**3GPP TSG-RAN WG4 Meeting # 113 R4-24xxxxx**

**Orlando, US, Nov. 18 – Nov. 22, 2024**

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

**Agenda Item:** 5.23.3

**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.

# 1 Topic #1: LTM - Core part

## Sub-topic 1-1 Early Sync

**Issue 1-1-1: The definition of Tfirst-SSB** **in early candidate cell’s TCI state activation delay and PDCCH-order RACH delay**

*Agreement at coffee break*

**<Agreement>:**

* RAN4 to 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.
	+ Differentiate the cases based on whether the SSB is to be measured within or outside gap.

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

*Follow RAN4#112’s guidance:*

|  |
| --- |
| **RAN4#112****Issue 1-2-1: Whether to consider early TCI state activation for multiple cells at the same time**< **Agreement**>: * Interested companies can have further offline discussion. If no further progress, the following will be agreed in the Nov meeting.
	+ 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.
 |

**<Agreement>:**

* 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.

## 1.2 Sub-topic 1-2 L1-RSRP Measurement

**Issue 1-2-1: Spec organization**

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

* + Option 1 (vivo):
		- Although same UE behaviour on L1-RSRP measurement for current serving cell is assumed from RRM requirements perspective, no matter it is configured by either CSI-ResourceConfig under csi-MeasConfig or LTM-CSI-ResourceConfig-r18 under ltm-Config-r18, it is still proposed to capture LTM L1 measurement on serving cell in clause 9.14 of TS 38.133, so as to better differentiate UE support of either rxTimingDiff-r18 or multiCellL1-measRTD-greaterThan-CP-r18.
		- To better capture UE capabilities related to the max number of layers/cells/resource UE can measure under LTM configurations, LTM related serving cell L1 measurement shall be captured under 9.14.
		- Capture all intra-frequency LTM L1 measurement requirements, including serving cell L1 measurement requirements if counted as LTM L1 measurement, 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.

## 1.3 Sub-topic 1-3 Cell switch delay requirements for Pcell/PSCell

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

**Issue 1-3-1-1: T/F tracking when TRS as QCL source in cell switch delay**

*Agreement at coffee break*

**<Agreement>:**

* + it is RAN4 common understanding that UE is allowed to use TRS for fine time tracking, if it comes earlier than SSB. Current core requirements do not need to be updated.

**Issue 1-3-1-2: Conditions of Tfirst-RS =0 in cell switch delay**

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

* + Proposal 1 (MTK): The following agreement is only applicable to intra-frequency:
		- Extend the condition for Tfirst-RS = 0 “the time gap between TCI state activation and the cell switch command is not more than 160 ms” to “480ms” in FR1 for UE not supporting/configured with L1 measurement.
	+ Proposal 2 (Ericsson, QC)
		- 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.
			* During the 480ms after the TCI state activation, longer L3 measurement delay may be expected.
	+ Proposal 3 (Huawei):
		- 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 early RACH transmission and cell switch command is larger than 160ms and the L3 measurement interval is larger than 160 ms.
	+ Proposal 4 (Nokia):
		- The condition for Tfirst-RS = 0 *“The time gap between the latest PDCCH ordered RACH preamble transmission on the target cell and the cell switch command is not more than [160 ms].”* applies also for the case when the UE is configured with L1 measurements.

#### 1.3.2 Conditions of Fast RRC decoding

**Issue 1-3-2-1: Which cell(s) TLTM-RRC-processing = 0 apply to when the total number of candidates triggered early TCI activation or early PDCCH order RACH exceed UE capability?**

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

* Proposals
	+ Proposal 1 (ZTE, Huawei, Ericsson, QC, Nokia):
		- When the total number of candidates triggered early TCI activation or early PDCCH order RACH exceed UE capability, TLTM\_RRC-processing =0 applies to the LTM candidates with the most recently activated TCI states (if any) or PDCCH-order PRACH transmission (if any) within UE capability *maxNumberStoredConfigCells-r18* and *maxNumberConfigs-r18*.
			* Huawei: The requirements are applicable to the case NW does not trigger TCI state activation or PDCCH-order RACH on different candidate cells at the same occasion.
	+ Proposal 2 (MTK):
		- Open to further optimize this scenario only if a simple and clear rule can be agreed. Otherwise, we prefer not to optimize further.
	+ Proposal 3 (Nokia):
		- * If the number of candidate cell configurations exceeds UE pre-processing capability and the UE has not received TCI state activation command or PDCCH order for any of the candidate cells before receiving the cell switch command, T\_LTM\_RRC-processing = 0, if the target cell is listed as one of the first Min(maxNumberConfigs-r18, maxNumberStoredConfigCells-r18 – number of serving cells) candidate cells in the LTM candidate cell configuration.

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

**Issue 1-3-3-1: Whether are cell switch delay requirements applicable to FR2 without L1 measurement report?**

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

* + Option 1 (MTK, Huawei, CTC):
		- Not to extend cell switch delay requirements to FR2 without L1 report and remove the following in known TCI state definition for cell switch:
			* [- The target TCI state in the cell switch command is activated not more than TBD 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 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 TBD ms after the TCI state activation command is received and SNR of the SSB associated to TCI state ≥ -3dB; or]
		- MTK: Open to discuss how to optimize the known TCI state definition in R19 considering L1 report can be triggered when leaving condition is met. Not to further optimize known TCI state definition in R18.
	+ Option 2 (ZTE):
		- cell switch delay requirements applicable to FR2 without L1 measurement report 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): Modifying the TCI known condition to following (For both FR1 and FR2)

The target joint DL/UL TCI state or separate DL and UL TCI states in the LTM cell switch command are known if the following conditions are met:

- 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 (Nokia):
		- A target TCI state in TCI state activation command is known if the UE has sent an L1-RSRP report for the RS of the TCI state within 1280 ms (i.e. under current known TCI state conditions), even if the UE is not required to measure the target cell at the time of TCI state activation due to an earlier TCI state activation for another candidate cell.

#### 1.3.4 Known cell definition

**Issue 1-3-4-1: Whether and how to update the known condition for candidate cell SSB, candidate cell TCI and LTM target cell?**

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

* + Proposal 1 (vivo):
		- Update the known condition for candidate cell SSB, candidate cell TCI and LTM target cell with the following:
			* A L1-RSRP report is valid if the reported L1-RSRP value corresponding to one of the valid codepoints for L1-RSRP in Table 10.1.6.1-1, or any codepoints other than DIFFRSRP\_15 in Table 10.1.6.1-2.

## 1.4 Sub-topic 1-4 UE feature

**Issue 1-4-1: Capability for fast RRC decoding**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** |
| 39.NR\_Mob\_enh2 | 39-6 | Fast processing of LTM candidate cell RRC configuration | 1. Indicates the maximum number of serving cell(s) and candidate cell(s), including serving SpCell(s), serving SCell(s) in MCG and SCG, SpCell in LTMCandidateConfig(s) and Scell(s) in LTMCandidateConfig(s) for MCG and SCG, that UE can store the configurations.2. Indicates the maximum number of LTMCandidateConfigs that UE can support fast processing. | 45-3a or 45-4a in RAN1 feature list |

*Agreement at coffee break*

**<Agreement>:**

* + Send LS to RAN2 to inform them that 45-3a/45-4a (MAC-CE activated joint LTM TCI states) are not the prerequisite FG of 39-6 “Fast processing of LTM candidate cell RRC configuration”.

**Issue 1-4-3: Clarification on LTM L1-RSRP related capabilities**

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Feature group** | **Components** | **Moderator’s understanding** |
| 39-3-1 | Number of frequency layers for L1-RSRP measurement | 1. The max number of frequency layers UE can measure for intra- and inter-frequency without measurement gaps L1-RSRP measurement

2. The max number of frequency layers UE can measure for inter-frequency L1-RSRP measurement with measurement gaps  | Component 1: If NW only configures L1 measurement on serving cell but not on any neighbor cell on the same frequency layer, this frequency layer will not be counted in the measurement requirement, no matter L1 measurement on serving cell is configured in LTM L1 measurement configuration or serving cell’s L1 measurement configuration. |
| 39-3-3 | Number of total cells to be measured | The max number of total cells of serving cells and neighboring cells across all frequency layers of intra-frequency and inter-frequency without measurement gaps for L1 measurement. | Including all the serving cells configured with SSB based L1-RSRP measurement |
| 39-3-5 | Number of SSB resources for L1-RSRP measurement per frequency layer | 1. The max number of SSB resources UE can measure for L1-RSRP per frequency layer for intra-frequency or inter-frequency without measurement gaps

2. The max number of SSB resources UE can measure for L1-RSRP per frequency layer for inter-frequency with measurement gaps | Component 1: including SSB resources from serving cell and neighbor cell(s). |
| 39-3-6 | Number of total SSB resources to be measured | The max number of total SSB resources of serving cells and neighboring cells across all frequency layers of intra-frequency and inter-frequency without measurement gaps for L1 measurement. | Including the serving cell(s) with no intra-frequency neigbor cell configured with SSB based L1-RSRP measurement |

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

* + RAN4 to clarify that in RAN4 FG 39-3-1 maxFreqLayersL1-Meas-r18, only serving SSB frequency layers configured with LTM L1 measurements are counted. It does not include serving SSB frequency layers on which only legacy L1 measurements configured by CSI-ResourceConfig under csi-MeasConfig, are to be performed. (vivo, E///, Nokia, Apple, Nokia, QC, Huawei, ZTE, CMCC, OPPO)
	+ RAN4 to clarify that in RAN4 FG 39-3-3 supportedMaxCellsWithoutGapsL1-Meas-r18, which option below is the common understanding:
		- Option 1: ‘total cells of serving cells and neighbouring cells’ includes only the LTM candidate cell(s), any of which can be one current serving cell or not. (vivo, E///, Nokia, ZTE, CMCC)
		- Option 2: ‘total cells of serving cells and neighbouring cells’ includes both LTM candidate cell(s) and all serving cells, including the serving cells that are not configured with LTM L1 measurements, i.e. cells with SSB resources configured by CSI-MeasConfig are also counted. (Apple, QC, MTK, Huawei, OPPO)
	+ RAN4 to clarify that in RAN4 FG 39-3-5 maxSSB-PerFreqLayerL1-Meas-r18, which option below is the common understanding:
		- Option 1: ‘number of SSB resources UE can measure for L1-RSRP per frequency layer’ includes only the SSB resources configured for LTM candidate cell(s), any of which can be one current serving cell or not. (vivo, E///, Nokia, ZTE, CMCC)
		- Option 2: ‘number of SSB resources UE can measure for L1-RSRP per frequency layer’ includes both LTM candidate cell(s) and SSBs from serving cells, including the serving cells that are not configured with LTM L1 measurements, i.e. SSB resources configured by CSI-MeasConfig are also counted. (Apple, QC, MTK, Huawei, OPPO)
	+ RAN4 to clarify that in RAN4 FG 39-3-6 supportedMaxSSB-L1-Meas-r18, which option below is the common understanding:
		- Option 1: ‘SSB resources of serving cells and neighbouring cells’ includes only the SSB resources configured for LTM candidate cell(s), any of which can be one current serving cell or not. (vivo, E///, Nokia, ZTE, CMCC)
		- Option 2: ‘SSB resources of serving cells and neighbouring cells’ includes both LTM candidate cell(s) and all SSBs from serving cells, including the serving cells that are not configured with LTM L1 measurements, i.e. SSB resources configured by CSI-MeasConfig are also counted. (Apple, QC, MTK, Huawei, OPPO)

## 1.5 Sub-topic 1-5 RAN2 LS on the fast RRC processing for LTM

**Issue 1-5-1: Answer to Q1**

Q1: As far as the network configures a number of total serving cell(s) + SpCell/SCell(s) in LTM candidate configurations which is up to *maxNumberStoredConfigCells* and where up to *maxNumberConfigs* LTM candidate configurations are included within the configured total cells, is it the correct understanding that UE will be capable of performing early ASN.1 decoding on all the configured LTM candidate configurations?

*Online agreement*

< **Agreement** >:

* + Reply “Yes” to Q1 in RAN2 LS on the fast RRC processing for LTM.

**Issue 1-5-2: Answer to Q2**

Q2: Does the UE need to know the number of SpCells and SCells within the configured LTM candidate configurations before doing the early ASN.1 decoding of an LTM candidate configuration?

*Online agreement*

< **Agreement** >:

* + Reply “No” to Q2 in RAN2 LS on the fast RRC processing for LTM.
	+ Further discuss what additional information to include in the reply LS if needed.

**Issue 1-5-3: Answer to Q3**

Q3: Is it possible that the number of serving cell(s) + SpCell/SCell(s) in LTM candidate configurations exceeds the UE reported *maxNumberStoredConfigCells*?

*Online agreement*

< **Agreement** >:

* + Yes.
	+ Capture the following in the LS:
		- RAN4 also agreed that both early TCI state activation command and PDCCH-order can be used to trigger early RRC decoding.
		- Further discuss wording in the LS regarding the condition under which UE can successfully perform early ASN.1 decoding.

## 1.6 Sub-topic 1-6 RAN2 LS on UE capabilities for inter-frequency L1 measurements for LTM

**Issue 1-6-1: RAN2 LS on UE capabilities for inter-frequency L1 measurements for LTM (R2-2409360/** **R4-2417508)**

*Online agreement*

< **Agreement** >:

* + no need to reply the LS, and discuss whether and how to reflect the interFreqL1-OnlyInBC-r18 capability in 38.133.

# 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**

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

* + Option 1 (ZTE):
		- when measReselectionCarrierListNR is not present, there maybe disalignment between RAN2 and RAN4.
		- RAN4 should confirm what the UE behavior is if measReselectionCarrierListNR is not present. UE will repoet any measurement results if available or UE will not repoet any measurement results.
	+ Option 2 (Nokia):
		- If needed, send an LS to RAN2 to fix the specification with the following RAN4 interpretation of RAN2#125bis (R2-2404006): If not configured, the UE reports what is has
			* *“If not configured”* refers to the ValidityDuration being configured / not configured
			* *“What it has”* refers to UE having performed measurements, which have previously been configured.
		- The current RAN4 requirements are well reviewed by all the companies are they shall remain unchanged. Any ambiguity should be resolved in RAN2.

# 3. Topic #3: Performance Part

## 3.1 Sub-topic 3-1 LTM

**Issue 3-1-1: Test case for PDCCH-ordered RACH to an inter-frequency candidate cell in FR1 (A.6.3.2.4.2)**

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

* + Proposal 1 (MTK):
		- In the test case for PDCCH-ordered RACH to an inter-frequency candidate cell in FR1 (A.6.3.2.4.2), add a limitation that PDCCH order is not expected on the frame with SFN mod 8 =3.

**Issue 3-1-2: Test cases for SSB based L1-RSRP measurement in FR1 – intra-f & inter-f without gap (A.6.6.26.1 & A.6.6.28.1.3)**

Discuss in the CR directly.

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

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

* + 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 options:

* + Option 1 (ZTE, Huawei):
		- Suggest not to introduce new test for Idle mode fast CA/DC eEMR measurement.
	+ Option 2 (CATT):
		- RAN4 need to discuss if the understanding of ‘If a UE has already passed the test for R16 EMR and R18 EMR tests, no matter how the validity time of the measurement results is defined, the UE shall be able to complete valid reporting because its reporting function has been verified to be good’ is right.
		- If the above understanding is assumed, then the current R18 test cases design is enough.
	+ Option 3 (Nokia):
		- Add Test case for Idle mode fast CA/DC eEMR measurement for FR1 with valid reporting.