from using the SMTC window for L1-RSRP measurements from NSC in addition to L3 measurements.  **Observation 7 :** Not limiting the NCS L1-RSRP to SMTC can have impact on SSB transmission frequency and UE measurement burden. It may, however, reduce the impact on existing L3 measurements and current UE requirements.  **Observation 8 :** There is physical time of arrive difference between SC and NSC, and the time difference needs to be limited for accurate L1-RSRP measurement under non-collocation TRxP scenario. RAN4 may need to work on a timing offset related requirement to maintain L1-RSRP performance. |
| R4-2110305 | Huawei, HiSilicon | Proposal 13: RAN4 need to study the Rx beam assumptions for L1-RSRP measurements on non-serving cell, and the following two options can be considered.   * Option 1: UE is assumed to perform L1-RSRP measurements on non-serving cell with fine beam pattern. * Option 2: UE is assumed to perform L1-RSRP measurements on non-serving cell with rough beam pattern as same as SMTC based RRM measurements   Proposal 14: For Option 1, UE is expected to perform L1-RSRP measurements on non-serving cell outside SMTC windows, and the timing information of SSB resources configured for L1-RSRP measurements on non-serving cell need to be indicated by network.  Proposal 15: For Option 2, UE can perform L1-RSRP measurements on non-serving cell based on the SSB resources within SMTC windows, and the L1-RSRP measurement period on non-serving cell need to be specified based on SMTC periodicity.  Proposal 16: Considering the typical scenarios for inter-cell mobility, the receive timing of the measurement RS from the non-serving cell can be different from the receive timing of the signals from the serving cell, otherwise the applicable scenarios for L1/L2-centric inter-cell mobility will be quite limited. |
| R4-2111269 | vivo | [Response to Q1]  Regarding limiting the measurements on RS of NSC within SMTC or not, RAN4 has identified the following impacts:   * The common understanding from RAN4 is that, for intra-frequency MO or inter-frequency MO configured on the same SMTC, the UE may be able to obtain neighbour cell measurement results for L1-RSRP reporting at the same time when it conducts layer-1 measurements for layer-3 RRM reporting, if RS of NSC is limited within SMTC. Otherwise, UE would always need to perform additional cell identification and L1 measurements on NSC on top of RRM measurements. * For the case that RS of NSC is limited within SMTC,   + there is no need to further define any measurement restrictions, and   + for intra-frequency NSC L1 measurements conducted outside measurement gap, the scheduling restriction defined for layer-3 RRM reporting can be re-used, and   + if the RS periodicity and offset for NSC L1 measurements is the same as the periodicity and offset of the SMTC, then,     - the overlapping factor Kp defined for layer-3 RRM, implying the overlapping occurrence for SMTC and measurement gap, can be re-used, and,     - in case measurement gap is needed due to SMTC fully overlapped with gap, NSC L1 measurements may also need to be conducted within measurement gap, even for the intra-frequency cases. * Conversely, for the case that RS of NSC is not limited within SMTC,   + introduction of additional measurement restriction is needed, and   + for intra-frequency NSC L1 measurements conducted outside measurement gaps, introduction of additional scheduling restriction is needed, and   + network may have full flexibility in configuration of the RS periodicity and offset, so that in some cases the overlapping between NSC L1 measurements and measurement gaps can be avoided.   [Response to Q2]  If the receive timing of the measurement RS from the non-serving cell can be different from the receive timing of the signals from the serving cell, RAN4 has identified the following impacts   * If the receive timing is different from the serving cell, for the case when the measurement RS from the non-serving cell is within SMTC, legacy measurement behaviour based on L3 measurement can be reused from RAN4 perspective; * For the case when the measurement RS from the non-serving cell is not within SMTC   + If the supported timing difference between RS from NSC and serving cell needs to be larger than 1 CP, then UE need to perform cell identification and cell measurement for SSB based on multiple FFT window, while the complexity of the UE is increased significantly.   + Otherwise, UE may only be able to support timing difference between RS from NSC and serving cell less than 1 CP, in case UE may use single FFT window for the measurement. In this case, if the actual timing difference between RS from NSC and serving cell is larger than 1 CP, measurement performance will be degraded. |
| R4-2110069 | OPPO | Observation 1: Longer evaluation period would be expected, if not limiting the measurement for L1-RSRP to be carried out within the SMTC windows.  Observation 2: The performance degradation should be expected for the measurement, if the time difference between the receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell exceed the minimum requirement of UE (e.g., MRTD or CP). |
| R4-2109734 | Qualcomm | Observation1: L1/L2 based inter-cell mobility will involve measuring the SSB resources of the non-serving cells in the L1 beam measurement framework to ensure lower measurement and reporting latency.  Proposal1: Indicate in the reply LS to RAN1 that for non-serving cell resources that donot require a measurement gap to measure, it is not necessary to limit the measurement resources within a SMTC window.  Proposal1.1: Indicate in the reply LS if the non-serving cell resources would require a measurement gap to be measured, a measurement window would be needed to confine the resources within a gap.  Proposal1.2: RAN4 to discuss if it is helpful to indicate to RAN1 there are possible solutons to support gapless inter-frequency measurements.  Proposal2: SSB resource can be supported for measuring the non-serving cell with the different receive timing from the serving cell.  Proposal2.1: RAN4 to discuss whether to clarify with RAN1 how to derive the measurement timing for non-serving cell, for example, based on the L3 cell detection(SSB based search).  Proposal2.2: RAN4 to discuss if the limitation of measuring CSI-RS of the non-serving cell shall be conveyed to RAN1. |

## Open issues summary

*In submitted contributions, companies provide the input for response to question 1 and 2 respectively. Therefore, the suggested sub-topics are*

*Sub topic 2-1: Response to Question 1*

*Sub topic 2-2: Response to Question 2*

### Sub-topic 2-1 Response to question 1

*Sub-topic description:*

*To response the question 1, two issues have to be discussed, i.e,*

**Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**

* Proposals
  + Option 1: Existing framework and requirements for L3 neighbor cell measurement could be reused (Apple, Nokia, vivo)
  + Option 2: In FR1, there is no impact on limiting L1-RSRP measurement within SMTC window. In FR2, sharing factor shall be considered (MTK)
  + Option 3: If it can be assumed that UE can perform L1-RSRP based on rough beam pattern, UE can perform L1-RSRP measurements on non-serving cell based on the SSB resources within SMTC windows (Huawei, HiSilicon)
  + Option 4: If the RS periodicity and offset for NSC L1 measurements is the same as the periodicity and offset of the SMTC, the overlapping factor Kp can be reused. Also, even intra-frequency L1-RSRP measurement shall be conducted within gap for the case that SMTC is fully overlapped with gap. (vivo)
  + Option 5: Longer measurement period (OPPO)
  + Option 6: Applicable for the non-serving cell resources would require a measurement gap to be measured (Qualcomm)
* Recommended WF
  + Collect companies’ view (More than 1 option can be selected)

**Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**

* Proposal
  + Option 1: Not limiting the NCS L1-RSRP to SMTC can have impact on SSB transmission frequency and UE measurement burden (Nokia)
  + Option 2: If it can be assumed that UE can perform L1-RSRP based on fine beam pattern, UE can perform L1-RSRP measurements on non-serving cell outside SMTC windows (Huawei, HiSilicon)
  + Option 3: New requirements including measurement restriction and scheduling restrictions (vivo)
  + Option 4: Network may have full flexibility in configuration of the RS periodicity and offset (vivo)
  + Option 5: Shorten measurement time (Apple)
  + Option 6: Applicable for Non-serving cell resources that donot require a measurement gap to measure (Qualcomm)
* Recommended
  + Collect companies’ view (More than 1 option can be selected)

**Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**

* Proposal
  + Option 1: Yes
  + Option 2: No
* Recommended
  + Collect companies’ view. If no clear consensus, 2nd round discussion can only focus on the draft of implication(s)/benefit(s) without any conclusions.

### Sub-topic 2-2 Response to question 2

*Sub-topic description*

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell**

* Proposals
  + Option 1: In FR1 TDD and FR2 the intra-frequency neighbor cell is assumed to be synchronous and can derive timing from serving cell. For FR1 FDD the intra-frequency cell could be asynchronous and have different receive timing compared to serving cell.(Apple)
  + Option 2: For R17 inter-cell mobility/mTRP, UE should receive downlink transmission from multiple TRP within a CP, otherwise UE may not be able to measure and receive the signals simultaneously from multiple TRPs. (MTK)
  + Option 3: Time difference needs to be limited for accurate L1-RSRP measurement under non-collocation TRxP scenario. RAN4 may need to work on a timing offset related requirement to maintain L1-RSRP performance(Nokia)
  + Option 4: For the case when the measurement RS from the non-serving cell is within SMTC, legacy measurement behaviour based on L3 measurement can be reused from RAN4 perspective. For the case when measurement outside SMTC, different performance for different cases of timing difference between SC and NSC, i.e., >CP case or < CP case (vivo)
  + Option 6: Performance degradation if timing difference exceed the minimum requirement of UE (e.g., MRTD or CP). (OPPO)
* Recommended WF
  + Collect companies’ view (more than 1 option can be selected)

**Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**

* Proposal
  + Option 1: Yes (Huawei, QC)
  + Option 2: No
* Recommended
  + Collect companies’ view. If no clear consensus reached for this issue, 2nd round discussion can only focus on the draft of implication(s)/benefit(s) without any conclusions.

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1: Response to question 1

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| **Company** | **Comments** |
| XXX | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?** |
| Ericsson | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  At least consider Options 2/3/5. Potentially Option 6.  For Options 1 and 4 we do not think this level of details can be agreed at this point.  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  At least consider Option 2/5/6. Potentially Option 1.  Regarding Option 3: Is this not already covered by the scheduling restrictions in 9.5.6.3, i.e., for this case the non-serving cell target RS would not be QCL’ed with TCI state for PDCCH/PDSCH?  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**  In our view: No. It cannot be concluded at this point. |
| Apple | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  Option 1, 5, 3, 6  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  Option 2, 5, 6  Option 3 is impact to RAN4  In case L1-RSPR measurements on NSC are not limited to SMTC, the assumptions on the configuration should be clarified by RAN1. Would UE still be required to detect the NSC prior to measurement, or some configuration is provided to UE for NSC measurement.  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**  We don’t think we can conclude and make a recommendation to RAN1. |
| Qualcomm | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  Option2;  We feel all the options imply a loss of flexibility for UE to measure and network to deploy the resources, so they are not benefits.  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  Options4/5/6  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**  Option1,  We suggest communicating RAN4’s impacts and implications to RAN1.  If final suggestion is not concluded, can we consider sending more than 1 LSs? |
| CMCC | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  Option 2/5. We are open to further discuss other options  Option 2 is what we already have for L1-RSRP measurement for serving cell in Rel-15/16. Option 5 is a consequence we can observe if the L1-RSRP measurement is limited within SMTC.  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  One question for clarification on option 5. In our understanding, the L1-RSRP measurement of a non-serving cell may need measurement gap. With MG, it seems that we can not say the measurement time is shortened. |
| Huawei | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  Option 1/3/5  If L1-RSRP measurements of non-serving cell are considered as some kind of RRM measurements, then the UE can perform L1-RSRP measurements of non-serving cell within SMTC window. The benefit of limiting L1-RSRP measurement with SMTC may be that no additional SSB timing information of non-serving cell need to be indicated. However, the non-serving cell shall be known cell and UE has identified the SSB(s) of non-serving cell within SMTC window, and L1-RSRP measurement period of non-serving cell rely on SMTC periodicity. So, L1-RSRP measurement period of non-serving cell might not be short.  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  Option 2/3/4/5  If L1-RSRP measurements of non-serving cell are considered as some kind of BM measurements, then the UE is assumed not to be able to simultaneously perform RRM measurements and L1-RSRP measurements of non-serving cell in FR2. It is better to perform L1-RSRP measurements of non-serving cell outside SMTC window, otherwise SMTC occasions need be shared between RRM measurements and L1-RSRP measurements of non-serving cell in FR2, which would cause a longer L1-RSRP measurement period of non-serving cell. If UE performs L1-RSRP measurements of non-serving cell on the SSB outside SMTC window, then the network needs to indicate the periodicity and offset information of SSB configured for L1-RSRP measurements of non-serving cell. Since SSB periodicity is assumed to be equal to or shorter than SMTC periodicity, L1-RSRP measurement period of non-serving cell based on SSB periodicity may be shorter.  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**  Support option 2 (No).  According to RAN1’s agreements, L1-RSRP measurement/reporting of non-serving cell is configured in a CSI report instance. So, L1-RSRP measurements of non-serving cell are more similar to BM measurements. A shorter measurement/reporting period than RRM measurement periods is expected for L1/L2 inter-cell mobility. |
| OPPO | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  Option 1, 5.  L1-RSRP measurement period of non-serving cell could be longer. FFS whether gap is needed, which could depend on intra-f or inter-f of the non-serving cell, if existing framework and requirements for L3 neighbour cell measurement could be reused.  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  Option 2, 4  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**  Option 2. The relation of MG, SMTC and L1-RSRP needs to be clarified more. |
| MediaTek | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  Support option 2.  For this issue, we can take the existing requirement rule as baseline to reply RAN1.  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  Option 2 & 5.  For this issue, as we know, the additional RS which is outside SMTC window can be measured by UE to complete L1-RSRP measurement. Because it is outside SMTC window case, the shorter measurement period can be achieved. But this will lead to more power consumption.  For option 6, we are not sure why we need to mention MGs?  For option 3, suggest FFS, it may depend on timing difference between SC & NSC.  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**  Support option 2. This question is out of scope of the LS. |
| Nokia | **Issue 2-1-1: Implication(s)/Benefit(s) of limiting L1-RSRP measurement within SMTC**  Option-1 seems like the intension of RAN1 agreement, but RAN4 need to further consider that L1-RSRP needs to be measured more quicker and more often than L3 SSB-RSRP. It will turn out new measurement requirements for NSC.  If limiting the NSC SSB based L1-RSRP measurement within SMTC, UE implementation burden can be reduced. A UE can reuse measurement behaviours within SMTC, but it wouldn’t be the same requirement as L3 RSRP. The current assumption is that network will transmit the SSB every 20ms which is used also as baseline assumption when developing the UE requirements. By reserving some SSBs for NCS L1-RSRP measurements would mean that there are less occasions available for L3-RSRP. Therefore, one alternative is to increase the SSB transmission e.g. from 20ms to 10ms.  **Issue 2-1-2: Implications/Benefits of not limiting L1-RSRP measurement within SMTC**  If not limiting the NSC SSB based L1-RSRP measurement to be carried out within the SMTC, the impact on the already defined SSB based L3 measurements will be reduced. However, having the SSB based measurements outside the SMTC has impact on the UE measurement burden and measurement time. As the network side impact, data scheduling restriction may be required for measurement out of SMTC window, also SSB transmission period needs to be shorter.  **Issue 2-1-3 Can RAN4 conclude the suggestion to RAN1 on limiting L1-RSRP measurement within SMTC?**  It would be preferable to avoid scheduling restriction in the network side and significant UE implementation impact (i.e. option-1), but it seems early to conclude into one option. Also, when RAN1 agrees to use CSI-RS based L1-RSRP for NSC measurement, it needs separate analysis. |

Sub topic 2-2: Response to question 2

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| --- | --- |
| **Company** | **Comments** |
| XXX | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?** |
| Ericsson | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  We do not quite see why it would be necessary to limit the timing difference between serving and non-serving cell. Assumptions on that signals need to be received within a certain window e.g. CP/2 seem to assume simultaneous reception and processing e.g. using single FFT. Is this limitation necessary? If so, it shall be stated in the reply so RAN1 can do the trade-off between feature limitations and UE complexity.  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**  Though we tend to agree that it can be concluded that receive time differences can be tolerated (and that it more is a matter of how large difference can be tolerated), we think it may need some more discussion. |
| Apple | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  Option 1. RAN1 is asking if receive time can be different between SC and NSC.  If neighbor has same timing as serving cell in L3 measurements, the cell identification time doesn’t include SSB index detection time from PBCH DMRS/ decoding .  Since this is still related to NSC measurement, we don’t see the issue of performance degradation. Also, the question is not related to intercell mTRP operation and only L1/L2 centric mobility in our understanding.  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**  Currently we have intra frequency measurement requirements with different cell timing, so we don’t see why it cannot be supported for L1-RSRP measurements. |
| Qualcomm | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  First of all, can we agree mTRP shallnot be considered in the context? In our opinion, only inter-cell L1/L2 mobility is relevant. As L3 mobility, it is possible larger time difference in the (non-colocated) neighbor cell can happen.  Agree with option1 that RAN4 needs RAN1/RAN2 design to ensure the availability of reference timing for the target resource measurement which could be something worth emphasizing in the LS.  Option4 is also agreeable to us that “*For the case when the measurement RS from the non-serving cell is within SMTC, legacy measurement behaviour based on L3 measurement can be reused from RAN4 perspective.*”; for the resources outside the SMTC, at least FR1 intra-frequency measurement on the NSC shall not cause performance loss as RAN1 agrees currently SSB is the employed.  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**  Consider this for L1/L2 centric mobility purpose, option1 is supported. |
| Huawei | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  UE performs L1-RSRP measurements of non-serving cell for inter-cell mobility purpose. In typical scenario, the serving cell and non-serving cell are non-co-located. The receive timing difference between serving cell and non-serving cell includes cell transmit timing misalignment error and propagation delay difference. The cell transmit timing misalignment error is within 3us for TDD and within 0.5slot for FDD. The propagation delay difference between serving cell and non-serving cell depends on cell coverage, which cannot be ignored.  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**  Support option 1 (Yes). |
| OPPO | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  Option 4, 6.  For option 1, it is a basic assumption to ensure the availability of reference timing for the target resource measurement.  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**  Option1 is supported. The minimum requirements of timing difference needs identified as well. |
| MediaTek | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  Support option 2  This issue is depending on the RAN1 design for L1/L2-centric inter-cell mobility and the design is still discussing in RAN1 now. But, in our understanding, RAN4 still can analysis this issue based on co-located & non-co-located assumptions. Our views are provided as follows:  For non-co-location case:  We believe that the assumption for mTRP in RAN1 can be applied for this case, i.e., UE is not required to receive the signals from SC & NSC simultaneously when timing difference is larger than CP.  For co-location case:  In our understanding, we do not need to consider difference in propagation delay so we expect timing difference can be further reduced.  According to observation above, UE should receive signals from SC & NSC within CP to guarantee single FFT is applicable.  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**  Support option 1. |
| Nokia | **Issue 2-2-1: Implication(s)/benefit(s) of different receive timing of the measurement RS from the non-serving cell and receive timing of the signals from the serving cell**  Time difference needs to be limited for accurate L1-RSRP measurement under non-collocation TRxP scenario through further discussions. RAN4 may need to work on a timing offset tolerance to maintain L1-RSRP performance requirements. However, as the assumption is SSB based L1-RSRP the UE should be able to use normal searcher for performing the measurements and the timing difference impact should minimal.  **Issue 2-2-2 Can RAN4 conclude that different receive timing of the measurement RS from the non-serving cell and the receive timing of the signals from the serving cell can be supported?**  We support option-1. |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#2-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Sub-topic#2-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Topic #3: Impac to RRM requirements for feMIMO

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2109733 | Qualcomm | Proposal1: RAN4 to prioritize identifying the RRM impacts of the enhancements in the multi-beam operations especially universal TCI state framework, BM overhead/latency reduction and L1/L2 based inter-cell mobility.  Proposal1.1: Discussions on MPUE and MPE mitigation may start later which depends on the RAN1 progress.  Proposal2: RAN4 to discuss whether the SRS switch for up to 8 antennas shall be handled in the work item of RRM further enhancement.  Proposal3: Depending on the RAN1 progress, RAN4 to discuss if HST-SFN related RRM topics would be discussed in the feMIMO WI or HST WI. |
| R4-2109837 | Samsung | Observation 1: TCI switch and update delay requirements has to be updated to accommodate the TCI states switch without DL assignments.  Observation 2: RAN4 has to discuss the TCI switch and update delay requirements after RAN1 has concreted conclusion on TCI framework.  Observation 3: RAN4 has to discuss the requirements impact due to the PL-RS design in Rel-17 FeMIMO  Observation 4: RAN4 is supposed to specify the delay and accuracy requirements for L1 measurements for non-serving cells in Rel-17 FeMIMO WI  Observation 5: Detailed requirements for L1 measurement for non-serving cells can be only discussed once the RAN1 design on reporting quantity and reporting capability is concluded  Observation 6: RAN4 is supposed to discuss the update of delay requirements for beam indication signalling  Observation 7: RAN1 terminologies, assumption, use cases and clarification notes for multi-panel UE for uplink panel selection shall be used as baseline in RAN4 for further discussions.  Observation 8: RAN4 is only supposed to discuss the impact to RRM requirements due to uplink panel selection after RAN1 design is clear.  Observation 9: RAN4 is only supposed to discuss the impact to RRM requirements due to MPE mitigation after RAN1 design is clear.  Observation 10: Link recovery requirements defined in current specification for cell specific beam management can be reused for TRP specific beam management. Wording in spec can be updated to accommodate the newly introduced TRP specific beam management in Rel-17.  Observation 11: RAN4 is supposed to discuss the update of link recovery procedure after RAN1 design is clear  Observation 12: Core requirements for group based L1-RSRP measurements assuming simultaneous reception channel/RS with different QCL type D can be postponed to further release unless request from RAN1 is received.  Observation 13: No impact to RRM requirements for SRS enhancement in Rel-17  Observation 14: No impact to RRM requirements for CSI enhancement in Rel-17 |
| R4-2110018 | Nokia | Proposal 1 : RAN4 needs to develop related TCI state switch delay requirements related to the Rel-17 common beam management agreements.  Proposal 2 : RAN4 needs to discuss if new TCI state switch delay requirements are needed based on the RAN1 agreements for unified TCI framework.  Observation 1 : RAN1 is under discussion about UL beam selection for UEs with multi-panels. A UE may need to assist the gNB with measurements related to the UL selection related to MPE. Further detail behaviors are up to RAN1 discussions.  **Proposal 3 :** Although it seems early to specify clear UE behaviors from RAN1 discussion, UE behaviors associated with inter-cell multi-TRP operations and multi-DCI based multi-PDSCH reception needs to be tested in RAN4.  **Observation 2 :** RAN1 is under discussions regarding reliability improvement on multi-TRxP UL transmissions for both PUCCH and PUSCH.  **Proposal 4 :** RAN4 needs to discuss beam-management-related enhancements for simultaneous multi-TRxP transmission with multi-panel reception including UE capabilities.  **Proposal 5 :** RAN4 needs to discuss UE behaviors related with synchronization and channel estimation (i.e. when two TCI states are indicated) to support HST-SFN deployment.  **Observation 3 :** RAN1 is discussing enhancement on SRS with open issues like whether UL granting DCI can have larger size than DL granting DCI. The DCI size may make decoding behavior difference for DCI overhead/usage reduction.  **Observation 4 :** RAN1 has introduced CSI reporting with multiple transmission/interference hypotheses that requires a UE to feedback multiple CSIs covering both single-TRxP and NCJT hypotheses.  **Proposal 6:** RAN4 needs to discuss UE behaviours making multiple CSIs feedback covering both single-TRxP and NCJT hypotheses to support multi-TRxP and/or multi-panel transmission.  **Proposal 7 :** RAN4 needs to discuss about a FDD test regarding how UE processes dominant SD-FD component pairs and use them to pre-code the CSI-RS for Type II port selection codebook enhancement. |
| R4-2110305 | Huawei, HiSilicon | Proposal 1: For L1/L2-centric inter-cell mobility, RAN4 investigate the beam measurement/reporting requirements on non-serving cell(s), and at least SSB based beam measurement/reporting requirements on non-serving cell(s) need to be defined.  Proposal 2: The L1-RSRP measurement/reporting requirements on serving cell(s) can be used as a starting point to define the beam measurement/reporting requirements on non-serving cell(s).  Proposal 3: For L1-RSRP measurements in FR2, the existing measurement restriction requirements in Rel-16 cannot be reused for multi-TRP transmission in R17 and RAN4 shall study new measurement restriction requirements for multi-TRP transmission.  Proposal 4: RAN4 study whether to introduce the sharing factor for multiple beam pairs/groups into L1-RSRP measurement period requirements.  Proposal 5: It is suggested that the existing L1-RSRP measurement accuracy requirements can be applied for multi-TRP transmission in Rel-17.  Proposal 6: The existing scheduling restriction requirements for L1-RSRP measurements can be applied in Rel-17.  Proposal 7: Due to introducing TRP-specific BFR in Rel-17, RAN4 study whether the existing sharing strategy of BFD/CBD measurements can be reused. If it cannot be reused, RAN4 needs to study the sharing strategy of BFD/CBD measurements in Rel-17.  Proposal 8: RAN4 need to evaluate FR2 measurement performance in HST-SFN deployments and investigate the FR2 measurement requirements applicable for HST-SFN deployments in Rel-17. |
| R4-2112368 | vivo | Proposal 1 RAN4 to discuss the potential RRM impact based on the progress, i.e. agreements achieved, in RAN1.   * Synchronization assumption, i.e. Timing assumption for inter-cell beam measurement. In R16 CSI-RS WI, RAN4 discussion was based on single FFT assumption. Not sure whether the same still works for R17 feMIMO. At least for inter-cell M-TRP it is concluded in RAN1 that DL transmission from multiple TRP is assumed to be within CP. * Measurement accuracy for L1-RSRP/L1-SINR on the non-serving cell RSs. * TCI states, uplink spatial relation and pathloss RS updating mechanism for the non-serving cell RSs * Pending on RAN2 progress, including   + Handover and interruption requirements for L1/L2-Centric handover * For the FFS part, i.e. inter-cell M-TRP transmission, including   + MRTD/MTTD   + RLM/BFD/CBD   + Others * For multi-panel enhancements, RAN4 can further discuss related RRM requirements as long as the definition of ‘panel’ becomes stable in RAN1. * RLM/BFD enhancements based on the 2 TCI-states DMRS. * TCI switching for 2 TCI-states DMRS * Others are not precluded. * The interruption requirements for SRS antenna switching   Proposal 2 RAN4 to discuss the potential evaluation assumptions for investigation on feasibility of FR2 link recovery procedure. |

## Open issues summary

In submitted contributions, companies provide the overall analysis for impact to RRM requirements for FeMIMO. Based on the observation, most of analysis related to RRM impact are quite aligned. Continue collecting other companies view is expected in this e-mail thread. It is also observed that no RRM impact is identified for some objectives, e.g, CSI enhancements. Sub topics are also setup to confirm RAN4 understanding on no RRM impact due to certain objectives. Therefore, the sub topics are arranged as

* Sub topic 3-1: Overall RRM impact
* Sub topic 3-2: Confirm no RRM impact for certain objectives

For overall RRM impact, table manner summary is provided. Companies are encouraged to provide comments/input for respective objective in the table. Based on the input from companies in the 1st round, detailed WF can be discussed in the 2nd round for future RAN4 meeting.

### Sub-topic 3-1 Overall RRM impact

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Overall RRM impact**

* Proposals
  + Companies are encouraged to provide the input, i.e., Yes or No, to indicate whether these is any impact to RRM requirements for certain feature in the below table. Additional clarification if any can be also added
  + The intension is to collect companies view at this stage instead of making any decision unless clear consensus reached.
* Recommended WF
  + Collect companies’ view

### Sub-topic 3-2 Confirm no RRM impact

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Confirm no RRM impact**

* Proposals: Confirm no RRM impact for below objectives
  + Option 1: No RRM impacts for M-TRP for PDCCH, PUCCH and PUSCH
  + Option 2: No RRM impact for CSI enhancement
  + Option 3: NO RRM impact for other objectives if any
* Recommended WF
  + Collect companies’ view (More than 1 options can be selected)

## Companies views’ collection for 1st round

### Open issues

Sub topic 3-1

Companies are encouraged to provide the input/comments in the below table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sub-items | | Samsung | Nokia | Qualcomm | Huawei | vivo |
| Item 1:  Multi-Beam operation Enhancement | 1a: Unified TCI for DL and UL | Yes  TCI state switch/delay requirements for unified TCI state | Yes  TCI switch delay | Yes | FFS | Yes |
| 1b: L1/L2 centric inter-cell mobility | Yes  Inter-cell L1 measurement for non-serving cells | Yes | Yes | Yes  L1-RSRP measurements of non-serving cell | Yes,  Measurement accuracy for non-serving cells  Handover and interruption pending on RAN2 |
| 1c: Beam indication signaling medium | Yes  TCI state switch delay and CBD requirements | Yes,  beam indication signaling includes TCI state and PL-RS switching operations, RAN4 needs to study the switching impacts up to RAN1/2 conclusion. | Yes | FFS |  |
| 1d: MP-UE | FFS  Pending on RAN1 agreement on MP-UE | FFS.  RAN1 is under discussion of MP-UE DL and UL operations, it is also related with RF support. | start later which depends on the RAN1 progress. | FFS |  |
| 1e: MPE | FFS  Pending on RAN1 agreement on MPE solutions | FFS,  it falls first in RF and RAN1 for MPE solutions, but RRM session needs to monitor measurement impact from MPE mitigation mechanism | start later which depends on the RAN1 progress. | FFS |  |
| Item 2:  Multi-TRP Enhancement | 2a: M-TRP for PDCCH, PUCCH and PUSCH | No | RRM impact seems minimal. |  | No  It seems more related to Demod part |  |
| 2b: M-TRP intel-cell operation | No | FFS, RAN1 is under discussion about indication CMR associated with multiple TRP. RAN4 can be involved after RAN1 completes the framework. |  | FFS | Yes  Sync assumption pending on RAN1 design  FFS for MRTD/MTTD/RLM |
| 2c: Beam management enhancement | Yes  FFS whether have impact on RRM requirements | Yes including UE capability |  | Yes  FFS the impacts due to multiple beam pairs/groups reporting.  FFS the impact due to TRP specific BFR | FFS for BFD/CBD |
| 2d: HST-SFN enhancement | No | FFS. Potential RRM impact is predicted. It is SFN but, if the UE is indicated with two TCI states, RRM measurement may accordingly get impact on the TCI switching. RAN4 needs to monitor RAN1 discussion. | Yes,  Handled in feMIMO WI or HST WI. | Yes  FR2 scenarios need to be considered for HST |  |
| Item 3:  SRS enhancement | | No | FFS. Antenna switching gaps between SRS resource sets may be considered. Needs to monitor RAN1 specification. | Yes,  handled in the work item of RRM further enhancement | FFS | Yes，  Interruption requirements |
| Item4:  CSI enhancement | 4a: CSI enhancement for FDD | No | RRM impact seems minimal |  | No |  |
| 4b: CSI enhancement for Multi-TRP | No | RRM impact seems minimal |  | No |  |
| Item 5  Investigation of link recovery procedure for FR2 serving cell | | FFS | FFS, If RAN1 agrees BFD and CBD procedure for link recovery procedure, RAN4 can be involved |  | FFS | potential evaluation assumptions |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Sub-items | | Ericsson | Apple | Qualcomm |  |  |
| Item 1:  Multi-Beam operation Enhancement | 1a: Unified TCI for DL and UL | Yes | Yes  Requirements for unified TCI state switch | Yes |  |  |
| 1b: L1/L2 centric inter-cell mobility | Yes | Yes  Requirements for L1 measurement on non serving cell  Delay requirements for TCI state switch involving non-serving cell | Yes |  |  |
| 1c: Beam indication signaling medium | Yes | Yes  Similar to UL spatial relation switch delay | Yes |  |  |
| 1d: MP-UE | FFS | FFS pending progress in RAN1 | FFS |  |  |
| 1e: MPE | FFS | FFS pending progress in RAN1 | FFS |  |  |
| Item 2:  Multi-TRP Enhancement | 2a: M-TRP for PDCCH, PUCCH and PUSCH | Out of scope for RRM | No | No |  |  |
| 2b: M-TRP intel-cell operation | FFS | No if same assumptions as R16 mTRP are assumed. May need to revisit timing requirements | Yes |  |  |
| 2c: Beam management enhancement | Yes | Yes  BFD/CBD | Yes |  |  |
| 2d: HST-SFN enhancement | Concurrent Rel-17 WI hence better to address in Rel-18 scope.  Additionally unclear whether RRM or only demod impact. | FFS based on agreements for switching scheme agreements in RAN1 | No\*  \* [QC] there are RAN1 designs to switch various schemes of Doppler pre-compensation. For now, it’s viewed as demod related. |  |  |
| Item 3:  SRS enhancement | | FFS | FFS for SRS antenna switching. | FFS |  |  |
| Item4:  CSI enhancement | 4a: CSI enhancement for FDD | FFS | No | No |  |  |
| 4b: CSI enhancement for Multi-TRP | FFS | No | No |  |  |
| Item 5  Investigation of link recovery procedure for FR2 serving cell | | FFS | FFS based on RAN4 discussion. | FFS |  |  |

Sub topic 3-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | This is the first meeting. It is good to check companies for views, but we think it is too early to conclude/confirm that there is no impact on certain objectives. |
| Qualcomm | Options 1 and 2 |
| Nokia | We add our preferences to the table, but agree to Ericsson. |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Topic #4: Work plan

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2109837 | Samsung | RAN4 99e (May 2021)   * Agree overall work plan for RRM core requirements * Initial analysis to potential RRM impact due to FeMIMO features   RAN4 100e (Aug 2021)   * Initial discussions on UE RRM requirements impact due to FeMIMO features   RAN4 101e (Nov 2021)   * Further discussions on UE RRM requirements impact due to FeMIMO features   RAN4 101-bis e (Jan 2022, meeting to be confirmed)   * Further discussions on UE RRM requirements impact due to FeMIMO features * Review draft CRs for endorsement if any   RAN4 102e (Feb 2022)   * Agree RAN4 CR to finalize the RRM core requirements   Note 1: This work plan only focused on RRM core part.  Note 2: Detailed work split on CR drafting if any will be provided during WI phase in appropriate time. |

## Open issues summary

### Sub-topic 4-1View collection for work plan

*Sub-topic description:*

*Companies are encouraged to provide the comments/view on work plan*

**Issue 4-1: Work plan**

* Proposals
  + Option 1: Work plan in R4-2109837
* Recommended WF
  + Approved Work plan based on companies’ comments.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We are fine with the proposed work plan. |
| Qualcomm | Would it be possible to agree on the prioritized order of topics for discussion in the work plan because of RAN1 progress and RAN4 limited TUs for the coming meetings?  Perhaps focus on one topic only for the next two meetings, which would be 1a/1c. |
| Nokia | The work plan is fine, but we also have similar views as QC. Rel-17 feMIMO is a big topic with open discussions in RAN1/2, RAN4 needs prioritized topics from the current status. It is preferable to make a work plan with agreed topic priority. Since LS discussions already touched inter-cell, multi-beam and multi TRXP topics, RAN4 can start from the points. |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents