**3GPP TSG-RAN WG4 Meeting #112 R4-241xxxx**

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

**Agenda item:** 8.23.3

**Source:** Apple

**Title:** WF on R18 Further NR mobility enhancement - part 2

**Document for:** Approval

# Work plan

**Issue 1-1: RAN4 work plan**

Agreement:

* Approve RAN4 work plan in R4-2411437.

# Wayforward

### Inter-CU LTM

**Issue 2-1-1: RAN4 scope of inter-CU LTM**

* Candidate solutions:
	+ Option 1: existing R18 LTM related RRM requirements also apply to same procedures in inter-CU scenario. (Apple, MTK, CMCC, Samsung, Nokia, E///,CTC)
	+ Option 1a: No RRM impact is foreseen to support inter-CU LTM. RAN4 can revisit this if any new procedure is introduced by RAN1/2. (Apple)
	+ Option 2: RAN4 should discuss whether to update TLTM-Processing in inter-CU LTM due to PDCP re-establishment and security key update. (ZTE)
	+ Option 3: RAN4 to postpone the discussion on the topic of Inter-CU Layer1/Layer 2 Triggered Mobility (LTM) until the group can get more clarity on the impact of the topic on RRM requirements. (QC)
* Agreement:
	+ Existing R18 LTM related RRM requirements also apply to same procedures in inter-CU scenario.
	+ No RRM impact is foreseen to support inter-CU LTM. RAN4 can revisit this if any issue identified.

**Issue 2-1-2: subsequent LTM**

* Candidate solutions:
	+ Option 1: For subsequent LTM, cell switch delay requirements for R18 LTM could be reused due to there is no component for RRC configuration after receiving cell switch command. (ZTE)
* Recommended WF
	+ Continue discussion.

### Event triggered L1 measurement reporting

**Issue 2-2-1: RRM scope of Event triggered L1 measurement reporting**

* Candidate solutions:
	+ Option 1: RAN4 need to discuss the absolute threshold for beam of serving cell and candidate cell in L1 LTM measurement events, including the measurement matrix and the value. RAN4 can wait for more RAN2 input. (CATT)
	+ Option 2: (Apple)
		- Requirements of Capabilities for Support of Event Triggering and Reporting Criteria specified in TS38.133 section 9.1.4 need to be updated to cover event triggered L1 measurement reporting. Details are FFS.
		- Existing framework in L3 event triggered reporting RRM requirements can be reused to cover L1 event triggered reporting.
	+ Option 3: define measurement reporting requirements for event triggered L1 measurement reporting, e.g. the L1 measurement reporting delay. (CMCC, Apple, Samsung, HW, ZTE, Nokia, E///, vivo,CTC)
		- Option 3a: “Event Triggered Reporting” for LTM L1 measurement is to be introduced in section 9.14.3 and section 9.15.3.
		- Option 3b: RAN4 can start the discussion based on SSB firstly. Further RAN1/RAN2 progress are needed. (Samsung)
		- Option 3c: RAN4 to define event-triggered L1 reporting delay requirement for SSB based and CSI-RS based measurements. (Nokia, E///, vivo, CMCC)
	+ Option 4: RAN4 should discuss the accuracy requirement for event triggered L1 measurement reporting. (ZTE)
	+ Option 5: RAN4 to discuss potential impact of event-triggered L1 reporting to other LTM requirements, for example (Nokia)
		- Known TCI state condition for early TCI state activation and cell switch
		- Applicability of cell switch delay requirements
		- early DL sync (Tfirst-RS = 0 conditions)
		- early ASN.1 decoding and validity check
		- LTM L1 measurement requirements
	+ Option 6: For the topic of ‘Measurements related enhancements for the purpose of supporting LTM,’ RAN4 to wait for further progress to be made in other working groups under this WI . (QC, vivo)
* Recommended WF
	+ Continue discussion.

**Issue 2-2-2: measurement result for event evaluation**

* Candidate solutions:
	+ Option 1: Use beam level measurement result for event evaluation as baseline and FFS for cell level measurement. (CTC)
* Recommended WF
	+ Continue discussion.

**Issue 2-2-3: filtering assumption in event evaluation**

* Candidate solutions:
	+ Option 1: Define additional SSB based L1 measurement delay requirements with filtering for event triggered L1 report. Wait for more RAN1/2 progress to discuss the detailed requirements. (MTK)
* Recommended WF
	+ Continue discussion.

**Issue 2-2-4: L1 event triggered reporting delay**

* Candidate solutions:
	+ Option 1: The event triggered L1 measurement reporting delay, measured without L3 filtering, is less than TL1-RSRP\_Measurement\_Period or TL1-RSRP\_Measurement\_Perioa + TSSB\_time\_index, which are the L1-RSRP measurement period defined for Rel-18 LTM. (CMCC)
	+ Option 2: For the delay of event triggered L1 measurement reporting requirements based on SSB, current LTM L1-RSRP measurement delay can be reused. (Samsung)
	+ Option 3: Starting point for the SSB-based LTM L1 event triggered reporting delay is TL1-RSRP\_Measurement\_Period\_SSB\_intra, TL1-RSRP\_Measurement\_Period\_SSB\_inter or TL1-RSRP\_Measurement\_Period\_SSB\_inter\_withoutGap. CSI-RS based delay is pending on Rel-19 work. (Nokia)
	+ Option 4: RAN4 to discuss the event evaluation time (i.e., the minimum time required to complete the event evaluation and be ready to send on the first reporting occasion from the measurement occasion). (E///)
* Recommended WF
	+ Continue discussion.

### CSI-RS based L1 measurement

**Issue 2-3-1: RRM scope of CSI-RS based L1 RSRP measurement on candidate cell(s)**

* Candidate solutions:
	+ Option 1: (CATT)
		- All requirements defined based on SSB will be defined for CSI-RS, which includes the following requirements:
			* PDCCH ordered Random Access for LTM
			* LTM PCell/ PSCell Cell Switch
			* Link Recovery Procedures
			* TRP specific Link Recovery Procedures
			* TCI state activation for LTM candidate cell
			* L1-SINR measurements for Reporting
			* Intra-frequency L1-RSRP measurements for neighbor cell
			* NR inter-frequency L1 measurement
	+ Option 2: define measurement period requirements for CSI-RS based L1 measurement, and the SSB based L1 measurement period requirements can be used as baseline. (CMCC)
	+ Option 3: For CSI-RS measurement and based beam management for LTM, RAN4 should define new RRM requirements. Need further RAN1 progress. (Samsung)
	+ Option 4: Define early DL sync requirements for using CSI-RS once RAN1 approval, and SSB based DL sync in LTM can be used as baseline. (ZTE)
	+ Option 5: RAN4 can start the requirements discussion of CSI-RS on periodic measurements while RAN1 is discussing about aperiodic and semi-persistent measurement support. (Nokia, vivo)
	+ Option 6: RAN4 to discuss at least the following set of requirements for CSI-RS based LTM measurements: (Nokia)
		- Measurement delay
		- Measurement reporting requirements
		- Measurement restrictions
		- Scheduling availability
	+ Option 7: For the topic of ‘Measurements related enhancements for the purpose of supporting LTM,’ RAN4 to wait for further progress to be made in other working groups under this WI . (QC)
* Agreement:
	+ The following requirements need to be discussed for CSI-RS based L1 RSRP measurement on LTM candidate cell(s)
		- Measurement delay
		- Measurement reporting requirements
		- Measurement restrictions
		- Scheduling availability
	+ FFS on other potential impact.

**Issue 2-3-2: definition of intra-frequency and inter-frequency for CSI-RS based L1 measurement**

* Candidate solutions:
	+ Option 1: following CSI-RS based L3 measurement, (Apple)
		- A measurement is defined as a CSI-RS based intra-frequency L1 measurement provided that:
			* the SCS of the CSI-RS resource of the neighbour cell configured for L1 measurement is the same as the SCS of the CSI-RS resource on the serving cell indicated for L1 measurement, and
			* the CP type of the CSI-RS resource of neighbour cell configured for L1 measurement is the same as the CP type of the CSI-RS resource of the serving cell indicated for L1 measurement, and
				+ It is applied for SCS = 60KHz
			* the centre frequency of the CSI-RS resource of the neighbour cell configured for L1 measurement is the same as the centre frequency of the CSI-RS resource of the serving cell indicated for L1 measurement
	+ Option 2: Categorize CSI-RS based L1-RSRP measurement into CSI-RS based L1-RSRP measurement within active BWP and outside active BWP for further discussion. (MTK)
	+ Option 3: For CSI-RS based L1 measurement, RAN4 not to introduce definition of intra-frequency/inter-frequency candidate cell measurement. (vivo)
* Recommended WF
	+ Continue discussion.

**Issue 2-3-3: supported measurement types**

* Candidate solutions:
	+ Option 1: (CATT)
		- Intra-frequency
		- Inter-frequency without gap
		- Inter-frequency with gap
	+ Option 2: (Apple)
		- Intra-frequency without gap
		- Inter-frequency with gap
	+ Option 3: deprioritize CSI-RS based L1-RSRP measurement outside active BWP in R19. (MTK)
	+ Option 4: (vivo)
		- For CSI-RS based L1 measurement on candidate cell with periodic reporting, RRM requirements are specified for the following cases:
			* CSI-RS based L1 measurement without gap
* Recommended WF
	+ Continue discussion.

**Issue 2-3-4: supported frequency range**

* Candidate solutions:
	+ Option 1: only FR1 and FR2-1 (Apple)
* Recommended WF
	+ Continue discussion.

**Issue 2-3-5: RTD assumption**

* Candidate solutions:
	+ Option 1: RTC<CP is taken as baseline. For the case of RTD>CP between serving cell and neighbour cell on the same carrier, UE capability should be introduced. (Apple)
	+ Option 2: Further study whether to support RTD>CP case for CSI-RS based L1-RSRP measurement. (MTK)
* Recommended WF
	+ Continue discussion.

**Issue 2-3-6: CSI-RS resource configuration**

* Candidate solutions:
	+ Option 1: the same CSI-RS resource configuration {D=3, PRB≧48} as for CSI-RS based L3 measurement is considered as a starting point. FFS on resource location limitation. (Apple)
	+ Option 1a: For CSI-RS based L1-RSRP measurement on neighbor cell, define the requirements for Density=3 with (≥) 48 PRBs and not to define tighter requirements for more 48 PRBs. (MTK)
* Recommended WF
	+ Continue discussion.

**Issue 2-3-7: definition of frequency layer in CSI-RS based L1-RSRP measurement**

* Candidate solutions:
	+ Option 1: Define the concept frequency layer for CSI-RS based L1-RSRP measurement. (MTK)
		- Following CSI-RS based L3 measurement, for CSI-RS resources of the same L1 frequency layer, SCS, CP type, center frequency, BW and periodicity are the same.
* Recommended WF
	+ Continue discussion.

**Issue 2-3-8: known cell definition in CSI-RS based L1 measurement**

* Candidate solutions:
	+ Option 1: (Apple)
		- The cell is considered as known if the following conditions are met:
			* The UE has performed L3 measurement on the target cell during the last 5 seconds, and
			* The CSI-RS from the target cell configured for L1 measurement remains detectable.
* Recommended WF
	+ Continue discussion.

**Issue 2-3-9: whether to cover both known and unknown cell for CSI-RS L1 measurement**

* Candidate solutions:
	+ Option 1: only consider known cell in CSI-RS based L1-RSRP measurement. (Apple, MTK)
* Recommended WF
	+ Continue discussion.

**Issue 2-3-10: other applicability of RRM requirements for CSI-RS based L1 RSRP measurement**

* Candidate solutions:
	+ P1: Consider SSB based L3 measurement as the pre-requisite condition to determine the target cells for CSI-RS based L1-RSRP measurement. (Apple)
	+ P1a:In FR1, UE shall first perform SSB based L3 measurement on candidate neighbour cells. Then UE performs configured CSI-RS L1 measurement on these candidate neighbour cells. (HW)
	+ P2: For L1 CSI-RS measurement on candidate neighbour cells in FR2, RAN4 needs to further discuss two possible options: (HW)
		- Option 1: UE performs SSB based L3 measurements and acquires SSB index information of the candidate cells. And then UE receives the configured CSI-RS resources and perform L1 CSI-RS measurement with Rx beam sweeping on candidate cells.
		- Option 2: UE performs SSB based L3 measurements and acquires SSB index information of the candidate cells. And then UE performs SSB based L1 measurement to refine the RX beam (with RX beam sweeping) which is the same as R18 LTM. Afterwards UE perform measurements without RX beam sweeping on the configured CSI-RS resources of candidate cells where each CSI-RS resource is QCL-typeD with SSB for L1-RSRP measurement.
	+ P3: For CSI-RS resources with repetition OFF, L1-RSRP measurement is performed only after UE has performed L1-RSRP measurement on the associated SSB. (MTK)
* Recommended WF
	+ Continue discussion.

**Issue 2-3-11: measurement gap for inter-frequency CSI-RS based L1 RSRP measurement on candidate cell(s)**

* Candidate solutions:
	+ P1: RAN4 need to discuss whether to reuse or introduce the new gap for CSI-RS based measurement. (CATT)
	+ P2: at least the type 1 MG needed to be supported. FFS: Whether to support other types of gap or gap patterns need to wait for more RAN1 conclusions on the type of CSI-RS for L1 measurement. (CATT)
* Recommended WF
	+ Continue discussion.

**Issue 2-3-12: accuracy**

* Candidate solutions:
	+ Option 1: The existing side condition for CSI-RS based L1-RSRP measurement for serving cell is used as the starting point. (Apple)
* Recommended WF
	+ Continue discussion.

### Others

**Issue 2-4-1: other issues**

* Candidate solutions:
	+ P1: continue to discuss the requirements on UE based TA measurement. (CTC)
	+ P2: Define cell switch delay requirements for PCell/PSCell switch with scell(s). (MTK)
	+ P3: Define SSB based L1-RSRP measurement requirements for deactivated SCell or intra-f neighbor cell of deactivated SCell in R19 mobility. (MTK)
	+ P4: If conditional LTM is introduced, RAN4 need to define the requirements as least for delay requirements. Wait further progress after the checkpoint. (Samsung)
* Recommended WF
	+ Continue discussion.