**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.

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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. |
| Huawei | The same issue is under discussion in RAN2 and belong to RAN2 scope. Wait for RAN2 conclusion. |
| Xiaomi | Support the recommended WF. |
| Intel | Fine with Recommended WF. |
| Ericsson | Agree with recommended WF.  |
| MTK | Wait and follow RAN2’s conclusion. |
| CMCC | OK with recommended WF. |
| Apple | Agree with recommended WF. |
| vivo | Agree with Recommended WF. |

#### 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. |
| Huawei | Support option 1.Simultaneous RX/Tx with both source and target cell is supported in R16 DAPS handover. DAPS handover requires high UE complexity, e.g., dual protocol stacks, enhanced RF/baseband capability. Simultaneous RX/Tx with both source and target cell is supposed to be regarded as a low priority for R18 L1/L2 inter-cell mobility. |
| Xiaomi | Option 1, this objective is to introduce L1/L2 based inter-cell mobility instead of L1/L2 based DAPS inter-cell mobility. In addition, there is no additional benefit compared with RRC based DAPS inter-cell mobility. |
| Intel | Support option 1. For L1/L2 inter-cell mobility, the target is to reduce handover delay by designing low layer based mobility procedure. |
| Ericsson | Support option 1. |
| MTK | Option 1.  |
| Apple | Support option 1. |
| vivo | Support option 1 for the intra-frequency case. FFS inter-frequency case. For UE capable of CA, there is no need for this restriction. As inter-frequency is still in the WID, we think this point should be celar |

#### 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 |
| Huawei | Option 1So far R18 multiple-panel RX WI considers intra-cell scenario as the first priority, and the inter-cell scenario is FFS. Moreover even if inter-cell scenario is supported in R18 multiple panel WI, it will focus on DL reception on serving cell using inter-cell mTRP. However L1/L2 inter-cell mobility focus on the inter-cell mobility (including L1/L2 measurement on neighbour cell). Whether the conclusions achieved in R18 multiple-panel RX reception can be directly applied for R18 mobility enhancement needs careful study. In addition, mixed two R18 features is supposed to be avoid. If there is strong motivation to do so, it shall first revise the WID in RAN plenary. |
| Xiaomi | Option 1. |
| Intel | Support option 1. Simultaneous multi-panel reception mainly focus about increasing DL MIMO layers and handle related beam management from m-TRP. While L1/L2 mobility focus about low layer mobility, where L1 measurement and report may be used to reduce the mobility delay. The purpose is different. At least measurement enhancement due to simultaneous multiple-panel reception shall not be considered. |
| Ericsson | Support option 2. To QC:We think four scenarios are possible for a UE capable of simultaneous reception from two panels.1. simultaneous data reception from serving TRP and data reception from additional serving TRP (this is supported in previous releases too)
2. simultaneous data reception from serving cell and L1 measurement of candidate cell
3. simultaneous data reception from serving cell and L3 measurement of candidate cell
4. simultaneous L1 measurement from serving cell and L1 measurement of candidate cell

From the context of L1L2 mobility, we think we need to consider 2 and 4. If we understood correctly, the requirements assuming above assumptions are not defined in previous release due to lack of time (though it was discussed in Rel-17).  |
| MTK | Option 1. In our understanding, the main reason not considering simultaneous multi-panel in R17 ICBM is that all the requirements are defined based on single active panel assumption. As the discussion in multi-Rx WI is still in the early stage, we are facing similar situation as R17 ICBM. And mixed WI discussion should be avoid. To QC: We are not quite clear of “whether L1/L2 mobility can be applied to FR2 inter-cell mTRP”. Do you refer to that serving cell is using inter-cell mTRP and will switch to a third cell?  |
| Apple | Support option 1. It is premature to conclude the scope to include the outcome of multi-panels, which may not even support inter-cell operation. |
| vivo | Support option 1. Prefer not to have parallel discussion in parallel WIs. |

#### 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 9.13.2The 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 R16The 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 R17The 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. |
| Huawei | Support option 1, option 1a and option 1b. Option 1a and option 1b seem similar, as the to-be-measured SSB of serving cell is indicated in *ServingCellConfigCommon.*Regarding option 2, the similar discussion ever carried out for L3 CSI-RS measurement. The conclusion is to follow the legacy L3 SSB measurement rule. Whether to –be-measured SSB is within BWP decides whether gap is needed. The definition of intra-frequency measurement and gap can be decoupled. |
| Xiaomi | Option 1/1a, the UE measurement behaviour e.g. measurement with or without gap should be consistent for L1 measurement and L3 measurement. |
| Intel | Support option 1/1a/1b, which are similar.We prefer to keep the intra/inter frequency definition as legacy L3 measurement to avoid confusion. Then we can further discuss whether Gap is needed or not. |
| Ericsson | We can reuse L3 measurement definition.  |
| MTK | Option 1a or Option 1b. Slightly prefer Option 1a in case more than one SSB are configured for serving cell. Regarding wording, we can use “neighbour cell” at this stage and align with RAN1/2 when writing CR. |
| CMCC | Support option 1/1a/1b. It is bettter to align the definition between L1 and L3, otherwise, it will result in complex situation that one layer is intra-frequency measurement for L1 measurement while turn out to be inter-frequency measurement for L3 measurement, or vise verse. |
| Apple  | Support option 1/1a/1b. having clear definition is helpful when implementing new requirements into RAN4 spec. |
| vivo | The measurement procedure is still being discussed in RAN1/2. In our understanding, which procedures that to be done prior to performing L1 measurements is still being discussed. In general, most companies prefer to perform DL sync before cell switch command in RAN1/2. However, in our understanding, in legacy L1 measurement requirements, DL sync is also ensured. Whether to perform L1 measurements on candidate cell after DL sync is not decided yet in RAN1/2.For the case when the SSB center frequency is different between source cell and target cell, the serving cell fine timing cannot be used for L1 measurements on candidate cell, since in most cases they are not co-located. How to ensure the performance of L1 measurements?Therefore, we prefer option 3. We prefer not to rush to have the definition of intra-frequency/inter-frequency measurements. Option 1/1a/1b should not be adopted in this early stage, in our view.  |

**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. |
| Huawei |  Support option 3.In R18 mobility enhancement WI, both intra-frequency and inter-frequency L1/L2 mobility are explicitly mentioned in the work scope.

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| *Note 3: The procedure of L1/L2 based inter-cell mobility are applicable to the following scenarios:** + - *Standalone, CA and NR-DC case with serving cell change within one CG*
		- *Intra-DU case and intra-CU inter-DU case (applicable for Standalone and CA: no new RAN interfaces are expected)*
		- *Both intra-frequency and inter-frequency*
		- *Both FR1 and FR2*
		- *Source and target cells may be synchronized or non-synchronized*
 |

To support intra-frequency and inter-frequency L1/L2 based inter-cell mobility, intra-frequency and inter-frequency L1/L2 measurement shall be supported. Moreover inter-frequency is a typical scenario for handover. Not supporting inter-frequency would loss a part of essential deployment scenario from network deployment perspective. |
| Xiaomi | According to the description in WI, the procedure of L1/L2 based inter-cell mobility are applicable to both intra-frequency and inter-frequency operation. |
| Intel | Support option 1.For L1/L2 mobility in RAN 2, it’s still FFS whether Rel-17 inter-cell BM will be involved.If Rel-17 inter-cell BM is involved, since RAN4 only defined the related L1-RSRP requirement when the BWP of cell with additional PCI is within the active BWP of serving cell, i.e. no measurement gap case. Therefore, we prefer to consider the inter-frequency without gap case first.Later, according to the RAN2 progress, we can further discuss whether to discuss inter-frequency with gap case. |
| Ericsson | We support option 3. In some cases L1L2 mobility may replace L3 mobility and it should cover inter-frequency HO. |
| MTK | Option 2. UE cannot measure two cells of the same frequency at the same time due to beam direction toward different cells may be different for L1 measurement in FR2. So for FR2, not only L3 and L1 share MG, but also different cells of the same frequency layer should be measured in a TDM fashion.We have a rough calculation of the measurement delay of L1 inter-frequency measurement as shown in the following table. It can be observed that measurement delay of inter-frequency L1 measurement may be even longer than L3 measurement. The objective of L1/L2 mobility is mobility latency reduction. We doubt the benefit of L1 inter-frequency measurement if the measurement delay is even longer than L3 measurement.

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|  | **Measurement Period (MP) equation** | **Before L1 measurement configured** | **After L1 measurement configured** |
| **L1 inter-frequency** | Suppose measurement requirement of L1 is:M\*N\*max(TSSB, TDRX, MGRP)\*CSSF | - | CSSF=4MP=128\*MGRP |
| **L3 inter-frequency** | Mmeas\_period\_inter × Max(TDRX, MGRP, SMTC period) × CSSFinter | CSSF=2MP=80\*MGRP | CSSF=4MP=160\*MGRP |
| Assumptions:* two L3 inter-frequency layers to measure and two L1 inter-frequency cells to measure
* {TSSB, TDRX, SMTC period} ≤ MGRP
* M=4 (one more sample than intra-frequency L1 measurement)
* N=8
* Mmeas\_period\_inter =40 for handheld UE
 |

We understand the intention to use L1/L2 mobility replace L3 HO. But can L1 measurement also replace L3 measurement?For Option 1: just double check “inter-frequency L1-RSRP measurement without gap” refer to “SSB center frequency is different from serving cell but SSB is within active BWP”?For Option 4: We think RAN4 is the best WG to conclude on inter-frequency L1-RSRP measurement. |
| CMCC | Support option 3. According to the WID, it is clearly stated that both intra-frequency and inter-frequency are included. If inter-frequency case is precluded from the WID, it needs to be discussed in RAN plenary. |
| Apple | Support option 3. Inter-frequency scenario is in the scope of this WI. We understand the concern from MTK and we are open to further study how to address the issue. |
| vivo | Support option 4.Without the measurement procedure get clarified in RAN1/2, it is pre-mature to discuss ‘inter-frequency’ for now.  |

**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. |
| Huawei | Support option 1. Inter-frequency L1/L2 mobility is in the WI scope. |
| Xiaomi | Option 1. |
| Ericsson | DO not understand this issue. |
| MTK | Fine with Option 1. The definitions of intra-frequency and inter-frequency may be different from the point of measurement and the point of cell switch. Take the scenario “the target PCell is a current Scell” as an example, from the point of measurement, the SCC is still an intra-frequency. But from the point of cell switch, this is inter-frequency cell switch. Therefore, we support to discuss this issue separately. Considering inter-frequency L1 measurement delay would be too long, inter-frequency L1/L2 mobility maybe bases on beam level L3 measurement results.  |
| CMCC | We would like to know the difference between this Issue 1-1-6 and Issue 1-1-5. |
| Apple | Option 1 is more like an observation of scope which has already been captured in the WID. Maybe some clarification can be helpful to make intention of option 1 clear. |
| vivo | Support option 1. We also support to have a separate issue for the discussion. The moderators’ explanation is also the same as our understanding.We are fine to agree on option 1 in this issue for this meeting. For 1-1-4, we think RAN1/2 progress is needed before we agree on this issue. |

#### 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. |
| Huawei | No strong view on the sync/non-sync definition. Option 1 is from UE reception perspective and option 3 is from network perspective.  |
| Xiaomi | Option1 from UE perspective. |
| Intel | Prefer Option 1.Since Rel-17 inter-cell BM requirement is defined when timing offset is within CP, we prefer to consider the same timing offset condition.  |
| Ericsson | From mobility perspective we should define requirements for both sync and async. We can reuse the legacy definition of sync and async for L3 HO. If legacy sync and async definitions cannot be reused, we can revisit this issue later. |
| MTK | Option 1. We suggest defining synchronous from the point of measurement. Or when discussing L1 measurement, we use RTD < CP or RTD≥CP instead of synchronous or non-synchronous. |
| Apple | If we really need to define the concept of sync and async, we prefer option 1.  |
| vivo | Support option 3. Option 1 is not aligned with definition of sync and async in RAN4 and may cause confusion. For example, do RAN4 assume the PCell and SCell are sync in inter-band CA? If yes, do RAN4 assume the timing difference is less than CP?Even for the case of two cells in a same CC, from deployment perspective the timing difference at UE side can be >CP. Option 3 is aligned to the cell phase synch definition in clause 7.4 of TS 38.133. |

**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. |
| Xiaomi | Option 3, for non-synchronous case, the RTD between serving cell and neighbour cell is not within CP. |
| Intel | Support option 1. |
| Ericsson | Option 3.  |
| MTK | Option 2. For FR1, if the timing difference of serving cell and neighbour cell is larger than a CP, either more FFTs are needed, or UE has to measure serving cell and different neighbour cells in TDM-ly. More FFTs lead to much higher cost. Measurement in TDM fashion leads to much longer measurement delay and much more scheduling restriction.We think RAN4 can discuss whether to define L1-RSRP measurement requirements for the case that RTD of serving cell and neighbour cell is larger than a CP independent of RAN2 progress. |
| Apple | We suggest RAN4 starting from synchronous case and putting async case in FFS. From UE complexity point of view, support of intra-frequency async case is not preferred. However, for gap-based inter-frequency case (if supported according to previous issues), it doesn’t matter too much whether it is sync or async. |
| vivo | Option 3. Option 1 is also acceptable at this stage. |

#### 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. |
| Huawei | Proposal 1. L3 measurement shall be always performed as the cell detection is always needed. The possible procedure is that the limited number of candidate cells selected through L3 measurement and then network configure L1/L2 related measurements related with the candidate cells and then UE report corresponding L1/L2 measurement report. |
| Xiaomi | In our understanding, the prerequisite for supporting L1/L2 inter-cell mobility is that the target cell is known to UE, whether report L3 measurement is up to NW configuration. |
| Intel | Support Proposal 3.It’s current FFS in RAN2 whether L3 or L1 measurement will be applied before HO command for mobility preparation, from the LS from RAN2.

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| * Assume that we rely on L1 measurements to trigger L1L2 mobility (still measurement for preparation could be L3, FFS)
 |

there may be some problem if L1 measurement is performed before HO command to replace legacy L3 measurement. 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. It seems that L3 measurement is still required before L1 measurement. L1 measurement will depend on L3 measurement as well. Therefore, we suggest to wait for the RAN2’s progress.For Proposal 2, in Rel-17, RAN4 agreed that inter-cell L1-RSRP don’t impact the L3 measurement. We prefer not to consider L1 measurement in SMTC. |
| Ericsson | We support proposal 2. To Intel: in Rel-17 it is for ICBM but this is for mobility. Main reason to reach that agreement was to not to impact the mobility performance. Here since both L1 and L3 are for mobility, we cannot apply same rule.Proposal 1 need not be prerequisite always. I think RAN1/2 is discussing blind L1-RSRP reporting if UE can detect other cells than the candidate cells.Proposal 3 can be studied further. |
| MTK | Support Proposal 1. If L3 measurement is not available, UE also needs to perform cell search and SBI reading before L1 measurement. We wonder how NW identifies candidate neighbour cells for L1 measurement if not based on L3 measurement report. If NW just configures a bunch of cells for L1 measurement, the measurement delay would be much longer and will lead to more scheduling restriction and unnecessary power consumption.Regarding Proposal 2: Open for further discussion.We prefer to discuss this issue in RAN4. In R17 ICBM, this was also discussed in RAN4. To Ericsson: Can you explain more on “blind L1-RSRP reporting”? Is there any restriction between detected cell and candidate cell when using blind L1-RSRP reporting? |
| Apple | Proposal 1 is ok. Blindly configuring L1 measurement without L3 would result in unnecessary latency. We are open to further discuss whether this proper NW behaviour needs to be reflected in RAN4 spec.Proposal 2 is ok, as it doesn’t preclude other possible configuration, which may be pending on other WG progress. On proposal 3, it is a bit unclear to us what is “when L3 measurement is not available recently”.  |
| vivo | For P1 and P2, we think these should be decided by RAN1/2. P3 is also RAN1/2’s work. In case there is LS from RAN1/2, RAN4 may further discuss the corresponding questions. |

#### 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. |
| Huawei | It is premature to discuss UE capability details at this stage. |
| Xiaomi | Similar view as HW, it is premature to discuss UE capability details at this stage. |
| Ericsson | We agree that it is early to discuss these details  |
| MTK | Option 1.At least UE should perform cell search and SBI reading before L1 measurement. And for L3 measurement, when there are multiple serving cells on the same FR2 band, UE performs L3 measurement on neighbor cells of only one frequency layer of that FR2 band as shown in the following figure. Thus we propose that UE would perform L1-RSRP measurement on neighbor cell of only one frequency of the FR2-1 band for FR2-1 CA.We wonder why it is not mature to have such restriction. We think it is a common case that PCell switches to a neighbour cell on the same frequency layer of a Scell. And RAN2 does not need to discuss whether to consider this case. |
| Apple | Support option 1. In our understanding option 1 is in line with current L3 measurement assumption. |
| vivo | We think this issue needs not to be discussed before we conclude in issue 1-1-4. |

**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.

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| **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. |
| Huawei | Option 3. It is premature to discuss UE capability details at this stage. |
| Xiaomi | Option 3 |
| Ericsson | Option 3 |
| MTK | Option 1.To our understanding, network can adjust the neighbor cell to measure based on measurement report from UE. The need to measuring L1-RS from multiple cells comes from the case that there are multiple intra-frequency cells better than serving cell, which seems not a typical case in real network. In addition, the more cells UE measures, the longer the measurement delay is. In our view, it is better to limit to single neighbor cell in FR2.At least RAN4 should discuss the impact on measurement of supporting multiple cells. This is also helpful for the design of the feature. |
| Apple | We think it is premature to discuss this capability, since the mobility/measurement procedure is not very stable yet. |
| vivo | Option 3. RAN4 discussion can be triggered by LS. |

#### 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.

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| **Company** | **Comments** |
| Qualcomm | This is RAN2 and RAN1 scope unless RAN4 is asked to scope it out via LS from RAN2 or RAN1. |
| Huawei | To clarify, this is a RAN4 issue.To avoid UE search L1-RSRP resources everywhere, it is suggested to define a window in which all to-be-measured L1-RSRP CSI-RS resources on one intra-frequency layer are configured. In R16 CSI-RS L3 mobility, similar window (5ms) is specified for the same intention. |
| Ericsson | We can further study this.  |
| MTK | Since it is for CSI-RS based L1-RSRP measurement, we should wait for RAN1/2 progress and conclude on whether to support CSI-RS based L1-RSRP measurement on neighbour cells at first. |
| Apple | We understand the motivation, which is good. However, we prefer to revisit it after we have more RAN1/2 inpurt, e.g. whether CSI-RS is supported. |
| vivo | This might be good for gap-based approach. Agree with Qualcomm that this should be concluded by RAN1/2 firstly. |

**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.

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| **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. |
| Huawei | Option 1 is not very clear. If RAN4 considers inter-frequency, more than 1 NCS, how to use R17 L1 measurement on NSC as a baseline? |
| Xiaomi | More inputs from RAN1/2 are needed. |
| Intel | It’s still FFS whether Rel-17 inter-cell BM will be involved in RAN2. We can wait for RAN2 progress. |
| Ericsson | We do not agree with this one. Principles of measurement needs to be clear first. |
| MTK | Support Option 1. From the point of L1 measurement, whether it is used for R17 ICBM or L1/L2 inter-cell mobility has no essential impact on the measurement delay requirements. What does matter is intra/inter-frequency, RTD within or larger than CP, the number of frequency layers and cells to measure and so on. We don’t know which one to be used as a baseline except the current L1 measurement delay requirement on NSC in R17. |
| Apple | FFS. At least it cannot apply to inter-frequency case. |
| vivo | The intention of option 1 is clear, and we are supportive to this intention. However, at least the term of NSC or CDP should not be used directly here. We are also OK to FFS this issue. |

**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.

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| **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. |
| Huawei | We understand the motivation of option 3 is from mobility perspective. However the following aspects need to be considered as well:1. In R15, the side condition of L1-RSRP measurement is 3dB. One reason is that the sample number of L1-RSRP measurement is smaller than L3 measurement, i.e., 1 or 3. To guarantee measurement accuracy, higher SINR is set.2. 3dB side condition is set for R17 ICBM L1-RSRP as well. The reason is that the non-serving cell is selected by network and it is supposed to in a good condition. Therefore the L1-RSRP on NSC would be performed at higher SINR.Considering the above aspects into account, we don’t find strong view to use a lower SNR for R18 inter-cell mobility. We are open to further discuss. |
| Intel | From our point of view, if inter-cell L1-RSRP is involved in L1/L2 mobility, the SNR condition may be kept. L1/L2 mobility apply in relative better channel condition. We are also fine to further discuss it later. |
| Ericsson | Option 2. Option 3 can be further studied. |
| MTK | Side condition Ês/Iot in current SSB based L1-RSRP accuracy requirement is -3dB. For L3 HO, the side condition is “Es/Iot<-2 dB”. We think -3dB is already low enough. We also agree with QC that L1 measurement requirement for a neighbour cell should not be tighter than serving cell.To QC: But we don’t quite get why this issue is related to outcome of issue 1-1-9. Would you please explain more? |
| Apple | In current spec side condition for L1 measurement is -3dB, which is even lower than side condition in unknown HO requirements. we do not see necessity any lower side condition. |
| vivo | Agree with Qualcomm that this is related to issue 1-1-9. This is related to the timeline of the L1 L2 mobility. We are not sure whether RAN1/RAN2 will discuss this without input from RAN4. In legacy mobility procedure, L3 measurement is performed at low SNR side condition, i.e. -9dB. This can help to find the neighbour cell and perform measurement early, while TimeToTrigger can be set to around several hundreds of mili-seconds to avoid ping-pong.However, how to avoid ping-pong, while the UL/DL performance can ensure robust signalling transmission needs further discussion in RAN1/RAN2. For example. There is no ACK transmission after HO command is received by UE. However, if it is the L1/L2 cell switch command, which is based on MAC CE or DCI, would there be any ACK? We think this issue might related to the side condition assumed during the whole ‘HO’ process. The side condition has RAN4 requirement impact.Based on above, we think the SNR value can be firstly discussed in RAN4. We are open to either -9dB or -3dB at this stage.  |

**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.*

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

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| *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 FRUp 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.

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| **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. |
| Huawei | In our understanding the term “HO interruption time” used in RAN2 discussion is not an accurate concept. RAN2 just uses the term to discuss which part can be further enhanced. This can be regarded as “handover delay”.From RAN4 perspective, we prefer option 2, for RACH based case, the real interruption is s the time duration from HO CMD to PRACH.  |
| Xiaomi | Option 1, according to RAN2 LS, the interruption time include the time for UE performs the first DL/UL reception/ transmission on the indicated beam of the target cell, thus, this procedure should be included in timeline for L1/L2 based mobility. |
| Intel | We suggest to wait for RAN2 progress about the whole mobility procedure timeline. Generally, we are fine with option 1 which define the starting and ending point. |
| Ericsson | Need to wait for further RAN1/RAN2 progress. |
| MTK | We are fine to use “receiving cell switch command” as the starting point. No matter the command is “PDCCH-order based” or “L1/L2 HO signalling based implicit or explicit triggering.”, the delay requirement starts at receiving the cell switch command. The difference would lie in the exact value of some components of the delay requirement, but not the starting point. Regarding the end point, we support the second bullet in option 2.Even for L3 HO, the interruption time used in RAN2 is different from “Tinterruption” in RAN4. We will take RAN2’s agreement/assumption into consideration and define the delay requirements and “Tinterruption” based on RAN4’s common understanding. |
| CMCC | We are open for discussion. For option 3, the motivation is that we observe that the RAN2 agreements on HO interruption time for L1/L2-based inter-cell mobility is different from conventional definition of HO nterruption time in RAN4. For normal HO interruption, the end point is transmission of the new PRACH. While according to RAN2 LS, the end point of interruption time for L1/L2-based inter-cell mobility is that UE performs the first DL/UL reception/transmission on the indicated beam of the target cell. We suggest companies to check the difference and how to specify requirements for cell switch delay and/or interruption time for L1/L2 mobility in RAN4 considering the difference. |
| Apple | We support option 2 and open for further discussion.One thing we would like to highlight is that typically interruption is discussed and defined in RAN4. RAN2 discussed this only for their better understanding of the procedure. RAN4 should not just wait for RAN1/2 discussion and put the outcome into RAN4 spec. |
| vivo | If it is the delay to be discussed, we are fine to FFS. The issue can be firstly discussed in RAN2. |

**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.*

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*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.

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| **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. |
| Huawei | Regarding the mobility delay, we would like to analyse each proponent one by one:* Handover command processing delay: in our understanding the L1/L2 inter-cell mobility would be triggered by MAC/DCI rather than RRC. Typically, processing of L1 or L2 (MAC CE) is faster.
* The pre-condition of UE performing L1/L2 mobility is based on the coarse timing. Therefore the target cell is already known to UE. Tsearch can be zero.
* The beam index/information may be indicated by network, therefore TCI state switching time is needed. However herein one thing needs to be further discussed that whether the fining timing is obtained (i.e., UE performs TRS tracking on the candidate beams before handover which is pointed out in option 1a) . If UE needs to track multiple candidate inter-cell beams, whether additional implementation complexation needs to careful analyse.
* UE processing time (Tprocessing 2) is UE software processing and RF warmup delay. As UE has already perform L1/L2 measurement on the target cell, the RF chain/baseband are activated in some extent. If only limited reconfiguration parameters of target cell are carried in L1/L2 handover command, then the software time for target cell parameter loading time can be reduced. Moreover in our understanding, the legacy UE processing time (20ms) has already has some margin. Therefore there are rooms to reduce UE processing time for L1/L2 mobility.
* RACH: to our knowledge, RACH-less solution is one potential direction in L1/L2 inter-cell mobility. But as suggested by Moderator, focusing on RACH-based L1/L2 inter-cell mobility at first, the Tiu time can reuse the legacy value.
 |
| Xiaomi | The beam information need to be indicated to perform fine timing tracking measurement or transmit RACH, according to the reported L1-RSRP measurement results, NW can configure the TCI state information. Thus, the active TCI state switching delay need to be considered in HO delay requirement, and it is assumed that the active TCI state remains unchanged during the HO procedure. |
| Intel | If L1 measurement is involved, TCI indication will be configured after L1 measurement, then TCI activation delay needs to be included. We are fine to wait for RAN2 progress. |
| Ericsson | We need to wait for further progress in other WG |
| MTK | The intention is to discuss whether to add the components proposed by companies but not already included in RAN2’s time chart.We think more clarifications are needed on component 1 and 1a.On component 1: We are not very clear on the motivation. As the objective of this WI is to reduce HO latency, we only need to consider known cell case in our view. If the TCI state is known but not active, the main procedure is T/F fine tracking. Hasn’t it been reflected by TΔ. So is this component for known cell but unknown TCI state? Or considering the impact of PL-RS even for known TCI state? Or if cell switch is based on L3 measurement results, we need to consider the time needed to switch to a fine beam? Or some others?On component 1a: why need TRS tracking? On component 2: In our understanding, UE can decode the configuration for target cell when HO condition is satisfied in CHO. So UE needs TCHO\_execution to decode the configuration for target cell. But for L1/L2 inter-cell mobility, we think UE can decode the configuration for target cell before cell switch command. |
| Apple | The reason we raised component 2 is that NW may configure L1 measurement multiple neighbour cells. Eventually UE performs handover to only one of them. With this assumption, UE probably don’t need to decode and apply configurations for all target cells. Once handover decision is made, UE can do that just for the selected target cell. |
| vivo | Same comment as issue 1-3-1. |

**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.

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| **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. |
| Huawei | Option 1 is not very clear to us. Does it mean for RACH based case, the real interruption is the time duration from HO CMD to PRACH? If yes, we agree on option 1.Option 2 depends on which components are included in L1/L2 inter-cell mobility delay.  |
| Ericsson | Need to wait for further progress of other WG. |
| MTK | We can focus on the delay requirement at first. When the components of the delay requirement is clear, it will be easy to get Tinterruption. |
| CMCC | Can be FFS. As we commented in Issue 1-3-1, we observe that the RAN2 agreements on HO interruption time for L1/L2-based inter-cell mobility is different from conventional definition of HO interuption time in RAN4. For normal HO interruption, the end point is transmission of the new PRACH. While according to RAN2 LS, the end point of interruption time for L1/L2-based inter-cell mobility is that UE performs the first DL/UL reception/transmission on the indicated beam of the target cell. The ending point has impact on the components of L1/L2 cell switch interruption. It is better for RAN4 to first align the ending point, whether to reuse conventional way of HO interuption time in RAN4 (i.e. ending point is PRACH transmission) or to follow RAN2 agreements (i.e. ending point is first DL/UL reception/transmission). |
| Apple | We only listed the components in high level in our contribution. The interruption 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. To HW, yes for RACH based case, the real interruption is the time duration from HO CMD to PRACH.Details can be further discussed after the procedure becomes clearer. |
| vivo | Same comment as issue 1-3-1. |

**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.

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| **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. |
| Huawei | Same comments in issue 1-3-2. |
| Xiaomi | Support proposal 4. |
| Intel | Suggest to wait for RAN2 progress. |
| Ericsson | Wait for further progress in other WG |
| MTK | As far as I know, RAN2 is discussing sending RAN4 a LS to trigger RAN4’s discussion on reducing some of the components. It is fine to us to discuss proposal 1 in this meeting or wait RAN2 LS. On the components those depend on RAN1/2 progress, i.e Tcmd, we think it is better to wait RAN1/2 input. |
| Apple | We are fine to wait for more RAN1/2 input. |
| vivo | Same comment as issue 1-3-1. |

### 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.

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| --- | --- |
| **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. |
| Huawei | Generally, option 1 is reasonable. We would like to know whether there is additional impact on specification. For RACH based L1/L2 mobility, it seems the existing requirements covers the case:“The UE initial transmission timing error shall be less than or equal to ±Te where the timing error limit value Te is specified in Table 7.1.2-1. This requirement applies:when it is the first transmission in a DRX cycle for PUCCH, PUSCH and SRS, or it is the PRACH transmission, or it is the msgA transmission, or it is the first transmission sent on the PSCell for activating the deactivated SCG without RACH.” |
| Ericsson | We are generally fine with principle of option 1. Having said that without knowing what the exact impact of the proposal, it may be early to make any agreement. |
| MTK | Support Option 1 in principle. Similar view as Huawei. Currently we don’t see there would be any impact on spec except multi-TA or RACH-less is supported in RAN1/2. |
| Apple |  Fine with option 1. |

## 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 |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
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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