**3GPP TSG-RAN WG4 Meeting #112 R4-2411819**

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

**Agenda item:** 8.23.3

**Source:** Apple

**Title:** Topic summary for [112][224] NR\_Mob\_Ph4

**Document for:** Information

# Introduction

This summary includes the proposals from companies on RRM requirements for R19 NR mobility enhancement phase 4. This is the first RAN4 meeting of this work item. The objectives in the latest WID is duplicated here for information:

|  |
| --- |
| * Specify support for inter-CU Layer1/Layer 2 Triggered Mobility (LTM) [RAN2, RAN3]   + Prioritize the case when CU is acting as MN when DC is not configured   + When DC is configured, inter-CU LTM can be configured either in MN or in SN but not both at the same time. For such cases:     - As secondary priority, support the case where CU is acting as SN and MN is unchanged     - As secondary priority, support the case where CU is acting as MN and SN is unchanged or SN is released   + Specify support for subsequent LTM mobility procedures aiming to avoid RRC configuration between cell switches as per Rel-18 LTM     - Coordination with SA3 needed with respect to security key handling   + Note: Rel. 18 intra-CU LTM procedure is considered as baseline for adding inter-CU support * Measurements related enhancements for purpose of supporting LTM: [RAN2, RAN1]   + Measurement related enhancements are applicable to Intra-CU MCG/SCG LTM and Inter-CU MCG/SCG LTM   + Specify necessary components to support event triggered L1 measurement reporting [RAN2, RAN1]     - RAN1 and RAN2 to progress independently on the event triggered measurements objectives of their respective MIMO and Mobility enhancement WIs. Review progress at RAN#105 to see if any modification of objectives is required to avoid/manage any overlap in the work   + Specify support for CSI-RS measurements for LTM procedures and enable CSI-RS based beam management, and/or other necessary physical layer operations on candidate cells before LTM [RAN1] * Specify support of conditional LTM [RAN2, RAN3, RAN1]   + Specify UE evaluated conditions for triggering LTM   + Aim to support conditional LTM including subsequent LTM   + Prioritise intra-CU LTM   + Checkpoint to review objective at RAN#105. RAN WG work to not start before this checkpoint * Specify RRM requirements related to the above objectives as necessary [RAN4] |

Moderator’s recommendation is also provided under issue. The following issues are recommended to be discussed online: 2-1-1, 2-2-3, 2-3-1, 2-3-2, 2-3-3, 2-3-5, 2-3-10.

# Topic #1: RAN4 work plan

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **TDoc** | **Source** | **Proposals** |
| [**R4-2411437**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411437.zip) | Apple, China Telecom | RAN4 Work Plan |

## Open issues summary

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

* Candidate solutions:
  + Option 1: work plan in R4-2411437 (Apple, CTC)
* Recommended WF
  + Discuss work plan using R4-2411437 as baseline. Agree RAN4 work plan in this meeting.

# Topic #2: RRM discussion

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **TDoc** | **Source** | **Proposals** |
| [**R4-2411354**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411354.zip) | CATT | **Proposal 1: All requirments defined based on SSB will be defined for CSI-RS, which includes the following requirments:**   * **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**   **Observation 1: RAN4 has defined the requirements for SSB based L1 inter-frequency with gap measurement in Rel-18 LTM.**  **Observation 2: The requirements for CSI-RS based L3 inter-frequency with gap measurement also has been defined in the current spec.**  **Proposal 2: For CSI-RS based L1 inter-frequency measurement in Rel-19 LTM, RAN4 need to define RRM requirements for the following：**   * **CSI-RS based L1 inter-frequency without gap measurement** * **CSI-RS based L1 inter-frequency with gap measurement**   **Observation 3: The configurable periodicity of CSI-RS and the method of transmitting and reporting for different purposes may vary, which may affect the gap configuration and the type of gap.**  **Proposal 3: In Rel-19 LTM, RAN4 need to discuss whether to reuse or introduce the new gap for CSI-RS based measurement.**  **Proposal 4: For CSI-RS based L1 inter-frequency with gap measurement, at least the type 1 MG needed to be supported in Rel-19 LTM.**   * **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.**   **Proposal 5: 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.** |
| [**R4-2411422**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411422.zip) | Apple | ***Proposal 0: It is proposed to consider SSB based L3 measurement as the pre-requisite condition to determine the target cells for CSI-RS based L1-RSRP measurement.***  ***Proposal 1: it is proposed to follow intra-frequency/inter-frequency definition for CSI-RS based L3 measurement, e.g. a measurement is defined as a CSI-RS based intra-frequency measurement provided that:***  ***- the SCS of the CSI-RS resource of the neighbour cell configured for measurement is the same as the SCS of the CSI-RS resource on the serving cell indicated for measurement, and***  ***- the CP type of the CSI-RS resource of neighbour cell configured for measurement is the same as the CP type of the CSI-RS resource of the serving cell indicated for measurement, and***  ***- It is applied for SCS = 60KHz***  ***- the centre frequency of the CSI-RS resource of the neighbour cell configured for measurement is the same as the centre frequency of the CSI-RS resource of the serving cell indicated for measurement***  ***Proposal 2: it is proposed only consider FR1 and FR2-1 for CSI-RS based LTM and L1-RSRP measurement.***  ***Proposal 3: It is proposed to prioritize intra-frequency measurement without GAP, inter-frequency measurement with GAP for CSI-RS based L3 measurement.***  ***Proposal 4: 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.***  ***Proposal 5: the same CSI-RS resource configuration {D=3, PRB≧48} as for CSI-RS based L3 measurement is considered. FFS on resource location limitation.***  ***Proposal 6: It is proposed to consider know cell case only.***  ***Proposal 7: The target cell is considered as known provided that the UE has performed L3 measurement on the target cell during the last 5 seconds, and the CSI-RS configured for L1 measurement remains detectable.***  ***Proposal 8: The existing side condition for CSI-RS based L1-RSRP measurement for serving cell is used as the starting point.*** |
| [**R4-2411438**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411438.zip) | Apple | **Observation 1: R18 LTM related RRM requirements were defined irrespectively of whether the configurations are from intra-CU or inter-CU.**  **Proposal 1: existing R18 LTM related RRM requirements also apply to same procedures in inter-CU scenario.**  **Proposal 2: no RRM impact is foreseen to support inter-CU LTM. RAN4 can revisit this if any new procedure is introduced by RAN1/2.** |
| [**R4-2411439**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411439.zip) | Apple | **Proposal 1: 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.**  **Proposal 2: existing framework in L3 event triggered reporting RRM requirements can be reused to cover L1 event triggered reporting.** |
| [**R4-2411473**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411473.zip) | China Telecom | **Observation 1:** **Event trigger L1 measurement report should be designed for selecting candidate beam(s)/cell(s) to trigger early synchronization and selecting target beam/cell to trigger LTM cell switch procedure.**  **Observation 2:** **The event A1-A5 for triggering L3 measurement report are reused as Event LTM1-Event LTM5 and the need for Event LTM1 is still under discussion.**  **Proposal 1: Use beam level measurement result for event evaluation as baseline and FFS for cell level measurement**  **Proposal 2:** **Continue to discuss the requirements on UE based TA measurement.** |
| [**R4-2411705**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411705.zip) | MediaTek Inc. | **Proposal 1: LTM requirements defined in R18 are applicable to inter-CU case.**  **Proposal 2: Define cell switch delay requirements for PCell/PSCell switch with scell(s).**  **Proposal 3: 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.**  **Proposal 4: CSI-RS based L1-RSRP measurement is performed only on known cells.**  **Proposal 5: For CSI-RS resources with repetition OFF, L1-RSRP measurement is performed only after UE has performed L1-RSRP measurement on the associated SSB.**  **Proposal 6: 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.**  **Proposal 7: Further study whether to support RTD>CP case for CSI-RS based L1-RSRP measurement.**  **Proposal 8: Categorize CSI-RS based L1-RSRP measurement into CSI-RS based L1-RSRP measurement within active BWP and outside active BWP for further discussion.**  **Observation 1:** **If to support CSI-RS based L1-RSRP measurement outside active BWP, all CSI-RS in the same frequency layer shall be confined in the same 5ms window.**  **Observation 2: If to support CSI-RS based L1-RSRP measurement outside active BWP, the definition of frequency layer should be discussed at first.**  **Observation 3: If to support CSI-RS based L1-RSRP measurement outside active BWP, concurrent gap shall be used.**  **Proposal 9: Deprioritize CSI-RS based L1-RSRP measurement outside active BWP in R19.**  **Observation 4: If to define requirements for RTD>CP case, the definition of frequency layer should be discussed at first.**  **Proposal 10: Define the concept frequency layer for CSI-RS based L1-RSRP measurement.**  **Proposal 11: 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.**  **Proposal 12: Define SSB based L1-RSRP measurement requirements for deactivated SCell or intra-f neighbor cell of deactivated SCell in R19 mobility.** |
| [**R4-2411973**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2411973.zip) | CMCC | ***Proposal 1: the starting point and ending point of Rel-18 intra-CU LTM can be reused for inter-CU LTM cell switch delay. In detail, for inter-CU LTM cell switch delay, the starting point is the end of the last TTI containing the MAC-CE command for cell switch, the ending point is the time the UE transmits the first UL message on the target cell.***  ***Proposal 2: it is proposed that the Rel-18 cell switch delay requirements can be used as baseline for inter-CU LTM.***  ***Proposal 3: it is proposed to define measurement reporting requirements for event triggered L1 measurement reporting, e.g. the L1 measurement reporting delay.***  ***Proposal 4: it is proposed that the event triggered L1 measurement reporting delay, measured without 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.***  ***Proposal 5: it is proposed to define measurement period requirements for CSI-RS based L1 measurement, and the SSB based L1 measurement period requirements can be used as baseline.*** |
| [**R4-2412113**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412113.zip) | Samsung | **Proposal 1: For Inter-CU LTM, no enhancement for RRM requirements. The requirements in Rel-18 can be applied to both intra-CU and inter-CU scenarios.**  **Proposal 2: For CSI-RS measurement and based beam management for LTM, RAN4 should define new RRM requirements. Need further RAN1 progress.**  **Proposal 3: RAN4 should discuss and specify new RRM requirements of delay/measurement period requirements based on SSB and CSI-RS resource. RAN4 can start the discussion based on SSB firstly. Further RAN1/RAN2 progress are needed.**  **Proposal 4: For the delay of event triggered L1 measurement reporting requirements based on SSB, current LTM L1-RSRP measurement delay can be used as baseline.**  **Proposal 5: If conditional LTM is introduced, RAN4 need to define the requirements as least for delay requirements. Wait further progress after the checkpoint.** |
| [**R4-2412222**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412222.zip) | Huawei, HiSilicon | **Proposal 1: “Event Triggered Reporting” for LTM L1 measurement is to be introduced in section 9.14.3 and section 9.15.3.**  **Proposal 2: 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.**  **Proposal 3: For L1 CSI-RS measurement on candidate neighbour cells in FR2, RAN4 needs to further discuss two possible options:**  **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.**  **Proposal 4: The discussion on the requirements of conditional LTM in RAN4 does not start before RANP#105.** |
| [**R4-2412387**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412387.zip) | ZTE Corporation, Sanechips | **Observation 1: Different from intra-CU LTM, PDCP re-establishment and security key update maybe needed for inter-CU LTM.**  **Proposal 1: RAN4 should discuss whether to update the value of TLTM-Processing in inter-CU LTM due to PDCP re-establishment and security key update.**  **Proposal 2: Define early DL sync requirements for using CSI-RS once RAN1 approval, and SSB based DL sync in LTM can be used as baseline.**  **Proposal 3: For subsequent LTM, cell switch delay requirements for R18 LTM could be reused due to there is no component for RRC configuration.**  **Proposal 4: Samilar as L3 event triggered reporting, RAN4 should define delay requirement for event triggered L1 measurement reporting.**  **Proposal 5: RAN4 should discuss the accuracy requirement for event triggered L1 measurement reporting.**  **Proposal 6: For conditional LTM, wait for RAN2 input to further discuss RRM requirements.** |
| [**R4-2412491**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412491.zip) | Nokia | [**Proposal 1: Rel-18 LTM RRM requirements apply for inter-CU LTM.**](#_Toc174103781)  [**Proposal 2: RAN4 to define event-triggered L1 reporting delay requirement for SSB based and CSI-RS based measurements.**](#_Toc174103782)  [**Proposal 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.**](#_Toc174103783)  [**Proposal 4: The impact of RAN1/RAN2 event evaluation and reporting design to the reporting delay is up to further RAN1/RAN2 agreements.**](#_Toc174103784)  [**Proposal 5: RAN4 to discuss potential impact of event-triggered L1 reporting to other LTM requirements, for example:  - Known TCI state condition for early TCI state activation and cell switch  - Applicability of cell switch delay requirements**](#_Toc174103785)  [**Proposal 6: RAN4 to consider the impact of L1 event triggered reporting to:  - early DL sync (Tfirst-RS = 0 conditions)  - early ASN.1 decoding and validity check  - LTM L1 measurement requirements**](#_Toc174103786)  [**Proposal 7: RAN4 can start the requirements discussion of CSI-RS on periodic measurements while RAN1 is discussing about aperiodic and semi-persistent measurement support.**](#_Toc174103787)  [**Proposal 8: Both CSI-RS intra- and inter-frequency measurements shall be supported. RAN4 can start by discussing intra-frequency CSI-RS measurement requirements first.**](#_Toc174103788)  [**Proposal 9: RAN4 to discuss at least the following set of requirements for CSI-RS based LTM measurements:  - Measurement delay  - Measurement reporting requirements  - Measurement restrictions  - Scheduling availability**](#_Toc174103789)  [**Proposal 10: Impact of CSI-RS support for early DL/UL sync procedures is to be discussed once RAN1 has made agreements on these aspects**](#_Toc174103790)  [**Observation 1:** As the WID states, the work on conditional LTM shall not start before RAN#105 meeting.](#_Toc174103791) |
| [**R4-2413018**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413018.zip) | Ericsson | 1. Intra-CU LTM requirements to be reused for inter-CU LTM unless some issue is identified. 2. RAN4 to specify the requirements for SSB based event triggered L1-RSRP reporting, and CSI-RS based event triggered L1-RSRP reporting. 3. 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). 4. RAN4 to define CSI-RS based LTM L1-RSRP requirements after sufficient progress is achieved in RAN1. |
| [**R4-2413186**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2413186.zip) | Qualcomm Incorporated | **Inter-CU Layer1/Layer 2 Triggered Mobility (LTM)**  **Proposal 1: 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.**  **Measurements related enhancements for purpose of supporting LTM**  **Proposal 2: 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 .**  **Support of conditional LTM**  **Proposal 3: For the topic of ‘Support of conditional LTM,’ RAN4 to wait for further progress to be made in other working groups under this WI.** |
| [**R4-2412524**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_112/Docs/R4-2412524.zip) | vivo | **Proposal 1 RAN4 specify RRM requirements for CSI-RS based L1 measurement on candidate cell with periodic reporting in R19 mobility. RAN4 may start to discuss RRM requirements assuming R18 NZP CSI-RS configurations are re-used for R19 LTM candidate cells.**  **Proposal 2 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**   **Proposal 3 For CSI-RS based L1 measurement, RAN4 not to introduce definition of intra-frequency/inter-frequency candidate cell measurement.**  **Proposal 4 For L1 measurements on candidate cells with event-triggered reporting, RRM requirement are specified for both SSB-based and CSI-RS based L1 measurements. Further conclusions from RAN1/2 are needed before RAN4 start discussion on this part.** |

## Open issues summary

### 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///)
  + 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)
* Recommended WF
  + 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 new procedure is introduced by RAN1/2.

**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
  + Discussion is needed.

### 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)
    - 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)
  + 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
  + Define measurement reporting delay requirements for event triggered L1 measurement reporting.
  + FFS whether other requirements need to be defined.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

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

* Candidate solutions:
  + Option 1: The event triggered L1 measurement reporting delay, measured without 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
  + Discussion is needed.

### 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 requirments defined based on SSB will be defined for CSI-RS, which includes the following requirments:
      * 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)
* Recommended WF
  + The following requirements need to be introduced 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
  + Discussion is needed.

**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
  + Discussion is needed.

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

* Candidate solutions:
  + Option 1: only FR1 and FR2-1 (Apple)
* Recommended WF
  + Discussion is needed.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

**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
  + Discussion is needed.

### 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
  + Discussion is needed.