**3GPP TSG-RAN WG4 Meeting # 112 R4-2413960**

**Maastricht, Netherlands, August 19 – 23, 2024**

**Title:** WF on Further NR mobility enhancements

**Agenda Item:** 5.24.3

**Source:** MediaTek Inc.

**Document for:** Approval

# 0 Notes:

In this document,

* < **Agreement** > represents the decisions made by in this meeting
* < **Way forward** > represents the next step in later meetings
  + “FFS” does not mean RAN4 will make a down-selection for the item. More other options can be proposed.
* < **Tentative Agreement**> will be changed to < **Agreement** > if no comments received.

# 1 Topic #1: LTM - Core part

## Sub-topic 1-1 PDCCH-order RACH on neighbor cell

**Issue 1-1-1: SFN acquisition**

*Ad hoc agreement*

**<Agreement>:** FFS the following options:

* Option 1:
  + In cell switch delay requirements, add the applicability that UE is not required to obtain SFN information.
* Option 2:
  + in RRM requirements applicability of LTM cell switch delay and PDCCH order RACH delay, clarify that SFN between serving and target cell should be the same even for inter-frequency target cell in FR1.
* Discuss the wording in CR.

**Issue 1-1-2: Interruption when PRACH is not fully contained in any of UE’s configured UL BWP(s) of active serving cells**

*For information:*

*RAN4#110bis*

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| **<Agreement >**   * + Interruption to both DL and UL duration before/after PDCCH-order LTM PRACH is extended by [1ms] for the following case:     - The PDCCH-order PRACH is not fully contained in any of UE’s configured UL BWP(s) of active serving cells, and     - the number of RRC-configured LTM cells whose PRACH resources are not fully contained in any of UE’s configured UL BWP(s) of serving cell(s) is more than [2], and     - UE is configured with SRS carrier switching. |

< **Tentative Agreement**>

* + Remove the brackets.
    - Interruption to both DL and UL duration before/after PDCCH-order LTM PRACH is extended by ~~[~~1ms~~]~~ for the following case:
      * The PDCCH-order PRACH is not fully contained in any of UE’s configured UL BWP(s) of active serving cells, and
      * the number of RRC-configured LTM cells whose PRACH resources are not fully contained in any of UE’s configured UL BWP(s) of serving cell(s) is more than ~~[~~2~~]~~, and
      * UE is configured with SRS carrier switching.

## 1.2 Sub-topic 1-2 Early Candidate cell’s TCI state activation

**Issue 1-2-1: Whether to consider early TCI state activation for multiple cells at the same time**

< **Agreement**>: TBD

Session Chair: E/// to kick off offline discussion on this issue. Conclude this issue in this meeting.

* Proposals
  + Option 1 (CATT, MTK, Huawei, CTC, ZTE):
    - No requirements of early TCI state activation delay are specified for the case that multiple LTM TCI activation commands are received at the same time.
  + Option 2 (Ericsson, QC):
    - When one or more of TCI state activation commands are received at slot n, UE shall be able to finish the TCI state activation within slot n+ THARQ +TTF + TSSB-proc. where TTF  is mentioned in the below table.

|  |  |  |
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|  | **TTF** | **Comments** |
| FR1 intra-frequency cell, known and unknown TCI state | max (Tfirst-SSB\_TCI1, Tfirst-SSB\_TCI2 .., Tfirst-SSB\_TCIn) | Tfirst-SSB\_TCIn is the time for first SSB associated to TCI state n. |
| FR1 inter-frequency cell without MG, known and unknown TCI state | max (Tfirst-SSB\_TCI1, Tfirst-SSB\_TCI2 .., Tfirst-SSB\_TCIn) + (M-1)\*TSSB | Tfirst-SSB\_TCIn is the time for first SSB reception associated to TCI state n.  M is the number of cells to activate the TCI states  TSSB is the SSB burst periodicity. |
| FR1 inter-frequency cell with MG, known and unknown TCI state | TFirstMG + (M-1) \*MGRP+MGL | TFirstMG is the time to start of first MG after slot n+THARQ+3ms,  MGL is measurement gap length  M is the number of cells to activate the TCI states  MGRP is the MG repetition periodicity |
| FR2 intra-frequency cell, known TCI state | max (Tfirst-SSB\_TCI1, Tfirst-SSB\_TCI2 .., Tfirst-SSB\_TCIn) + (M-1)\*TSSB | Tfirst-SSB\_TCIn is the time for first SSB reception associated to TCI state n.  M is the number of cells to activate the TCI states  TSSB is the SSB burst periodicity |
| FR2 inter-frequency cell without MG, known TCI state | max (Tfirst-SSB\_TCI1, Tfirst-SSB\_TCI2 .., Tfirst-SSB\_TCIn) + (M-1)\*TSSB | Tfirst-SSB\_TCIn is the time for first SSB reception associated to TCI state n.  M is the number of cells to activate the TCI states  TSSB is the SSB burst periodicity |
| FR2 inter-frequency cell with MG, known TCI state | TFirstMG + (M-1) \*MGRP+MGL | TFirstMG is the time to start of first MG after slot n+THARQ+3ms,  MGL is measurement gap length  M is the number of cells to activate the TCI states  MGRP is the MG repetition periodicity |

* Recommended WF
  + Recommend following the majority view and agree on Option 1
    - No requirements of early TCI state activation delay are specified for the case that multiple LTM TCI activation commands are received at the same time.

**Issue 1-2-2: The definition of Tfirst-SSB in early candidate cell’s TCI state activation delay for inter-frequency with gap for known TCI state case**

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| **RAN4#111**  < **Agreement**>:   * + In early candidate cell’s TCI state activation delay for known TCI state case: Tfirst-SSB is the time to the first SSB occasion overlapped with MGL after slot n + THARQ + + [2ms] if the SSB needs to be measured with MG.     - FFS: this is only applicable to UE supporting inter-frequency L1 measurement with MG.   + Same agreement applies to the definition of Tfirst-SSB in PDCCH order RACH delay requirement. |

< **Way Forward** > FFS the following options:

* + Option 1 (Apple, MTK):
    - remove “FFS: this is only applicable to UE supporting inter-frequency L1 measurement with MG” in definition of TSSB in PDCCH ordered RACH and early TCI activation requirements.
  + Option 2 (ZTE, vivo):
    - Confirm the FFS.

**Issue 1-2-3: Whether and how to support unknown TCI state in FR2 for early TCI state activation**

*Online Agreement:*

< **Agreement**>:

* + Not to define requirements of SSB based early TCI state activation delay for FR2 unknown TCI state case.

**Issue 1-2-5: Conditions to support unknown TCI state in FR1 for early TCI state activation**

*RAN4#111*

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| < **Agreement**>:  Unknown TCI state in FR1 for early TCI state activation is supported with the following conditions:   * + UE has reported beam-level L3 measurement result of the associated SSB of the TCI state within [1280ms or 5 seconds] before the LTM TCI state activation command.   + SNR of the associated SSB is above -3dB. |

< **Tentative Agreement** >

* + Unknown TCI state in FR1 for early TCI state activation is supported with the following conditions:
    - UE has reported L3 measurement result with the associated SSB index of the TCI state within 5s before the LTM TCI state activation command.
    - SNR of the associated SSB is above -3dB.

## 1.3 Sub-topic 1-3 L1-RSRP Measurement

**Issue 1-3-1: Measurement period of serving cell L1-RSRP measurement**

< **Tentative Agreement**>

* + RAN4 not to modify the serving cell measurement period by scaling it with NLayer for UE supporting RTD > CP.

**Issue 1-3-2: Measurement period of neighbor cell L1-RSRP measurement**

< **Way Forward** > FFS the following option:

* + Consider to revisit the agreements for L1 RSRP measurement on neighbour cell, e.g., either follow the logic of serving cell L1-RSRP measurement or L3 intra-frequency measurement.

**Issue 1-3-3: L1 report for unmeasured candidate cells**

< **Tentative Agreement**>

* + Use DIFFRSRP\_15 in Table 10.1.6.1-2 for measurement reporting of differential values for unmeasured LTM L1-RSRP resources.

**Issue 1-3-4: Spec organization**

< **Way Forward** > FFS the following options:

* + Option 1 (vivo):
    - Capture all intra-frequency LTM L1 measurement requirements, including serving cell L1 measurement requirements, in 9.14.
    - The impact to serving cell L1 measurement, which is configured by CSI-ResourceConfig, due to Rx beam sharing with neighbour cell LTM L1 measurement is captured by PL1\_sharing in 9.5.4.1.

## 1.4 Sub-topic 1-4 Cell switch delay requirements for Pcell/PSCell

#### 1.4.1 T/F fine tracking: Tfirst-RS and Tmargin

**Issue 1-4-1-1: T/F tracking when TRS as QCL source in cell switch delay**

*Ad hoc agreement*

**<Agreement>:**

* + Confirm current cell switch delay requirements are applicable to the case that TRS is configured as a QCL source in the indicated TCI state in cell switch command.
  + FFS whether Tfirst-ssb in cell switch delay requirements need to be updated, e.g. based on TRS.

**Issue 1-4-1-2: Conditions of Tfirst-RS =0 in cell switch delay**

*Ad hoc agreement*

**<Agreement>:**

* For cell switch with L1 measurement: Extend the condition for Tfirst-RS = 0 “the time gap between receiving the LTM candidate cell TCI state activation MAC-CE and the cell switch command is not more than [160 ms]” from the agreed 160 ms, to TCI state activation delay stated in section 8.25.3 + 160 ms.
  + Discuss the wording in CR.
* FFS the following assumption
  + In FR1, for UE not supporting/configured with L1 measurement, one SSB occasion is needed from RAN4 requirement point of view for T/F fine tracking, if
    - the time gap between completion of TCI activation and cell switch command is larger than [480ms] and the L3 measurement interval is larger than 160 ms, or
    - the time gap between early RACH transmission and cell switch command is larger than [480ms] and the L3 measurement interval is larger than 160 ms.

#### 1.4.2 Conditions of no extra time for PL-RS measurement in cell switch delay

**Issue 1-4-2-1:** **Conditions of no extra time for PL-RS measurement in cell switch delay**

*Online agreement*

**<Agreement>:**

* + No additional PL-RS measurement time is needed, provided L3-RSRP or L1-RSRP on the SSB associated with PL-RS has been measured/reported.
    - Further discuss offline whether to add: PL-RS is associated with TCI state indicated by LTM cell switch command in terms of QCL chain.

#### 1.4.3 Conditions of Fast RRC decoding

**Issue 1-4-3-1: Which cell(s) TLTM-RRC-processing = 0 apply to when candidate cells configured are more than UE capability?**

*Online agreement*

**<Agreement>:**

* + - If the total number of cells to be fast RRC decoded does not exceed UE capability *maxNumberStoredConfigCells-r18* and the number of *LTMCandidateConfigs* fast decoded does not exceed *maxNumberConfigs-r18*, TLTM\_RRC-processing =0 applies to the LTM candidates with early TCI activation or early PDCCH order RACH,
    - Further discuss:
      * FFS: Otherwise, TLTM\_RRC-processing =0 applies to the LTM candidates with the most recently activated TCI states (if any) [and/or] PDCCH-order PRACH transmission (if any) within UE capability *maxNumberStoredConfigCells-r18* and *maxNumberConfigs-r18.*
        + FFS: This is at least applicable to the case that NW does not trigger TCI state activation or PDCCH-order RACH on different candidate cells at the same occasion.
        + FFS: Whether to support and further optimize the case that NW triggers TCI state activation or PDCCH-order RACH on different candidate cells at the same occasion.

#### 1.4.4 Cell Switch without L1 measurement in FR1

**Issue 1-4-4-1: Applicable conditions of cell switch delay requirements in FR1 without L1 measurement**

*Online agreement*

**<Agreement>:**

* Cell switch delay requirements apply to FR1 without L1 measurement provided that
  + UE has reported L3-RSRP measurements for the SSB associated to the target TCI state in [1280] ms before the cell switch command.
  + SNR of the SSB associated to TCI state ≥ -3dB

**Issue 1-4-4-2: How to capture the applicable conditions of cell switch delay requirements in FR1 without L1 measurement in spec?**

*Online agreement*

**<Agreement>:**

* Allow FR1 cell switch delay requirements applicable to unknown TCI state case with the agreed conditions in Issue 1-4-4-1.

#### 1.4.5 Cell Switch without L1 measurement report in FR2?

**Issue 1-4-5-1: Whether are cell switch delay requirements applicable to FR2 without L1 measurement report?**

< **Way Forward** > FFS the following options:

* + Option 1 (OPPO):
    - Yes when SNR of the TCI state≥ -3dB and TCI state has been activated, it is also required that the RS associated to the target TCI state is available at least every 1280ms after TCI state activation command.
  + Option 2 (Nokia): Yes with the following conditions:
    - The target TCI state in the cell switch command is activated not more than 1280 ms before the reception of the cell switch command and SNR of the SSB associated to TCI state ≥ -3dB; or
    - The target TCI state in the cell switch command is activated before receiving the cell switch command and the SSB associated to target TCI state is available at least once every 1280 ms after the TCI state activation command is received and SNR of the SSB associated to TCI state ≥ -3dB
  + Option 3 (Ericsson, QC): Yes with the following conditions:
    - [- The TCI state is activated not more than TBD ms before the reception of the cell switch command and SNR of the SSB associated to TCI state is ≥ -3dB; where the TCI state is considered activated if the activated TCI state and target TCI state in the cell switch command are same or the SSB associated to target TCI state in cell switch command and the SSB associated to activated TCI state are same; or]
    - [- The TCI state is activated before the reception of the cell switch command (where the TCI state is considered activated if the activated TCI state and target TCI state in the cell switch command are same or the SSB associated to target TCI state in cell switch command and the SSB associated to activated TCI state are same) and the SSB associated to target TCI state is available at least once every TBD ms after the TCI state activation command is received and SNR of the SSB associated to TCI state ≥ -3dB; or]
  + Option 4 (MTK):
    - Not to extend cell switch delay requirements to FR2 without L1 measurement report

## 1.5 Sub-topic 1-5 UE feature

**Issue 1-5-1: Capability for supporting RTD>CP**

< **Way Forward** > FFS the following option:

* + Option 1 (CATT, MTK):
    - The current capability of SSB based L1-RSRP measurements for multiple cells with RTD > CP (39-2) should be revised.
      * It only needs to describe the capability of handling multiple cells with RTD > CP.
      * This capability will be supported together with the capabilities of SSB based L1-RSRP measurements and/or early T/F tracking and/or PDCCH order RACH.

**Issue 1-5-2: Capability for RACH-less LTM cell switch**

< **Way Forward** > FFS the following option:

* + Proposal 1 (Ericsson, QC): RAN4 to define the following UE capability:
    - RACH-less LTM cell switch can be conducted to one of ‘N’ cells to which the UE most recently transmitted the ‘PDCCH-order PRACH’ except for the cell configured as SCell.
      * N = {[1], 2, …, 7}, if not reported, N=8.
      * Granularity: Per UE

# 2 Topic #2: Improvement on SCell/SCG setup delay - Core part

**Issue 2-1-1: Mis-alignment between RAN2 and RAN4 spec when *measReselectionCarrierListNR* is not configured**

* Proposals
  + Option 1 (ZTE):
    - RAN4 should confirm what the UE behavior is if *measReselectionCarrierListNR* is not configured. UE will report any measurement results if available or UE will not report any measurement results.

**<Tentative Agreement>:**

* + Discuss in the CR directly.

# 3. Topic #3: Performance Part

## 3.1 Sub-topic 3-1 LTM

**Issue 3-1-1: Definition of L1-RSRP measurement relative accuracy**

* Proposals
  + Proposal 1 (MTK):
    - The intra-frequency relative accuracy of SSB based L1-RSRP is defined as the L1-RSRP measured from one SSB compared to the value of L1-RSRP measured from another SSB of the cell(s) on the same frequency, or between any two SSBs measured on the same cell.
    - The inter-frequency relative accuracy of SSB based L1-RSRP is defined as the L1-RSRP measured from one SSB compared to the value of L1-RSRP measured from another SSB of the cell(s) on a different frequency.

**<Tentative Agreement>:**

* + Discuss in the CR directly.

**Issue 3-1-2: TCI state configurations**

< **Way Forward** > FFS the following option:

* + Proposal 1 (vivo): In RRM test case design for LTM, RAN4 avoid TCI configuration with ‘QCL-D’ or ‘UL TCI’ to UE in FR1, which means only DL or Joint TCI with QCL-A/C configuration, and pathloss RS configuration if necessary, shall be provided to UE in FR1, even if UE supports *ltm-MAC-CE-SeparateTCI-r18*.

## 3.2 Sub-topic 3-2 Improvement on SCell/SCG setup delay

**Issue 3-2-1: More test for Improvement on SCell/SCG setup delay**

< **Way Forward** > FFS the following option:

* + Proposal 1 (Nokia):
    - Introduce test cases with valid reporting for FR1 and FR2 also for the case when the UE is configured with EMR measurements.