**3GPP TSG-RAN WG4 Meeting # 104-bis-e R4-22XXXXX**

**Electronic Meeting, 10– 19 October 2022**

**Agenda item:** 6.20.3

**Source:** Moderator (MediaTek Inc.)

**Title:** Email discussion summary for [104-bis-e][222] NR\_Mob\_enh2\_part1

**Document for:** Information

# Introduction

This document is the email discussion summary for [104-e][222] NR\_Mob\_enh2\_part1 with the following topic

* AI 6.20.3: L1/L2 based inter-cell mobility

List of candidate target of email discussion for 1st round and 2nd round

* 1st round: Invite companies to comment in each sub-topic.
* 2nd round: TBA.

It is appreciated that the delegates for this topic put their contact information in the table below.

Contact information

|  |  |  |
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| **Company** | **Name** | **Email address** |
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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic #1: L1/L2 inter-cell mobility

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2215359 | Intel Corporation | **Proposal 1**: Not consider simultaneous multi-panel in FR2 for L1/L2 inter-cell mobility.  **Proposal 2**: For L1/L2 inter-cell mobility, we prefer to keep the intra/inter frequency definition as legacy L3 measurement.  **Proposal 3**: For inter-frequency L1/L2 mobility, focus about inter-frequency L1-RSRP measurement without gap first.  **Proposal 4**: Synchronous scenario will refer to timing offset smaller than CP between source cell and target cell.  **Proposal 5**: Further discuss whether non-synchronous scenarios need to be considered according to the RAN2 progress.  **Observation 1**: Rel-17 inter-cell L1-RSRP is only defined under known cell condition where the UE has sent a valid L3 measurement report during the last 5 seconds.  **Proposal 6**: Further discuss whether to support inter-cell L1-RSRP measurement when L3 measurement is not available recently.  **Proposal 7**: Further discuss whether TCI activation is considered in L1/L2 mobility delay requirement. |
| R4-2215425 | CATT | **Observation 1**: According the RAN2’s conclusion, to reduce HO interruption time, we can study solutions to reduce the time of UE reconfiguration, downlink and uplink synchronization after the handover decision.  **Observation 2**: The components that can be reduced involve Tcmd,Tprocessing,2, Tsearch, TΔ, Tmargin, TIU and TRAR. where Tcmd is the time for processing L1/L2 command (HARQ and parsing), which is different from L3 baseline handover of NR Rel-17.  **Proposal 1**: To reduce HO interruption time, RAN4 can further consider the possibility of reducing Tprocessing,2, Tsearch and TΔ.  **Observation 3**: The key to the issue is how to define synchronous and non-synchronous scenarios and whether the same scenario should be considered for L1/L2 mobility and L3 mobility.  **Proposal 2**: The following options could be studied for distinguishing network synchronization and non-synchronization:   * Whether the time offset between the serving cell and the adjacent cell under test is within CP? * Whether the time offset between the serving cell and the adjacent cell under test is within MRTD/MTTD? * Whether the UE needs to do RACH to obtain TA in the target cell?   Whether some information is synchronized between the source cell and target cell in the interface? |
| R4-2215447 | MediaTek Inc. | **Proposal 1**: Not consider simultaneous data Rx/Tx with both serving cell and target cell during cell switch delay in R18 L1/L2 mobility.  **Proposal 2**: For intra-frequency L1 measurement on neighbor cell, use the requirements for L1 measurement on NSC in R17 as a baseline:   * + FFS: whether to consider multiple neighbor cells in a frequency layer,   + FFS: whether to consider timing difference between neighbor cell and serving cell larger than a CP.   **Proposal 3**: For R18 L1/L2 mobility, Network shall configure L1 measurement on a neighbor cell after receiving L3 measurement report on that cell.  **Proposal 4**: Define RRM requirements assuming single panel in FR2-1.  **Observation 1**: The definition of intra-frequency and inter-frequency may be different from the point of measurement and the point of cell switch.  **Proposal 5**: A measurement is defined as a SSB based intra-frequency L1 measurement provided the center frequency and SCS of the SSB of the neighbor cell is the same as SSB of the serving cell indicated in *ServingCellConfigCommon*.  **Observation 2**: The measurement delay of L1 inter-frequency measurement may be longer than L3 measurement.  **Proposal 6**: We suggest deprioritizing the discussion on L1 inter-frequency measurement.  **Proposal 7**: For L1-RSRP measurement on neighbor cell, UE measures only one *intra-frequency* layer on each FR2-1 band in FR2-1 CA.  **Proposal 8**: For L1-RSRP measurement, UE measures only one neighbor cell on each *intra-frequency* layer in FR2-1.  **Proposal 9**: For FR1 CA, RAN4 needs to discuss the total number of neighbor cells to perform L1-RSRP measurement on.  **Proposal 10**: From the point of L1-RSRP measurement, serving cell and neighbor cell are synchronous when the timing offset is within a CP.  **Proposal 11**: From the point of L1-RSRP measurement, focus on synchronous case in R18 L1/L2 mobility. |
| R4-2215459 | Xiaomi | **Proposal 1**: The timeline for L1/L2-based inter-cell mobility is the time from UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell.  **Observation 1**: For L1/L2 based inter-cell mobility, the MAC/DCI decoding delay instead of RRC processing delay should be defined in HO delay requirement.  **Observation 2**: For L1/L2 based inter-cell mobility, the delay of cell search is not needed in HO delay requirement.  **Observation 3**: For L1/L2 based inter-cell mobility, the UE processing time can be reduced in HO delay requirement.  **Observation 4**: For L1/L2 based inter-cell mobility, fine timing tracking and RACH uncertainty delay need to be considered in HO delay requirement.  **Observation 5**: For L1/L2 based inter-cell mobility, active TCI state switching delay need to be considered in HO delay requirement.  **Proposal 2**: For L1/L2 based inter-cell mobility, the HO delay should consider the following components:   * HO command processing delay, e.g. MAC/DCI decoding time; * UE processing time, e.g. the software processing time; * Fine timing tracking time; * RACH uncertainty delay; * Active TCI state switching time;   **Proposal 3**: For L1/L2 based inter-cell mobility, simultaneous Rx/Tx with both source cell and target cell is not considered.  **Proposal 4**: For L1/L2 based inter-cell mobility, both intra-frequency and inter-frequency measurement need to be considered.  **Proposal 5**: For L1/L2 based inter-cell mobility, both synchronized and non-synchronized scenario need to be considered.  **Proposal 6**: For the definition of SSB based L1 intra-frequency and inter-frequency, the definition of SSB based L3 intra-frequency and inter-frequency measurement can be reused. |
| R4-2215519 | Nokia, Nokia Shanghai Bell | **Observation 1:** The service interruption time is defined differently between RAN2 and RAN4. The main difference is the ending point which mark the end of service interruption.  **Observation 2:** LLM will need to support both, RACH, and RACH-less procedures  **Observation 3:** Cell change interrupt related to a cell change by LLM should aim at being significantly shorter than existing interrupt due to L3 handover to enable gains from LLM over existing L3 mobility.  **Observation 4:** RAN4 has defined requirements for L1-RSRP measurement for a cell with different PCI than serving cell.  **Observation 5:** Inter-frequency L1-RSRP measurement requirements on non-serving cell need to be defined.  **Observation 6:** Intra- and Inter-frequency are clearly both within the WID scope.  **Observation 7:** Intra-frequency is included and RAN4 can start to work on it.  **Proposal 1**: L1/L2-based inter-cell mobility can be referred as Lower Layer Mobility or LLM  **Proposal 2**: RAN4 is to review the delay components of the existing definition for L3 handover and discuss the adaptability of such definition in LLM.  **Proposal 3**: To distinguish from Cell Switch command in LLM from L3, we should call it LLM switch command  **Proposal 4**: Exact time values displayed in the Table 2 for LLM are for FFS  **Proposal 5**: LLM cell switch interruption time should be minimized, and upper limit should be agreed not to exceed the existing L3 HO interruption time  **Proposal 6**: Existing L1-RSRP measurement requirements for a cell with different PCI than serving cell can applied for LLM.  **Proposal 7**: Discuss the L1-RSRP measurement accuracies and whether they can be improved for LLM.  **Proposal 8**: RAN4 to define L1-RSRP measurement accuracy requirement for non-serving cell.  **Proposal 9**: Intra-frequency is included in the WID scope and ready for RAN4 work  **Proposal 10**: Transmit timing accuracy requirements for any uplink transmission should follow existing requirements as a starting point  **Proposal 11**: Whether to consider simultaneous Rx/Tx with both source cell and target is FFS  **Proposal 12**: Consider multi-panel requirements impact in LLM study item |
| R4-2215608 | Apple | **Proposal 1**: L1/L2 inter-cell mobility delay (DL1/L2\_mobility) depends on whether RACH is needed/allowed:   * For RACH-less case (if supported), it is defined as the time UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell. * For RACH-based case (if supported), it is defined as the time UE receives the cell switch command to UE starts transmission of the new uplink PRACH channel to the target cell.   **Proposal 2**: cell switch command processing time (Tprocess) needs to be considered in L1/L2 inter-cell mobility delay requirements.  **Proposal 3**: interruption time during the mobility procedure (Tinterrupt) includes several aspects, such as to acquire fine T/F tracking, suitable beam and so on. Under certain conditions some of the components can be zero.  **Observation 1**: complexity would be significantly increased if UE needs to support simultaneous data Rx/Tx with both source and target cells during L1/L2 inter-cell mobility. However, the gain is not that attractive since the functionality has already been supported in R16 DAPS handover.  **Proposal 4**: L1/L2 inter-cell mobility execution time needs to be considered.  **Proposal 5**: as baseline assumption, UE is not required to perform simultaneous data Rx/Tx with both source and target cells during L1/L2 inter-cell mobility.  **Proposal 6**: as baseline, do not consider simultaneous multi-Rx in FR2.  **Proposal 7**: RAN4 to discuss the definition of intra-frequency/inter-frequency in L1/L2 inter-cell mobility.  **Observation 2**: UE is expected to perform L1 measurement on neighbour cell for L1/L2 inter-cell mobility.  **Proposal 8**: for definition of intra-frequency/inter-frequency SSB based L1-RSRP measurement, follow the definition of L3 measurement, i.e. an SSB based L1 measurement is defined as an intra-frequency SSB based L1 measurement provided the centre frequency of the SSB of the serving cell indicated for measurement and the centre frequency of the SSB of the neighbour cell are the same, and the subcarrier spacing of the two SSBs are also the same. Otherwise, it is an inter-frequency SSB based L1 measurement.  **Proposal 9**: as agreed in RAN2, ICBM is not a prerequisite for using L1L2 mobility, RAN4 requirements need to cover the scenario that ICBM is not supported/enabled.  **Proposal 10**: RAN4 shall initially focus on PCell mobility. Other scenarios like CA can be discussed later. |
| R4-2215724 | CMCC | **Observation 1**: according to RAN2 agreements, the end point of HO interruption time for L1/L2-based inter-cell mobility is the time when UE performs the first DL/UL reception/transmission on the indicated beam of the target cell, which is different from existing RAN4 HO interruption requirements (taking Preamble transmission as ending point)  **Proposal 1**: taking RAN2 agreements on HO interruption time for L1/L2-based inter-cell mobility into account, it is proposed to discuss following issues when RAN4 specify HO interruption requirements.   * For the RAN2 agreements that end point of HO interruption is when UE performs the first UL transmission on the indicated beam of the target cell, it is proposed to further discuss whether first UL transmission refer to PRACH transmission or UL data? If it refers to UL data, how to reflect this in RAN4 HO interruption requirements * For the RAN2 agreements that end point of HO interruption is when UE performs the first DL reception on the indicated beam of the target cell, it isproposed to further discuss how to reflect this in RAN4 HO interruption requirements   **Proposal 2**: for the definition of intra-frequency/inter-frequency in inter-cell operation, it is proposed to reuse the definition of L3 measurement.  **Proposal 3**: for L1/L2 based inter-cell mobility, it is proposed to consider both intra-frequency and inter-frequency case. |
| R4-2215817 | OPPO | **Proposal 1**: RAN4 to discuss the details of HO delay requirements based on the conclusion of RAN1/2 on L1/L2 based procedures.  **Proposal 2**: RAN4 can further study any enhancement of Tinterrupt in mobility delay requirements.  **Proposal 3**: Intra-frequency for L1-RSRP measurement can be defined as: the measured SSB or CSI-RS for L1-RSRP measurement is within active BWP(s) of the UE, and SCS of SSB or CSI-RS is the same as serving cell SSB or CSI-RS. Otherwise, it is inter-frequency L1-RSRP measurement.  **Proposal 4**: Not to define requirement s for inter-frequency L1-RSRP measurement.  **Proposal 5**: Define UE capability of supporting the total number of cells to be monitored per frequency layer, and update related RRM requirements，e.g., Psc and PCDP. |
| R4-2215957 | LGE | **Proposal 1**: The intra- and inter-frequency L1-RSRP measurement accuracy requirements can be discussed in performance part. |
| R4-2216308 | Huawei | **Proposal 1**: Both intra-frequency and inter-frequency L1/L2 measurement are supposed to be supported as it is in the WI scope.  **Proposal 2**: Simultaneous RX/Tx with both source and target cell is regarded as a low priority for R18 L1/L2 inter-cell mobility.  **Proposal 3**: Don’t consider R18 simultaneous multiple-panel in this WI.  **Proposal 4**: For R18 L1/L2 inter-cell mobility, the number of cells to be monitored per frequency layer and supported inter-frequency layers are to be discussed.  **Proposal 5**: If more than 1 non-serving cell are supported to perform L1/L2 mobility, the R17 scaling factor between serving cell L1 measurement and non-serving cells, i.e., Psc and PCDP, needs update correspondingly.  **Proposal 6**: Each component of L1/L2 inter-cell mobility delay would be analyzed.  **Proposal 7**: Specify a window where all L1-RSRP resources on one intra-frequency layer are configured. |
| R4-2216367 | Vivo | **Observation 1** In SCell activation and R17 ICBM, high-performance data transmission can be ensured at the end of the related procedures, from RRM requirements perspective.  **Observation 2** From RAN4 RRM perspective, the TRS tracking can be merged with the T\_firstSSB only when the corresponding cell is known, i.e. corresponding L3 measurements report is sent by UE within a pre-defined period before the L1L2 activation signalling is received. For FR2, the known conditions of corresponding cell to be activated by L1L2 signaling have further restricted that, the SSB index associated to the TCI state of the SCell has to be one of the reported SSB indexes in MR.  **Observation 3** High-performance data transmission is not always ensured after legacy HO or PSCell addition/change, from RRM requirements perspective.  **Proposal 1** RAN4 to align common understanding on whether TRS tracking for high-performance data transmission is always considered in legacy mobility procedure, including HO, PSCell addition/change, SCell activation, activation of TCI from cell with additional PCI.  **Proposal 2** TRS tracking for high-performance data transmission should always be considered in R18 L1L2 mobility related enhancements, no matter it is considered in legacy mobility latency or not.  **Observation 4** In R17, only ‘intra-frequency’ ICBM, i.e. the case when SSBs of serving cell and the cell with additional PCI are on the same frequency layer, is supported. However, in R18, both ‘intra-frequency’ and ‘inter-frequency’ L1L2 based mobility, i.e. the cases when SSBs of serving cell and the candidate target cell are either on the same frequency layer or on different frequency layers, need to be supported according to the WID.  **Proposal 3** In R18 FeMob WI, inter-frequency L1L2-based mobility should be supported according to the WID, where the SSBs of active serving cell(s) and the corresponding candidate target cell(s) are on different frequency layers.  **Proposal 4** RAN4 to discuss the definition/necessity of inter-frequency L1 measurements after RAN1/2 achieve conclusions on the L1 measurement/reporting mechanism for the potential L1L2 mobility. RAN4 may further discuss the issues that RAN1/2 should prioritize to discuss for RAN4 to proceed, and provide feedback to RAN1/2 via LS.  **Proposal 5** No need to restrict the RTD between serving cell and neighbour cell to be within CP, at least for the case when SSB-based inter-cell L1 measurement is performed.  **Proposal 6** Do not consider the case when UE always support simultaneous Rx/Tx with both source cell and target cell without any restriction to the scenario in R18, which is similar to the case of DAPS HO.  **Observation 5** UE is able to simultaneous Rx with both source cell and target cell for the scenarios when   * the RTD between source cell and target cell is within MRTD for inter-band CA in FR1, or * the RTD between source cell and inter-frequency target cell is within MRTD for inter-band CA in FR2, and IBM is assumed, or * the RTD between source cell and intra-frequency target cell is within MRTD for inter-band CA, and UE support simultaneous Rx with different QCL-D in FR2, or * the RTD between source cell and inter-frequency target cell is within MRTD for inter-band CA, and UE support simultaneous Rx with different QCL-D in FR2, if CBM is assumed between the source cell and target cell.   **Observation 6** UE is able to simultaneous Tx with both source cell and target cell for the scenarios at least when   * the Tx timing difference (TTD) between source cell and inter-frequency target cell is within MTTD for inter-band CA in FR1, or * the TTD between source cell and inter-frequency target cell is within MTTD for inter-band CA in FR2, and IBM is assumed, or * the RTD between source cell and intra-frequency target cell is within MTTD for inter-band CA, and UE support simultaneous Tx with different panels in FR2, or * the RTD between source cell and inter-frequency target cell is within MTTD for inter-band CA, and UE support simultaneous Tx with different panels in FR2, if CBM is assumed between the source cell and target cell.   **Proposal 7** Simultaneous multi-panel Rx/Tx in FR2 is not considered in this WI.  **Proposal 8** Whether to support L1 measurement on multiple candidate cells should be firstly discussed in RAN1/2.  **Proposal 9** RAN4 further clarify the scenario of L1 measurement in the context of mobility, i.e. whether lower SNR would be assumed compared to the case when L1 measurements are only used for beam managements. If no clear consensus, LS to RAN1/2 can be considered. |
| R4-2216831 | Ericsson | **Proposal 1**: RAN4 not to discuss simultaneous Rx/Tx with both source cell and target cell in the context of L1L2 mobility.  **Proposal 2:** UE capability of supporting multi-RX chain and simultaneous RX from different QCL type-D should be considered in L1/L2 mobility.  **Proposal 3:** RAN4 to consider both intra-frequency and inter-frequency candidate cells for defining the requirements for L1 measurements.  **Proposal 4:** RAN4 to consider the definition intra and inter-freq. of L3 measurement as baseline.  **Proposal 5:** RAN4 to agree that MG can be used for inter-frequency L1 measurements.  **Proposal 6:** RAN4 to agree HO delay as processing time of cell switch command plus the interruption time.  **Proposal 7:** RAN4 to consider RTD>CP for L1/L2 mobility candidate cell measurements.  **Proposal 8:** RAN4 to discuss the tightening of intra-frequency L1-RSRP measurement accuracy for L1/L2 mobility.  **Proposal 9:** RAN4 to define inter-frequency L1-RSRP measurement accuracy requirements on non-serving cell  **Proposal 10:** Candidate cell L1-RSRP measurements can be measured within SMTC. |

## Open issues summary

### Sub-topic 1-1 General and Scenarios

#### Terminology

**Issue 1-1-1 Terminology of L1/L2 based inter-cell mobility**

*As the same issue is in discussion in RAN2 and RAN2 leads this WI, moderator suggests we RAN4 waiting and following RAN2’s conclusion.*

* Proposals
  + Proposal 1 (Nokia): L1/L2-based inter-cell mobility can be referred as Lower Layer Mobility or LLM.
  + Proposal 2 (Nokia): To distinguish from Cell Switch command in LLM from L3, we should call it LLM switch command.
* Recommended WF
  + Wait and follow RAN2’s conclusion.

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| **Company** | **Comments** |
| Qualcomm | Agree with Recommended WF. |
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#### Simultaneous data Rx/Tx?

**Issue 1-1-2: Whether to consider simultaneous data Rx/Tx with both source cell and target cell**

* Proposals
  + Option 1 (MTK, Apple, Huawei, Ericsson, Xiaomi): Not consider simultaneous data Rx/Tx with both source cell and target cell during L1/L2 inter-cell mobility delay.
  + Option 2 (Nokia): FFS

*Note: UE receives signals/channels or transmits signals/channels from/to the current PCell, and measure SSB from the candidate cell, is not included in “simultaneous data Rx/Tx”.*

* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | Support Option 1. This should not be any different from legacy L3 HO, not DAPS. |
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#### Single panel & multiple panel

**Issue 1-1-3: Whether to consider simultaneous multi-panel in FR2**

* Proposals
  + Option 1 (Intel, MTK, Huawei): Not consider simultaneous multi-panel in FR2
  + Option 2 (Nokia, Ericsson): Consider simultaneous multi-panel in FR2
* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | If the question is about whether L1/L2 mobility can be applied to FR2 inter-cell mTRP, we are still open to further study.  **To proponent of Option 2:**  Please clarify what “simultaneous” exactly means and whether it is limited to any specific cases, e.g.   * simultaneous data reception from serving cell and L1 measurement of candidate cell * simultaneous data reception from serving cell and L3 measurement of candidate cell   simultaneous L1 measurement from serving cell and L1 measurement of candidate cell |
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#### Intra-frequency & inter-frequency

**Issue 1-1-4: Definition of L1 intra-frequency/inter-frequency measurement**

*For information*

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| 38.133 clause 9.13.2  The SSB of the cell with different PCI from serving cell has the same SCS, sfn-SSB-Offset and center frequency as the SSB of the serving cell  38.331 R16  The IE *CSI-SSB-ResourceSet* is used to configure one SS/PBCH block resource set which refers to SS/PBCH as indicated in *ServingCellConfigCommon*.  38.331 R17  The IE *CSI-SSB-ResourceSet* is used to configure one SS/PBCH block resource set which refers to SS/PBCH as indicated in *ServingCellConfigCommon* and *ServingCellConfig*. |

* Proposals
  + Option 1(Intel, MTK, xiaomi, apple, CMCC, Ericsson): For SSB L1-RSRP measurement, follow the definition of L3 measurement.
    - Option 1a (MTK): A measurement is defined as a SSB based intra-frequency L1 measurement provided the center frequency and SCS of the SSB of the neighbor cell is the same as SSB of the serving cell indicated in *ServingCellConfigCommon*
    - Option 1b (Apple): an SSB based L1 measurement is defined as an intra-frequency SSB based L1 measurement provided the centre frequency of the SSB of the serving cell indicated for measurement and the centre frequency of the SSB of the neighbour cell are the same, and the subcarrier spacing of the two SSBs are also the same.
  + Option 2 (OPPO): For SSB L1-RSRP measurement, intra-frequency is defined as long as the SSB-based L1 measurement is performed within active BWP(s) of the UE.
  + Option 3 (vivo): wait for RAN1/2 progress.
* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | We do not have a strong view on this.  What matters in the end is whether the measurement needs any form of measurement gap(s) or not, no matter what it is called. Unless there is any technical concern, Option 1b seems okay. But the exact language should wait for RAN1/2 progress, e.g. “neighbour cell” vs. “candidate cell” etc. |
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**Issue 1-1-5: Whether to cover inter-frequency L1-RSRP measurement**

* Proposals
  + Option 1 (Intel): focus on inter-frequency L1-RSRP measurement without gap first
  + Option 2 (MTK, OPPO): deprioritize the discussion on L1 inter-frequency measurement
  + Option 3 (xiaomi, CMCC, Nokia, Huawei, Ericsson): cover inter-frequency
    - FFS: the number of supported inter-frequency layers
    - FFS: MG can be used for inter-frequency L1 measurements.
  + Option 4 (vivo): wait for RAN1/2 progress
* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | We assume that the definition of “inter-frequency L1 measurement” here in the Issue is conceptually the same as “inter-frequency L3 measurement.”  We support Option 4. Both intra- and inter-freq scenarios are in the scope according to WID, and RAN1 has been discussing whether and how to define/use L1 measurement gap. |
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**Issue 1-1-6: Whether to cover inter-frequency L1/L2 inter-cell mobility**

* Proposals
  + Option 1 (vivo): support inter-frequency L1/L2-based mobility, where the SSBs of active serving cell(s) and the corresponding candidate target cell(s) are on different frequency layers
* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | We do not think this issue needs to be separately discussed. To us, the issue seems to be part of Issue 1-1-4 and 1-1-5. |
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#### Synchronous & non-synchronous

**Issue 1-1-7: Definition of synchronous and non-synchronous**

* Proposals
  + Option 1 (Intel, MTK): From the point of measurement, synchronous scenario will refer to timing offset smaller than CP between source cell and target cell.
  + Option 2 (CATT): take the following into consideration
* Whether the time offset between the serving cell and the adjacent cell under test is within CP?
* Whether the time offset between the serving cell and the adjacent cell under test is within MRTD/MTTD?
* Whether the UE needs to do RACH to obtain TA in the target cell?
* Whether some information is synchronized between the source cell and target cell in the interface?
  + Option 3 (vivo): From RAN4 perspective, non-synchronous scenario refers to the case when slot boundary between serving cell and neighbour cell is not aligned, i.e. larger than TAE, from gNB perspective, e.g. FDD. All other cases are called synchronous.
* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | If the group wants to define the exact definition of “sync,” the condition of “smaller than CP” does not seem very precise either. If where the question is headed is “RACH-less” vs “RACH-based” L1/L2 HO, we believe RAN4 need to define requirements for both cases. Detailed constraints, applicability rule and such can be defined later according to RAN1/2 progress. |
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**Issue 1-1-8: Whether to cover non-synchronous scenarios**

* Proposals
  + Option 1 (Intel): wait for RAN2’s progress
  + Option 2 (MTK): focus on synchronous L1-RSRP measurement
  + Option 3 (xiaomi, vivo, Ericsson): No need to restrict the RTD between serving cell and neighbour cell to be within CP for SSB-based L1-RSRP measurement
* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | Option 1. This may be also related to details about intra-/inter-CU which are under discussion in RAN2. |
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#### Relation of L1 measurement and L3 measurement

**Issue 1-1-9: Relation between L3 measurement and L1 measurement**

* Proposals
  + Proposal 1 (MTK): Network shall configure L1 measurement on a neighbor cell after receiving L3 measurement report on that cell
  + Proposal 2 (Ericsson): Candidate cell L1-RSRP measurements can be measured within SMTC
  + Proposal 3 (Intel): Further discuss whether to support inter-cell L1-RSRP measurement when L3 measurement is not available recently.
* Recommended WF
  + Collect companies’ views on the proposals.

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| **Company** | **Comments** |
| Qualcomm | Proposal 1 seems to be a proper way of NW implementation. However, whether the spec has to define such a constraint explicitly should be first discussed in RAN2. Proposal 3 also needs to wait for RAN2 progress further.  Regarding Proposal 2, it is not yet clear to us whether candidate cell L1 measurements will be based on SMTC of the cell or another new parameter because L1 measurement may need a bit more frequent measurements. |
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#### Single cells & multiple cells

**Issue 1-1-10: Number of intra-frequency layers to measure per band**

* Proposals
  + Option 1 (MTK): For L1-RSRP measurement on neighbor cell, UE measures only one intra-frequency layer on each FR2-1 band in FR2-1 CA
* Recommended WF
  + Need more discussion.

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| **Company** | **Comments** |
| Qualcomm | We understand the motivation and rationale behind the proposal, but it is premature yet to define such a restriction. |
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**Issue 1-1-11: Number of cells to measure per intra-frequency layer**

* Proposals
  + Option 1 (MTK):
    - For L1-RSRP measurement, UE measures only one neighbor cell on each intra-frequency layer in FR2-1.
    - For FR1 CA, RAN4 needs to discuss the total number of neighbor cells to perform L1-RSRP measurement on.
  + Option 2 (OPPO): Define UE capability of supporting the total number of cells to be monitored per frequency layer
    - If more than 1 non-serving cell are supported to perform L1/L2 mobility, the R17 scaling factor between serving cell L1 measurement and non-serving cells, i.e., Psc and PCDP, needs update correspondingly.
  + Option 3 (vivo): wait for RAN1/2 progress
* Recommended WF
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Option 3. It is too early to discuss this level of details and restrictions. Let’s wait and see an overall framework of L1/L2 mobility to be designed by RAN2 and RAN1. |
|  |  |

#### Others

**Issue 1-1-12: L1-RSRP resources window**

* Proposals
  + Option 1 (Huawei): To avoid UE search L1-RSRP resources everywhere, it is suggested to define a window in which all to-be-measured L1-RSRP resources on intra-frequency layer are configured
* Recommended WF
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | This is RAN2 and RAN1 scope unless RAN4 is asked to scope it out via LS from RAN2 or RAN1. |
|  |  |

**Issue 1-1-13: Others**

*As the two proposals are basically the agreements in RAN2. Moderator suggests following RAN2’s conclusion without further discussion.*

* Proposals
  + Proposal 1 (Apple): as agreed in RAN2, ICBM is not a prerequisite for using L1L2 mobility, RAN4 requirements need to cover the scenario that ICBM is not supported/enabled.
  + Proposal 2 (Apple): RAN4 shall initially focus on PCell mobility. Other scenarios like CA can be discussed later.
* Recommended WF
  + No need for further discussion.

### Sub-topic 1-2 L1-RSRP measurement requirements

**Issue 1-2-1: L1-RSRP measurement delay requirements**

* Proposals
  + Option 1 (MTK, Nokia): use the measurement delay requirements for L1 measurement on NSC in R17 as a baseline
* Recommended WF
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We do not disagree with Option 1. However, we would like to wait for further RAN2 and RAN1 progress before making any explicit restriction on the applicability of L1/L2 mobility. Although ICBM is agreed as one of scenarios for L1/L2 mobility in the last RAN2 meeting, other scenarios are still under discussion in RAN2. And RAN2 also agreed that ICBM is not a prerequisite for using L1/L2 mobility. |
|  |  |

**Issue 1-2-2: intra-frequency L1-RSRP measurement accuracy**

*Generally, measurement accuracy requirements are discussed in performance part. But in moderator’s view, we can discuss the side condition in core part as it may have impact on core part requirements. Therefore, moderator suggests focusing on Option 3 in this issue.*

* Proposals
  + Option 1 (LGE ): discuss in performance part
  + Option 2 (Nokia, Ericsson): Discuss whether they can be improved for L1/L2 inter-cell mobility.
  + Option 3 (vivo): RAN4 further clarify the scenario of L1 measurement in the context of mobility, i.e. whether lower SNR would be assumed compared to the case when L1 measurements are only used for beam managements. If no clear consensus, LS to RAN1/2 can be considered.
* Recommended WF
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | The issue might be also related to outcome of Issue 1-1-9. Although we understand where the option 3 is coming from, it would be strange to have L1 measurement requirement tightened for a non-serving cell (candidate cell) compared to a serving cell.  FFS for now. |
|  |  |

**Issue 1-2-3: inter-frequency L1-RSRP measurement accuracy**

*Considering that* *measurement accuracy requirements are discussed in performance part and whether to support inter-frequency L1-RSRP measurement is still in discussion, moderator suggest not discussing this issue in this meeting.*

* Proposals
  + Option 1 (LGE): discuss in performance part
  + Option 2 (Nokia, Ericsson): define inter-frequency L1-RSRP measurement accuracy requirements.
* Recommended WF
  + No need for further discussion.

### Sub-topic 1-3 L1/L2 inter-cell mobility delay requirements

*Background: RAN2 had a discussion on the time chart of L1/L2 inter-cell mobility (R2-2209256). As pointed out by some companies, the terminology “interruption” used in RAN2’s assumption as in Figure 1 and RAN2’s LS R2-2209257 is different from conventional definition in RAN4.*

**Timeline

Description automatically generated with low confidence**

*Figure 1. Components of mobility latency for L1/L2-based inter-cell mobility (from RAN2)*

|  |
| --- |
| *RAN2 assumption captured in LS R2-2209257:*  *Assumption: HO interruption time for L1/L2-based inter-cell mobility is the time from UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell. FFS if TRS tracking after HO and CSI RS measurement should also be included, i.e. the time to use a high-performance beam (can be clarified further).* |

*For information (from R2-2209256):*

|  |  |  |
| --- | --- | --- |
| **Component** | **Meaning** | **Value** |
| TRRC | Processing time for *RRCReconfiguration* carrying candidate configurations | Up to [10] ms |
| Tprocessing,1 /  Tprocessing,2 | Time for UE processing, before and after cell switch command, respectively. This may include L2/3 reconfiguration, RF retuning, baseband retuning, security update if needed, etc. | Up to [20] ms for same FR  Up to [40] ms for different FR |
| Tmeas | Measurement delay (from target appears to cell switch command) | - |
| Tcmd | Time for processing L1/L2-command (HARQ and parsing) | Up to [5] ms |
| Tsearch | Time required to search the target cell | 0ms (if cell is known)  Up to [60] ms (if cell is unknown) |
| TΔ | Time for fine tracking and acquiring full timing information | SMTC periodicity (typ. [20] ms) |
| Tmargin | Time for SSB or CSI-RS post-processing | Up to [2] ms |
| TIU | interruption uncertainty in acquiring the first available PRACH occasion in the new cell | Typ. [15] ms |
| TRAR | Time for RAR delay | Typ. [4] ms |
| Tfirst-data | Time for UE performs the first DL/UL reception/ transmission on the indicated beam of the target cell, after RAR | - |

*As far as I know, the purpose that RAN2 discusses the components of cell switch latency/interruption is to have a whole picture of the procedure, and use this as a base to further discuss potential latency reduction solutions. We RAN4 will define the cell switch delay and interruption requirements.*

**Issue 1-3-1: L1/L2 cell switch delay**

* Proposals
  + Option 1 (xiaomi): The timeline for L1/L2-based inter-cell mobility is the time from UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell.
  + Option 2 (Apple):
    - For RACH-less case (if supported), it is defined as the time UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell.
    - For RACH-based case (if supported), it is defined as the time UE receives the cell switch command to UE starts transmission of the new uplink PRACH channel to the target cell.
  + Option 3 (CMCC): taking RAN2 agreements on HO interruption time for L1/L2-based inter-cell mobility into account, and discuss following issues
    - For the RAN2 agreements that end point of HO interruption is when UE performs the first UL transmission on the indicated beam of the target cell, it is proposed to further discuss whether first UL transmission refer to PRACH transmission or UL data? If it refers to UL data, how to reflect this in RAN4 HO interruption requirements
    - For the RAN2 agreements that end point of HO interruption is when UE performs the first DL reception on the indicated beam of the target cell, it is proposed to further discuss how to reflect this in RAN4 HO interruption requirements
  + Option 4 (vivo): TRS tracking for high-performance data transmission should always be considered in the timeline for R18 L1L2 mobility related enhancements, no matter it is considered in legacy mobility latency or not.
* Recommended WF
  + Suggest focusing on RACH-based case since RACH-less case is not supported yet in RAN1/2.
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We believe the whole framework should be first defined by RAN2. For example, RACH-based L1/L2 mobility can be also “PDCCH-order based” or “L1/L2 HO signalling based implicit or explicit triggering.” If “PDCCH-order based RACH” is adopted, RAN2 will also discuss and define whether the PDCCH (triggering RACH to the target cell) should be from “serving cell” or “target cell.”  Until we see the whole framework and the sequence of UE/NW behaviour, we cannot agree with anything yet. |
|  |  |

**Issue 1-3-2: Components of L1/L2 inter-cell mobility delay**

*Some companies (Intel, Huawei, CATT, Apple, Nokia, xiaomi, vivo, Ericsson) have proposed to discuss the components of L1/L2 inter-cell mobility delay.* *As RACH-less cell switch is not concluded in RAN1/2 yet, moderator suggests focusing on RACH-based L1/L2 inter-cell mobility at first. Although the terminology “interruption” used in RAN2’s assumption is different from conventional definition in RAN4, the time chart discussed in RAN2 can be a base for further discussion. Moderator suggests further discussing the components based on RAN2’s time chart.*

*Moderator summaries the components proposed by companies but not captured in Table 1 for further discussion.*

**Timeline

Description automatically generated with low confidence**

*Figure 2*

|  |  |
| --- | --- |
| Components | Meaning |
| Tcmd | Time for processing L1/L2-command (HARQ and parsing) |
| Tprocessing,2 | Time for UE processing. This may include L2/3 reconfiguration, RF retuning, baseband retuning, security update if needed, etc. |
| Tsearch | Time required to search the target cell |
| TΔ | Time for fine tracking and acquiring full timing information |
| Tmargin | Time for SSB or CSI-RS post-processing |
| TIU | interruption uncertainty in acquiring the first available PRACH occasion in the new cell |

* Proposals
  + Component 1 (Intel, xiaomi): TCI state switching time
    - Component 1a (vivo): TRS tracking for high-performance data transmission
* (vivo) Note: In RAN2 running CR and LS to RAN4, the term ‘*TRS tracking after HO to use a high-performance beam*’ is used instead of ‘TCI state switching’, but the intention is the same.
  + Component 2 (Apple): L1/L2 inter-cell mobility execution time, which is similar as “TCHO\_execution” in CHO delay.
* Recommended WF
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We do not quite understand what we are supposed to discuss here. The components 1 and 2 look incomplete.  The overall framework and sequence of UE/NW behaviour should be first defined by RAN2 and RAN1. RAN4 can start discussions on the detailed requirements and components from there. |
|  |  |

**Issue 1-3-3: Components of L1/L2 cell switch interruption Tinterruption**

* Proposals
  + Option 1 (Apple): Tsearch, TΔ etc.
  + Option 2 (Ericsson): all the other components in L1/L2 inter-cell mobility delay except Tcmd.
* Recommended WF
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | For now, our view is close to Option 2.  Again, however, overall framework and sequence of UE/NW behaviour should be first defined by RAN2 and RAN1. RAN4 can start discussions on the detailed requirements and components from there. |
|  |  |

**Issue 1-3-4: On each component**

* Proposals
  + Proposal 1 (CATT, OPPO, Apple): further consider the possibility of reducing Tprocessing,2, Tsearch and TΔ
  + Proposal 2 (Nokia): LLM (low layer mobility) cell switch interruption time should be minimized, and upper limit should be agreed not to exceed the existing L3 HO interruption time
  + Proposal 3 (Huawei, Nokia): Analyze each component of L1/L2 inter-cell mobility delay
  + Proposal 4 (Xiaomi): For L1/L2 based inter-cell mobility,
    - the MAC/DCI decoding delay instead of RRC processing delay should be defined in HO delay requirement;
    - the delay of cell search is not needed in HO delay requirement;
    - the UE processing time can be reduced in HO delay requirement;
    - fine timing tracking and RACH uncertainty delay need to be considered in HO delay requirement
  + Proposal 5: (Nokia): RAN4 is to review the delay components of the existing definition for L3 handover and discuss the adaptability of such definition in LLM
* Recommended WF
  + Collect companies’ views on the proposals.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | The same comment as Issues 1-3-1 , 1-3-2, and 1-3-3.  The overall framework and sequence of UE/NW behaviour should be first defined by RAN2 and RAN1. RAN4 can start discussions on the detailed requirements and components from there. |
|  |  |

### Sub-topic 1-4 Others

**Issue 1-4-1: Transmit timing accuracy requirements**

* Proposals
  + Option 1 (Nokia): Transmit timing accuracy requirements for any uplink transmission should follow existing requirements as a starting point.
* Recommended WF
  + Need more discussion.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Unless any technical issue is identified or exceptions are allowed by other working groups, Option 1 should be the case in our opinion. And RAN4 may have to define L1/L2 mobility requirements in such a way that Option 1 can be ensured. |
|  |  |

## Companies views’ collection for 1st round

### Open issues

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

## 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:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

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

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | 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** | **Revised to** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | 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