**3GPP TSG-RAN WG2 Meeting #129**  **R2-2500xxx**

**Athens, Greece, Feb. 17th – 21st, 2025**

Agenda Item: 8.6.2

Source: CATT

**Title:** Report of [POST129][111][MOB] (CATT)

**Document for:** Discussion and Decision

# Introduction

This document is the report of the following email discussion.

* **[POST129][111][MOB] (CATT)**

**Scope:** Discuss UE capability open issues in R2-2500224.

**Intended outcome:** Discussion summary.

**Deadline: Long email discussion**

|  |  |
| --- | --- |
| **Company** | **Name (Email)** |
| MediaTek | Xiaonan.zhang@mediatek.com |
| Nokia | endrit.dosti@nokia.com |
| Xiaomi | Yujian Zhang (zhangyujian@xiaomi.com) |
| Ericsson | antonino.orsino@ericsson.com |
| ZTE | liu.jing30@zte.com.cn |
| vivo | liangjing@vivo.com |
| Ofinno | flatheef@ofinno.com |

# UE capability open issues

In paper R2-2500224, there are some initial considerations on the high-layer specific UE capabilities for inter-CU LTM and CLTM.

***Note: The email discussion will be performed directly based on the proposals from R2-2500224.***

## Inter-CU LTM

To support intra-CU LTM in R18, the capabilities indicating whether a UE can support intra-frequency MCG/SCG LTM have been defined on a per-band basis, namely ltm-MCG - IntraFreq-r18 and ltm-SCG-IntraFreq-r18. Meanwhile, the capability specifying whether a UE can support inter-frequency MCG/SCG LTM, denoted as ltm-InterFreq-r18, has been defined on a per-UE basis. Since the main difference between inter-CU LTM and intra-CU LTM lies in the L2 behavior, these capabilities can be reused for inter-CU LTM scenarios.

Similarly, the capabilities related to beam indication with TCI/L1 measurement/UE fast processing/RACH-Less/TA acquisition/LTM for MCG with or without of NR-DC, can also be reused for inter - CU LTM. The detailed capabilities are presented in Annex A.

**Proposal 1: The following R18 intra-CU LTM related capabilities are reused for inter-CU LTM, separate capabilities are not needed.**

* **Intra-frequency LTM/inter-frequency LTM**
* **beam indication with TCI/L1 measurement**
* **UE fast processing**
* **RACH-Less**
* **TA acquisition**
* **LTM for MCG with or without of NR-DC**

### Question 1

**Do you think P1 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes | It seems Annex A includes almost all R18 LTM capabilities. Could rapporteur clarify which capability is NOT included in Annex A and need further modification in R19 inter-CU LTM for simplicity?  Besides, for the capabilities in Annex A,   1. The ltm-Recovery-r18 may need further discussion, as we are unsure the fast recovery procedure for R19 inter-CU LTM. 2. The ltm-ReferenceConfig-r18 may need further discussion, if the reference configuration for inter-CU differs much than intra-CU (not sure about this one)   The following capabilities are not included in Annex A, but we think they should be (can be reused):  L1 MR related:   * currentSpCellInclL1-Report-r18 (per BC) * supportedMaxCellsWithoutGapsL1-Meas-r18 (per BC) * supportedMaxSSB-WithinSlotL1-Meas-r18 (per BC) * supportedMaxSSB-L1-Meas-r18 (per BC)   Early TA related:   * pdcch-RACH-AffectedBandsList-r18 (per FS) * pdcch-RACH-PrepTimeList-r18 (per FS) * pdcch-RACH-SwitchingTimeList-r18 (per FS) |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes but | We tend to agree with MediaTek comments that is not completely clear which capabilities apply and which not. In general, we agree that Rel-18 LTM capabilities can be re-used also in Rel-19, but some of them require additional discussions. Maybe we can capture a general statement such as “Rel-18 LTM capabilities are the baseline for Rel-19 LTM”, or something similar. |
| ZTE | Yes | We are ok with the general principle mentioned by Ericsson. Then it is up to companies to point out the exception case if identified. |
| vivo | Yes | Whether ltm-Recovery-r18 in Annex A can be reused for inter-CU LTM could be considered once progress has been made on the inter-CU LTM fast recovery issue. |
| Ofinno | Yes | We agree with ZTE and Ericsson for the capabilities for the capabilities listed in Proposal 1. As Mediatek mentioned, the other capabilities in Annex A may require further discussion. We also think that reference configuration for inter-CU is quite different from that of intra-CU cases especially considering the support of addition DC scenarios. |

As a new functionality, UE capability is to be defined for “inter-CU LTM”. Given the distinct UE behaviors in inter-CU SCG LTM and inter-CU MCG LTM, it is advisable to have separate capabilities for inter-CU MCG LTM and inter-CU SCG LTM. Moreover, these capabilities ought to be configured on a per - UE basis.

**Proposal 2: Define per-UE capabilities for inter-CU MCG LTM and inter-CU SCG LTM e.g. ltm-interCU-MCG-r19 and ltm-interCU-SCG-r19. UE supports these capabilities should also support ltm-MCG-IntraFreq-r18 or ltm-SCG-IntraFreq-r18 respectively.**

### Question 2

**Do you think P2 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | No | Defining a capability which is “inter-CU” does not make any sense since the UE is not able to distinguish whether an LTM cell switch is intra-CU or inter-CU. The existing capabilities ltm-MCG-r18 and ltm-SCG-r18. We can discuss other capabilities (such as security key change) but it does not make sense to have any capability which differentiate the UE behaviour for something that is inter-CU or intra-CU. |
| ZTE | No | We tend to agree with Ericsson’s comments, so far, there is no UE capability defined to be associated with intra-CU/inter-CU scenarios, because this is transparent to the UE.  We can introduce two separate per-UE capabilities to indicate the support of key update during LTM, one for MCG key change, the other for SCG key change.  For the SCG one, we think there is no need to put it under MeasAndMobParametersMRDC, because EN-DC/NE-DC is not considered. It is fine to put it under MeasAndMobParameters (without MRDC).   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | x-2 | Inter-CU LTM | Indicates UE supports SN initiated inter-CU SCG LTM on all the bands where the UE indicates support of *ltm-SCG-IntraFreq-r18*. | support of Intra-CU LTM as specified in TS 38.331 [2]. | *ltm-interCU-SCG-r19* | *MeasAndMobParametersMRDC-Common-v1900* | |
| vivo | Yes, with comments | Generally we think it is OK but we are also fine to further discuss whether the inter-CU capability is needed considering Ericsson’s comment that the UE is not able to distinguish the intra/inter CU case. |
| Ofinno | Yes |  |

## Conditional LTM

As only the conditional intra-CU LTM in non-DC is supported, hence only this case is taken into consideration in the following discussion.

In R16 CHO, the capability of condHandover-r16 is defined on a per band basis, the same way can be reused for conditional LTM.

**Proposal 3: Define a per-band capability for conditional LTM e.g. cltm-IntraCU-MCG-r19.It indicates whether the UE supports intra-CU MCG LTM on the band where the UE is in non-DC. This includes supports execution condition, subsequent LTM. UE supports this capability should support ltm-MCG-IntraFreq-r18 on the same band.**

### Question 3

**Do you think P3 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes | “Conditional” is missing in P3:  “It indicates whether the UE supports intra-CU MCG Conditional LTM on the band where the UE is in non-DC” |
| Nokia | Yes, but see comment | Agree with the intention, suggest to re-word the subsequent LTM part as: “UE supports storing the configurations until they are explicitly released from the NW”. |
| Xiaomi | Comments | Our understanding is that the execution condition is an integral part of CLTM, i.e. a UE support CLTM should support at least one of L1 condition and L3 conditions (as in P6). Currently we have cyclic dependencies (as in P4/P5 and P6). To simplify, we suggest that we do not define *cltm-IntraCU-MCG-r19* at all, and only define per-band capability for L1 and L3 execution conditions, *cltm-ExecutionConditionL1-r19*, and *cltm-ExecutionConditionL3-r19*. UE supports these capabilities should support *ltm-MCG-IntraFreq-r18* on the same band. |
| Ericsson | No with comments | We are fine with the perBand capabilities, but such capabilities should be simply called cltm-MCG-IntraFreq-r19 and cltm-SCG-IntraFreq-r19. It does not make any sense to associate a UE capability to the case where something is intra-CU or inter-CU. |
| ZTE | Yes with comments | Similar to R16 CHO capabilities, even if the capability is defined as per-band, we need to clarify that the UE should set the value consistently for all FDD-FR1 band, all TDD-FR1 bands and so on respectively.  And agree with Ericsson to not mention “intra-CU” in IE name. |
| vivo | Yes | Generally, it is ok to have this per-band capability for conditional LTM. For xiaomi’s comments, we understand it can be on possible way but we slightly prefer the more straightforward way to have a simple capability for CLTM. |
| Ofinno | Yes | We suggest to update the description about non-DC: “It indicates whether the UE supports intra-CU MCG conditional LTM on the band. A UE does not support it when operating in DC”. Alternatively, we are fine to not include the non-DC part in capability description as rely on 38.331. |

It was agreed that both L3 based execution condition and L1 based execution condition are supported for C-LTM. And only one triggering event is associated with L1 execution condition, but one or two triggering events can be associated with L3 execution condition as CHO.

1. The triggering condition of conditional LTM can be based on L3 measurement.
2. CondEventA3 and CondEventA5 conditions can be baseline for the conditional LTM execution.
3. The L1 execution condition of a candidate cell is associated to only one triggering event.
4. For L3 execution condition, it may consist of one or two triggering condition(s). If there are two triggering conditions associated with the same candidate cell, the UE shall consider the execution condition is fulfilled only when both triggering conditions are met. Only single RS type is supported and at most two different trigger quantities can be configured simultaneously for the evaluation of execution condition of a single candidate cell.

Hence separate capability can be defined for L1 and L3 execution condition. UE supports CLTM should support at least one of the two capabilities. In R16 CHO, the capability of condHandoverTwoTriggerEvents-r16 is defined per band, the same way can be reused for these related execution condition capabilities for conditional LTM. i.e. define these capabilities to be per band capability.

**Proposal 4: Define a per-band capability for L1 execution condition, e.g.** **cltm-ExecutionConditionL1-r19 is defined to indicate whether the UE supports L1 execution condition for conditional LTM. The UE supports this capability should support cltm-IntraCU-MCG-r19 on the same band.**

### Question 4

**Do you think P4 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Comments | See our reply for Q3. |
| Ericsson | In principle yes but.. | See our reply to Q3 |
| ZTE | No | We think if per-band CLTM capability is introduced, by default, the support of CLTM should already contain the support of L1 execution condition.  Is there real need to only support CLTM to be associated with L3 events?  If companies think CLTM associated with L3 execution condition needs separate capability. We prefer to introduce a per-UE capability. Not per-band.  On the “two trigger event”, it seems the condHandoverTwoTriggerEvents-r16 was not so useful based on below statement in FD “This feature is mandatory supported if the UE supports *condHandover-r16*”. If companies really see the need to have this capability, we suggest to rely on existing CHO capability (condHandoverTwoTriggerEvents-r16). In our view, if the UE already supports two events for CHO, it is natural to support it also for CLTM for the same band. |
| vivo | Yes |  |
| Ofinno | Yes |  |

**Proposal 5: Define a per-band capability for L3 execution condition, e.g.** **cltm-ExecutionConditionL3-r19 is defined to indicate whether the UE supports L3 execution condition for conditional LTM and whether the UE supports 2 trigger events for same execution condition. UE supports this capability should support cltm-IntraCU-MCG-r19 on the same band.**

### Question 5

**Do you think P5 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Comments | See our reply for Q3. |
| Ericsson | In principle yes but.. | See our reply to Q3 |
| ZTE | Comments | See our reply to Q4. |
| vivo | Yes | It should be modified to that ‘cltm-ExecutionConditionL3-r19 is defined to indicate whether the UE supports L3 execution condition for conditional LTM and whether the UE supports AT MOST 2 trigger events for same execution condition’ |
| Ofinno | Yes |  |

**Proposal 6: A UE that supports conditional LTM (i.e., cltm-IntraCU-MCG-r19) should indicate the support for at least one of cltm-ExecutionConditionL3-r19 or cltm-ExecutionConditionL1-r19.**

### Question 6

**Do you think P6 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes |  |
| Nokia | Yes | Maybe we can rephrase to: “A UE that supports conditional LTM (i.e., cltm-IntraCU-MCG-r19) **on a band** should indicate the support for at least one of cltm-ExecutionConditionL3-r19 or cltm-ExecutionConditionL1-r19 **on the same band”**    It may be implicitly assumed, so not strictly necessary, but maybe good to be consistent and follow similar formulation as in P5. |
| Xiaomi | Comments | See our reply for Q3. |
| Ericsson | Yes |  |
| ZTE |  | See our reply to Q3/Q4, we prefer to not define separate capability for L1 execution condition. |
| vivo | Yes |  |
| Ofinno | Yes |  |

It has agreed CG based RACH-Less LTM is supported for C-LTM, the capability of ltm-RACH-LessCG-r18 can be reused for C-LTM. If the UE indicates support of cltm-IntraCU-MCG-r19 and ltm-RACH-LessCG-r18, it indicates that the UE supports RACH-less conditional LTM with configured grant.

**Proposal 7: When a UE indicates support for both conditional LTM (i.e., cltm-IntraCU-MCG-r19) and ltm-RACH-LessCG-r18, it implies that the UE has the capacity to support RACH-less conditional LTM with a configured grant.**

### Question 7

**Do you think P7 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes, but | In the description of ltm-RACH-LessCG-r18, it is mentioned UE should also support at least one band of either ta-IndicationCellSwitch-r18 or ue-TA-Measurement-r18.  But as discussed in Q9, ta-IndicationCellSwitch-r18 will not be used for R19 CLTM and a new capability is introduced. Does it introduce compatibility issue if we reuse ltm-RACH-LessCG-r18 for R19 CLTM? |
| Nokia | Yes |  |
| Xiaomi | Comments | We agree with the intention. As we propose (in Q3) to not have *cltm-IntraCU-MCG-r19,* the proposal 7 can be changed to “When a UE indicates support for both conditional LTM (i.e., *cltm-ExecutionConditionL1-r19* or *cltm-ExecutionConditionL3-r19*) and *ltm-RACH-LessCG-r18*, it implies that the UE has the capacity to support RACH-less conditional LTM with a configured grant.”. |
| Ericsson | Yes but | We can combine the two capabilities, but the field description would need some update. |
| ZTE | Yes |  |
| vivo | Yes | We think the intention is OK, and agree with Ericsson’s comment that the field description should be updated. |
| Ofinno | Yes, but | We agree with MediaTek.  A UE supporting ltm-RACH-LessCG-r18 should also support of either *ltm-BeamIndicationJointTCI-r18* or *ltm-BeamIndicationSeparateTCI-r18.*Since there is no LTM cell switch MAC-CE in conditional LTM, either the description of the current capability needs to be revised, or a new capability is introduced. |

Conditional LTM supports UE based early TA acquisition and PDCCH order based TA acquisition. Due to there is no difference between the UE behaviors of UE based TA measurement for LTM and conditional LTM, hence the capability of ue-TA-Measurement-r18 could be reused for CLTM and LTM.

**Proposal 8a: Reuse the R18 capability (i.e., ue-TA-Measurement-r18) to indicate whether UE supports UE-based TA measurement for C-LTM. There is no need to define a separate capability for this purpose.**

### Question 8a

**Do you think P8a is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes | Maybe field description of existing capability should be updated? |
| ZTE | Yes |  |
| vivo | Yes |  |
| Ofinno | Yes |  |

However, in the case of PDCCH order-based TA acquisition, it mandates that the UE acquires the TA (Timing Advance) value prior to CLTM execution. Moreover, for CLTM, the UE must maintain this TA value using a new timer. This process differs from the R18 PDCCH-ordered TA acquisition mechanism.

In R18 LTM, the UE capability rach-EarlyTA-Measurement-r18 is defined for PDCCH ordered TA acquisition.

| ***rach-EarlyTA-Measurement-r18***  Indicates the maximum number of candidate cells for TA acquisition based on PDCCH ordered CFRA procedure before receiving cell switch command MAC-CE. Power ramping for PRACH retransmission based on PDCCH order indication. UE also supports dropping the serving cell UL to handle the overlap between UL transmission on serving cell(s) and PRACH on candidate cell(s).  A UE supporting this feature shall also indicate support of *ta-IndicationCellSwitch-r18* and at least one of *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18*. | Band | No | N/A | N/A |
| --- | --- | --- | --- | --- |

Whether new capability is needed for PDCCH order TA acquisition in CLTM should be discussed.

**Proposal 8b: RAN2 discuss whether rach-EarlyTA-Measurement-r18 could be reused for PDCCH order TA acquisition in CLTM.**

### Question 8b

**Do you think rach-EarlyTA-Measurement-r18 could be reused for PDCCH order TA acquisition in CLTM?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | No | We believe a new capability(s) is needed due to the introduction of the TA timer maintenance of candidate cells. This capability is abandoned as the new capability is introduced. |
| Nokia | No | The current capability used for Rel. 18 LTM will likely need to be revised. Additionally, the handling of the timer is not captured anywhere. Perhaps it would be simpler to follow the suggestion from MTK and have a separate capability for this and have the timer handling as part of this capability. |
| Xiaomi | Comments | It might be possible that we reuse this IE only for early RACH, and define TA operation for CLTM in a separate UE capability (as discussed in Q9). In this way, the capability can handle both LTM and CLTM. |
| Ericsson | Need more discussion |  |
| ZTE | Yes | To be honest, for LTM (not condition), the usage of rach-EarlyTA-Measurement-r18 is quite unclear, since UE just sends preamble to candidate cell, there is no need to maintain the TA, then how to under the value reported by the UE? E.g. Number of RACH attempts in one serving cell for how long?  The design of rach-EarlyTA-Measurement-r18 (with value 1-8) seems more useful for CLTM, as it can indicate the maximum number of TA timers that maintained by the UE. |
| vivo | No with comments | We agree with companies that at least the TA timer maintenance should be considered for new capability. But whether the TA timer capability can also represent that the UE support PDCCH order TA acquisition in CLTM can be further discussion. |
| Ofinno | Comments | It may be possible but we think introducing a new capability is simpler than revising the current capability due to the introduction of the TA timer maintenance of candidate cells |

RAN2 has reached an agreement that the network can convey the timing advance (TA) information of the candidate cell to the UE through a new MAC CE. In light of this, a new capability needs to be defined for TA indication in the context of CLTM.

**Proposal 9: Define a per-band capability, such as “cltm-TA-Indication-r19”. This capability serves to indicate whether the UE can support TA indication within the early TA MAC CE for conditional LTM.**

### Question 9

**Do you think P9 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes but | We don’t need to tight this capability to only CLTM but it can be more general for LTM and CLTM. |
| ZTE | Yes but | We agree a capability is needed, but whether it is per-band or per-UE needs clarification. For per-band, whether network only check the source band? Or need to check both source band and target band (where preamble is sent)?  In addition, this relates to the outcome of Q8, if separate early TA-measurement capability is introduced for CLTM, then that capability should already contain the support of new TA MAC CE. (We answer Yes to Q9 because we answer Yes to Q8) |
| vivo | Yes |  |
| Ofinno | Yes |  |

There was also an agreement to reuse the Candidate Cell TCI States Activation/Deactivation MAC CE for the early activation or deactivation of the CLTM candidate cell. The capabilities defined for R18 LTM, namely “ltm-MAC-CE-JointTCI-r18” and “ltm-MAC-CE-SeparateTCI-r18”, can be reused. As such, there is no necessity to define a new capability for CLTM in this regard.

**Proposal 10: Reuse the R18 capability (i.e., ltm-MAC-CE-JointTCI-r18 and ltm-MAC-CE-SeparateTCI-r18) to indicate whether the UE supports MAC-CE activated joint/separate LTM TCI states for CLTM.**

### Question 10

**Do you think P10 is agreeable?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek | Yes |  |
| Nokia | Yes |  |
| Xiaomi | Yes |  |
| Ericsson | Yes |  |
| ZTE | Yes |  |
| vivo | Yes |  |
| Ofinno | Yes |  |

## Other UE capability open issues

This section is to collect other UE capability open issues identified by companies.

### Question 11

**Do you identify other UE capability open issues?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments if any** |
| MediaTek |  | We assume the following Annex A is only for inter-CU LTM. In the case of CLTM, do we need a question similar to Question 1 to discuss which R18 LTM capabilities can be reused? |
| Nokia |  | We should also consider other UE capability related to PDCCH ordered RACH, i.e., ***rach-EarlyTA-BandList-r18,*** which is where UE indicates support for simultaneous transmission to handle the overlap between UL transmission on serving cell(s) and PRACH on candidate cell(s). |
| Xiaomi | Yes | Our understanding is that UE capabilities for L1 event triggered measurement reporting should be defined? |
| ZTE | Yes | Agree with Xiaomi, but on the other hand, it is unclear to us which capabilities will be discussed in RAN1 (e.g. for L1 event). We should avoid overlapping discussion in two WGs. |
| Ofinno | Yes | We think the following capabilities need to be introduced:   * Ltm-refenceConfig-r19: see comments to P1 * L1 event triggered measurement reporting |
|  |  |  |

# Conclusion

# Reference

1. 3GPP TS 38.306, " NR;User Equipment (UE) radio access capabilities"

# Annex A

| ***ltm-BeamIndicationJointTCI-r18***  Indicates whether the UE supports unified TCI with joint DL/UL LTM TCI-state indication for LTM procedure, indicating and activating a single joint LTM TCI state in a cell switch command.  This capability comprises the following parameters:  - *maxNumberJointTCI-PerCell-r18* indicates the maximum number of configured joint LTM TCI state(s) per candidate cell  - *qcl-Resource-r18* indicates of the supported QCL source RS in the LTM TCI-state- configuration.  - *maxNumberJointTCI-AcrossCells-r18* indicates index *N* of the maximum number of configured joint DL LTM TCI state(s) across candidate cells. The maximum number of configured joint LTM TCI state(s) across candidate cells is *N*\*8, where *N*={1..128}.  - *maxNumberCells-r18* indicates the maximum number of configured cells for joint LTM TCI state(s).  A UE supporting this feature shall also indicate support of *unifiedJointTCI-r17* and at least one of *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18*. |
| --- |
| ***ltm-BeamIndicationSeparateTCI-r18***  Indicates whether the UE supports unified TCI with separate DL/UL TCI-state indication for LTM procedure and indicating/activating a pair of UL/DL TCI-state in a cell switch command.  This capability comprises the following parameters:  - *maxNumberDL-TCI-PerCell-r18* indicates the maximum number of configured DL TCI state(s) per candidate cell.  - *maxNumberUL-TCI-PerCell-r18* indicates the maximum number of configured UL TCI state(s) per candidate cell.  - *qcl-Resource-r18* indicates the supported QCL source RS in the LTM TCI-state configuration.  - *maxNumberDL-TCI-AcrossCells-r18* indicates value *N* of the maximum number of configured separate DL LTM TCI state(s) across candidate cells. The maximum number of configured separate DL LTM TCI state(s) across candidate cells is *N*\*8, where *N*={1..128}.  - *maxNumberUL-TCI-AcrossCells-r18* indicates value *N* of the maximum number of configured separate UL LTM TCI state(s) across candidate cells. The maximum number of configured separate UL LTM TCI state(s) across candidate cells is *N*\*8, where *N*={1..64}.  - *maxNumberCells-r18*indicates the maximum number of configured cells for separate DL/UL LTM TCI states  A UE supporting this feature shall also indicate support of *unifiedSeparateTCI-r17* and at least one of *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18*. |
| ***ltm-FastProcessingConfig-r18***  Indicates whether the UE supports fast processing of LTM candidate cell RRC configuration. This capability signalling comprises the following parameters:  - *maxNumberStoredConfigCells-r18* 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 LTM candidate configurations and Scell(s) in LTM candidate configurations for MCG and SCG, that UE can store the configurations.  - *maxNumberConfigs-r18* represents the maximum number of LTM candidate configuration for which the UE can perform early ASN.1 decoding and validity check, as described in TS 38.133 [5].  A UE supporting this capability shall also indicate support of *ltm-MAC-CE-JointTCI-r18* or *ltm-MAC-CE-SeparateTCI-r18*. UE shall set the capability values for *maxNumberStoredConfigCells-r18* and *maxNumberConfigs-r18* consistently for all bands. These capability values represent the maximum number across all the supported bands.  NOTE: The conditions for fast processing of an LTM candidate cell RRC configuration is defined in clause 6.3 in TS 38.133 [5]. |
| ***ltm-MAC-CE-JointTCI-r18***  Indicates whether the UE supports MAC-CE activated joint LTM TCI states.  This capability comprises the following parameters:  - *qcl-Resource-r18* indicates the supported QCL source RS for MAC-CE activated DL/UL LTM TCI states configuration.  - *maxNumberJointTCI-PerCell-r18* indicates the maximum number of MAC-CE activated joint LTM TCI states per candidate cell.  - *maxNumberJointTCI-AcrossCells-r18* indicates the maximum number of MAC-CE activated joint LTM TCI states across candidate cells and serving cell TCI states across serving cells in the band.  A UE supporting this feature shall also indicate support of *ltm-BeamIndicationJointTCI-r18*.  NOTE: The maximum number of MAC-CE activated joint TCI states across all servings cells is limited by of *unifiedJointTCI-r17.* |
| ***ltm-MAC-CE-SeparateTCI-r18***  Indicates whether the UE supports MAC-CE activated DL/UL LTM TCI states.  This capability comprises the following parameters:  - *qcl-Resource-r18* indicates the supported QCL source RS for MAC-CE activated DL/UL LTM TCI states configuration.  - *maxNumberDL-TCI-PerCell-r18* indicates the maximum number of MAC-CE activated DL TCI states per candidate cell.  - *maxNumberUL-TCI-PerCell-r18* indicates the maximum number of MAC-CE activated UL TCI states per candidate cell.  - *maxNumberDL-TCI-AcrossCells-r18* indicates the maximum number of MAC-CE activated LTM DL TCI states across all candidate cells and serving cell DL TCI states across all serving cells.  - *maxNumberUL-TCI-AcrossCells-r18* indicates the maximum number of MAC-CE activated UL TCI states across all candidate cells and serving cell UL TCI states across all serving cells in the band.  A UE supporting this feature shall also indicate support of *ltm-BeamIndicationSeparateTCI-r18*.  The maximum number of MAC-CE activated DL/UL TCI states across all servings cells is limited by *unifiedSeparateTCI-r17.* |
| ***ltm-MCG-IntraFreq-r18***  Indicates whether the UE supports intra-frequency LTM for MCG with RACH as defined in TS 38.331 [9] and TS 38.321 [8] without NR-DC configured. UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands, all TDD-FR2-1 bands and all TDD-FR2-2 bands respectively.  UE supporting this feature shall also indicate support for *ltm-BeamIndicationJointTCI-r18* or *ltm-BeamIndicationSeparateTCI-r18*. |
| ***ltm-SCG-IntraFreq-r18***  Indicates whether the UE supports intra-frequency LTM for SCG with RACH as defined in TS 38.331 [9] and TS 38.321 [8]. UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands, all TDD-FR2-1 bands and all TDD-FR2-2 bands respectively.  UE supporting this feature shall also indicate support for *ltm-BeamIndicationJointTCI-r18* or *ltm-BeamIndicationSeparateTCI-r18*. |
| ***rach-EarlyTA-Measurement-r18***  Indicates the maximum number of candidate cells for TA acquisition based on PDCCH ordered CFRA procedure before receiving cell switch command MAC-CE. Power ramping for PRACH retransmission based on PDCCH order indication. UE also supports dropping the serving cell UL to handle the overlap between UL transmission on serving cell(s) and PRACH on candidate cell(s).  A UE supporting this feature shall also indicate support of *ta-IndicationCellSwitch-r18* and at least one of *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18*. |
| ***ta-IndicationCellSwitch-r18***  Indicates whether the UE supports TA indication in cell switch command.  A UE supporting this feature shall also indicate support of at least one of *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18*. |
| ***ue-TA-Measurement-r18***  Indicates whether the UE supports UE-based TA measurement by indicating the maximum number of candidate cells that the UE maintains the TA for.  A UE supporting this feature shall also indicate the support of at least one of *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18*. |
| ***interFreqL1-MeasConfig-r18***  Indicates whether UE supports inter-frequency L1-RSRP measurement and reporting based on SSB(s) of candidate cell(s), regardless whether the candidate cell(s) are inside or outside of the BC (unless the UE also indicates support of *ltm-interFreqL1-OnlyInBC-r18*).  This capability signalling comprises of the following parameters:  - *supportedMaxIntraInterFreqCellsConfig-r18* indicates the maximum number of RRC configured candidate cells for intra- and inter-frequency L1-RSRP measurement;  - *supportedMaxIntraInterFreqCellsPerReport-r18* indicates maximum number of candidate cells in one report where a SSBRI-RSRP pair is used for each beam report for intra- and inter-frequency L1-RSRP measurement;  - *supportedMaxIntraInterFreqBeamsPerCellReports-r18* indicates maximum number of candidate beams per candidate cell in one report where a SSBRI-RSRP pair is used for each beam report for intra- and inter-frequency L1-RSRP measurement;  - *supportedMaxIntraInterFreqBeamsReports-r18* indicates maximum number of candidate cells beams in total across all cells in one report where a SSBRI-RSRP pair is used for each beam report for intra- and inter-frequency L1-RSRP measurement;  UE supporting this feature shall also indicate support of *intraFreqL1-MeasConfig-r18*. |
| ***interFreqSSB-L1-MeasWithoutGaps-r18***  Indicates whether UE supports SSB based inter-frequency L1-RSRP measurements on SSBs within active DL BWP without measurement gaps (without interruption on serving cell(s)) for LTM.  UE supporting this feature shall also indicate support of *interFreqL1-MeasConfig-r18.* |
| ***intraFreqL1-MeasConfig-r18***  Indicates whether UE supports intra-frequency L1-RSRP measurement and reporting based on SSB(s) of candidate cell(s).  This capability signalling comprises of the following parameters:  - *supportedMaxIntraFreqCellsConfig-r18* indicates the maximum number of RRC configured candidate cells for intra-frequency L1-RSRP measurement;  - *supportedMaxIntraFreqCellsPerReport-r18* indicates the maximum number of candidate cells in one report where a SSBRI-RSRP pair is used for each beam report for intra-frequency L1-RSRP measurement;  - *supportedMaxReportBeamsPerReportedCell-r18* indicates the maximum number of candidate beams per candidate cell in one report where a SSBRI-RSRP pair is used for each beam report for intra-frequency L1-RSRP measurement;  - *supportedMaxReportBeamsReports-r18* indicates the maximum number of candidate beams in total across all cells in one report where a SSBRI-RSRP pair is used for each beam report for intra-frequency L1-RSRP measurement;  - *supportedMaxAperiodic-LTM-CSI-ReportConfig-r18* indicates maximum number of aperiodic *LTM-CSI-ReportConfig*;  - *supportedMaxPeriodic-LTM-CSI-ReportConfig-r18* indicates maximum number of periodic *LTM-CSI-ReportConfig*;  - *supportedMaxSemiPersistent-LTM-CSI-ReportConfig-r18* indicates maximum number of semi-persistant *LTM-CSI-ReportConfig*;  UE supporting this feature shall also indicate support of *periodicBeamReport* or *aperiodicBeamReport* or *sp-BeamReportPUCCH* or *sp-BeamReportPUSCH.* |
| ***maxFreqLayersL1-Meas-r18***  Indicates the number of frequency layers for L1-RSRP measurement.  This capability signalling comprises of the following parameters:  - *supportedMaxIntraInterFreqLayersWithoutGaps-r18* indicates the maximum number of frequency layers UE can measure for intra- and inter-frequency without measurement gaps L1-RSRP measurement.  A UE indicating support for this component shall also indicate support for *intraFreqL1-MeasConfig-r18* and/or *interFreqSSB-L1-MeasWithoutGaps-r18.*  - *supportedMaxInterFreqLayersWithGaps-r18* indicates the maximum number of frequency layers UE can measure for inter-frequency L1-RSRP measurement with measurement gaps. A UE indicating support for this component shall also indicate support for *ltm-InterFreqMeasGap-r18*. |
| ***maxNeighCellsPerFreqLayerL1-Meas-r18***  Indicates the number of neighbouring cells per frequency layer for L1-RSRP measurement.  This capability signalling comprises of the following parameters:  - *supportedMaxNeighCellsPerFreqLayersWithoutGaps-r18* indicates the max number of neighbour cells UE can measure for L1-RSRP per frequency layer for intra-frequency or inter-frequency without measurement gaps.  A UE indicating support for this component shall also indicate support for *intraFreqL1-MeasConfig-r18* or *interFreqSSB-L1-MeasWithoutGaps-r18.*  - *supportedMaxNeighCellsPerFreqLayersWithGaps-r18* indicates the max number of neighbour cells UE can measure for L1-RSRP per frequency layer for inter-frequency with measurement gaps. A UE indicating support for this component shall also indicate support for *ltm-InterFreqMeasGap-r18.* |
| ***maxSSB-PerFreqLayerL1-Meas-r18***  Indicates the maximum number of SSB resources for L1-RSRP measurement per frequency layer UE can measure.  This capability signalling comprises of the following parameters:  - *supportedMaxSSB-PerFreqLayersWithoutGaps-r18* indicates the max number of SSB resources UE can measure for L1-RSRP per frequency layer for intra-frequency or inter-frequency without measurement gaps.  A UE indicating support for this component shall also indicate support for *intraFreqL1-MeasConfig-r18* or *interFreqSSB-L1-MeasWithoutGaps-r18.*  - *supportedMaxSSB-PerFreqLayersWithGaps-r18* indicates the max number of SSB resources UE can measure for L1-RSRP per frequency layer for inter-frequency with measurement gaps. A UE indicating support for this component shall also indicate support for *ltm-InterFreqMeasGap-r18*. |
| ***multiCellL1-measRTD-greaterThan-CP-r18***  Indicates the capability of simultaneous L1-RSRP measurements for more than one cell when the max RTD among the cells on the same frequency layer or in the same active BWP is larger than CP length of the cell on the frequency layer or in the same active BWP.  A UE supporting this feature shall also indicate support of either *intraFreqL1-MeasConfig-r18, interFreqSSB-L1-MeasWithoutGaps-r18* or *ltm-InterFreqMeasGap-r18.* |
| ***ltm-FastUE-Processing-r18***  Indicates the reduced TLTM\_processing delay of the UE during cell switch.  The capability signalling includes the following parameters:  - *fr1-r18* indicates the reduced TLTM\_processing for cell switch from FR1 to FR1.  - *fr2-r18* indicates the reduced TLTM\_processing for cell switch from FR2 to FR2.  - *fr1-AndFR2-r18* indicates the reduced TLTM\_processing for cell switch from FR1/FR2 to FR2/FR1. |
| ***ltm-InterFreq-r18***  Indicates UE supports inter-frequency MCG LTM on all the bands where the UE indicates support of *ltm-MCG-IntraFreq-r18* or inter-frequency SCG LTM on all the bands where the UE indicates support of *ltm-SCG-IntraFreq-r18* respectively.  A UE supporting this feature shall also indicate support of *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18.* |
| ***ltm-interFreqL1-OnlyInBC-r18***  When included, for each BC in which the UE indicates support of *interFreqL1-MeasConfig-r18*, the UE only supports inter-frequency L1-RSRP measurement and reporting based on SSB(s) of LTM candidate cell(s) that are inside the BC. When not included, the description in *interFreqL1-MeasConfig-r18* is applicable.  A UE supporting this feature shall also indicate support of *interFreqL1-MeasConfig-r18*. |
| ***ltm-InterFreqMeasGap-r18***  Indicates whether the UE supports SSB based inter-frequency L1-RSRP measurements with measurement gaps for LTM.  A UE supporting this feature shall also indicate support of *interFreqL1-MeasConfig-r18*. | |
| ***ltm-MCG-NRDC-r18***  Indicates whether the UE supports LTM for MCG with RACH with NR-DC configured as defined in TS 38.331 [9] and TS 38.321 [8]. UE indicating support for this feature shall also indicate support of *ltm-MCG-IntraFreq-r18.* | |
| ***ltm-MCG-NRDC-Release-r18***  Indicates whether the UE supports LTM for MCG with the release of NR-DC configuration as part of LTM execution when LTM cell switch command MAC CE is received. UE indicating support for this feature shall also indicate support of *ltm-MCG-IntraFreq-r18.* | |
| ***ltm-RACH-LessCG-r18***  Indicates whether the UE supports RACH-less LTM with configured grant for MCG LTM if the UE indicates support of *ltm-MCG-IntraFreq-r18* or for SCG LTM if the UE indicates support of *ltm-SCG-IntraFreq-r18* respectively.  UE indicating support for this feature shall also indicate support of either *ltm-BeamIndicationJointTCI-r18* or *ltm-BeamIndicationSeparateTCI-r18* for at least one band and either *ta-IndicationCellSwitch-r18* or *ue-TA-Measurement-r18*. | |
| ***ltm-RACH-LessDG-r18***  Indicates whether the UE supports RACH-Less LTM with dynamic grant, for MCG LTM if the UE indicates support of *ltm-MCG-IntraFreq-r18* or for SCG LTM if the UE indicates support of *ltm-SCG-IntraFreq-r18* respectively.  UE indicating support for this feature shall also indicate support of either *ltm-BeamIndicationJointTCI-r18* or *ltm-BeamIndicationSeparateTCI-r18* for at least one band and TA indication in *ta-IndicationCellSwitch-r18* or *ue-TA-Measurement-r18*. | |
| ***ltm-Recovery-r18***  Indicates whether the UE supports recovery procedure for MCG LTM execution when the selected cell in RRC re-establishment procedure is a LTM candidate as specified in TS 38.331 [9].  UE indicating support for this feature shall also indicate support of *ltm-MCG-IntraFreq-r18* for at least one band. | |
| ***ltm-ReferenceConfig-r18***  Indicates whether UE supports a reference configuration for LTM.  UE indicating support for this feature shall also indicate support of either *ltm-MCG-IntraFreq-r18* or *ltm-SCG-IntraFreq-r18* for at least one band. | |

# Annex B

UE feature list for Rel-19 mobility enhancement Ph4 based on above proposals.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Features** | **Index** | **Feature group** | **Components** | **Prerequisite feature groups** | **Field name in TS 38.331 [2]** | **Parent IE in TS 38.331 [2]** | **Need of FDD/TDD differentiation** | **Need of FR1/FR2 differentiation** | **Note** | **Mandatory/Optional** |
| x. Mob\_enh\_Ph4 | x-1 | Inter-CU LTM | Indicates UE supports inter-CU MCG LTM on all the bands where the UE indicates support of *ltm-MCG-IntraFreq-r18* | support of intra-CU LTM as specified in TS 38.331 [2]. | *ltm-interCU-MCG-r19* | *measAndMobParametersCommon* | No | No | A UE supporting this feature shall also indicate support of *ltm-MCG-IntraFreq-r18* | Optional with capability signalling |
| x-2 | Inter-CU LTM | Indicates UE supports SN initiated inter-CU SCG LTM on all the bands where the UE indicates support of *ltm-SCG-IntraFreq-r18*. | support of Intra-CU LTM as specified in TS 38.331 [2]. | *ltm-interCU-SCG-r19* | *MeasAndMobParametersMRDC-Common-v1900* | No | No | A UE supporting this feature shall also indicate support of *ltm-SCG-IntraFreq-r18* | Optional with capability signalling |
| x-3 | Conditional LTM | Indicates whether the UE supports conditional intra-CU MCG LTM when the UE is in non-DC. Including execution condition, subsequent LTM. If the UE indicates support of ltm-RACH-LessCG-r18, it indicates the UE supporting RACH-less conditional LTM with configured grant. UE supporting this feature shall also indicate support of at least one of *cltm-ExecutionConditionL1-r19* or *cltm-ExecutionConditionL3-r19.* | support of Intra-CU LTM as specified in TS 38.331 [2]. | *cltm-IntraCU-MCG-r19* | BandNR | No | No | A UE supporting this feature shall also indicate support of *ltm-MCG-IntraFreq-r18* | Optional with capability signalling |
| x-4 | Conditional LTM | Indicates whether the UE supports L1 measurement based execution condition for conditional MCG LTM. | Support *cltm-IntraCU-MCG-r19* | *cltm-ExecutionConditionL1-r19* | BandNR | No | No | A UE supporting this feature shall also indicate support of *tm-CondIntraCU-MCG-r19.* | Optional with capability signalling |
| x-5 | Conditional LTM | Indicates whether the UE supports L3 measurement based execution condition for conditional MCG LTM and whether the UE supports 2 trigger events for same execution condition. | Support *cltm-IntraCU-MCG-r19* | *cltm-ExecutionConditionL3-r19* | BandNR | No | No | A UE supporting this feature shall also indicate support of *tm-CondIntraCU-MCG-r19.* | Optional with capability signalling |
| x-6 | Conditional LTM | Indicates whether the UE supports TA indication and maintain before conditional LTM execution.A UE supporting this feature shall also indicate support of ltm-CondIntraCU-MCG-r19. | Support *cltm-IntraCU-MCG-r19* | *cltm-TA-Indication-r19* | BandNR | No | No | A UE supporting this feature shall also indicate support of *tm-CondIntraCU-MCG-r19.* | Optional with capability signalling |