3GPP TSG-RAN WG2 Meeting #121-bis electronic \_R2-23xxx

April 17th - 26th, 2023

Agenda Item: 7.4.2.1

Source: Huawei, HiSilicon

**Title:** **Summary of [AT121bis-e][018][eMob] Procedure Consolidation (Huawei)**

Document for: Discussion and Decision

# Introduction

This paper aims at capturing the summary of the offline discussion.

* **[AT121bis-e][018][eMob] Procedure Consolidation (Huawei)**

Scope: 1: Identify agreements (easy / tentative), and Open Issues that should be resolved to consolidate and clarify LTM procedures, can also suggest/indicate wanted updates to procedural descriptions (ST-2)

2: Collect comments on R3 LS and propose resolution.

Use R2-2303549, R2-2302829 as inspiration, Can also include proposals from other papers that seem relevant.

Intended outcome: Report

Deadline: CB W2 Wednesday

Please note the PDCCH order early RACH related issues (like TA maintenance, early RACH config, following questions related the two RAR options, etc) are not included in this LTM procedure offline scope.

**Contact information**

|  |  |
| --- | --- |
| **Company** | **Name (Email)** |
| Apple | Naveen Palle (naveen.palle@apple) |
| Ericsson | Antonino Orsino (antonino.orsino@ericsson.com) |
| MediaTek | Li-Chuan Tseng (li-chuan.tseng@mediatek.com) |
| OPPO | Xin You (youxin@oppo.com) |
| Xiaomi | Yumin Wu (wuyumin@xiaomi.com) |
| NEC | Hisashi Futaki (hisashi.futaki @ nec.com) |
| ZTE | Mengjie Zhang (zhang.mengjie@zte.com.cn) |
| Panasonic | Quan Kuang (quan.kuang@eu.panasonic.com) |
| Huawei, HiSilicon | Yulong (shiyulong5@huawei.com) |
| Futurewei | Jialin Zou (jialinzou88@yahoo.com) |
| Samsung | Anil Agiwal (anilag@samsung.com) |
| Qualcomm | Ozcan Ozturk (oozturk@qti.qualcomm.com) |
| s | Xiaoxuan Tang (tangxiaoxuan@chinamobile.com) |
| CATT | Rui Zhou(zhourui@catt.cn) |
| ITRI | Jung Mao ([moumou3@itri.org.tw](mailto:moumou3@itri.org.tw)) |
| LGE | Siyoung Choi (see0.choi@lge.com) |

**Endorsed 38.300 CR procedure**

Followings are copied from the last meeting endorsed running CR R2-2302039.



**Figure x. Signaling procedure for LTM**

The procedure for LTM is as follows.

1. The UE sends a *MeasurementReport* message to the gNB. The gNB decides to use LTM and initiates candidate cell(s) preparation.

2. The gNB transmits an *RRCReconfiguration* message to the UE including the LTM candidate cell configurations of one or multiple candidate cells.

3. The UE stores the LTM candidate cell configurations and transmits a *RRCReconfigurationComplete* message to the gNB.

4a/4b. The UE may perform DL synchronization and TA acquisition with candidate cell(s) before receiving the cell switch command.

Editor’s note: DL synchronization for candidate cell(s) before cell switch command is supported, at least based on SSB. FFS necessary mechanism.

Editor’s note: TA acquisition of candidate cell(s) before LTM cell switch command is supported, at least based on PDCCH ordered RACH, where the PDCCH order is only triggered by source cell. FFS detailed mechanism.

5. The UE performs L1 measurements on the configured candidate cell(s), and transmits lower-layer measurement reports to the gNB.

Editor’s note: FFS whether the lower-layer measurement reports are carried on L1 or MAC.

Editor’s note: The order of DL/UL sync (step 4a/4b) and L1 measurement (step 5) is not defined and subject to change.

6. The gNB decides to execute cell switch to a target cell, and transmits a MAC CE triggering cell switch by including the candidate configuration index of the target cell. The UE switches to the configuration of the target cell.

Editor’s note: FFS how beam indication is done.

7. The UE performs random access procedure towards the target cell, if cell switch needs to include performing random access procedure.

8. The UE indicates successful completion of the cell switch towards the target cell.

The UE can perform the steps 4-8 multiple times for subsequent LTM cell swith based on the configuration provided in step 2.

Editor’s note: FFS whether a uplink signal or message after the UE has switched to the target cell is used to indicate successful completion of the LTM cell switch.

# Discussion

**2.1 RRCReconfigurationComplete message transmission**

Several motivations was mentioned that UE should send the RRCReconfigurationComplete message to the target cell upon LTM execution:

* The agreed RRC modelling1 implies the corresponding RRCReconfigurationComplete message to the target cell is reasonable.
* The RRCReconfigurationComplete message to the target cell is useful to include the uplinkTXDirectCurrent, needForGaps, etc information as supported in legacy.
* It can be the UE arrival indication or LTM completion indication to the target cell.

**Question 1: do you agree the RRCReconfigurationComplete message is always sent at each LTM execution?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No?** | **Comments** |
| Apple | No | We do not think sending this every time is useful. Would like to keep the L2 based mechanism as is… UE can send an RRC message if needed (UE triggered if the need arises) |
| Ericsson | Yes | Since in the last meeting it was agreed to support the RRC model 1, sending the RRCReconfigurationComplete message is a natural consequence.  Enhancements on this specific case are not needed, without considering the fact that modify the legacy L2 mechanism (RRCReconfiguration+RRCReconfigurationComplete) may have big implication from a specification point of view.  Since we already have a lot of our plate to discussion, we prefer to keep this simple and re-use he legacy procedure. |
| MediaTek | Yes | We prefer to have *RRCReconfigurationComplete* to indicate LTM completion |
| OPPO | Yes | We have agreed that UE arrival in the target cell need to be indicated, and as we agreed to provide LTM candidate cell configuration with RRCReconfiguration message, so it is straightforward to use RRCReconfigurationComplete as a response to the target cell. |
| Xiaomi | Yes | We think this is aligned with the RRC model agreed by RAN2. |
| NEC | Yes | This would be the natural consequence from selecting the RRC modelling 1. Having said that, the UE arrival indication can be discussed separately. For example, from CU perspective, this can be the UE arrival indication, while from target DU perspective, earlier signaling may be used as the UE arrival indication. This can be discussed separately from this question. |
| vivo | Yes | As the Cell Group configuration to be applied in the target is configured with RRC, it is straightforward that UE completes the handover procedure by sending RRCReconfigurationComplete message to target cell. |
| ZTE | Yes | Considering that RRC model 1 (i.e. RRCReconfiguration message) for LTM candidate cell configuration was agreed in the last meeting, it’s natural to response the RRCReconfigurationComplete message to the target cell. |
| Panasonic | Yes | We agree the motivations listed by the Moderator above |
| Huawei, HiSilicon | Yes | This is the simple solution. |
| Futurewei | Yes | This should be a baseline solution. |
| Samsung | No | Same view as apple. For RACH based LTM this seems unnecessary. Based on Q2b and Q2d, RACH towards target cell is enough. During RA procedure C-RNTI MAC CE anyways will be included in Msg3/MsgA. |
| Qualcomm | Yes | Agree with the rapporteur |
| CMCC | Comments | RRCReconfigurationComplete could be the baseline solution. Share the same view with Apple, L2 based mechanism may not be precluded to further reduce the latency. |
| CATT | Yes | Due to the LTM candidate configuration is RRCReconfiguration message, it seem natural to response with the RRCReconfigurationComplete message when UE apply the message. |
| ITRI | Yes | This will be a simple solution. |
| LGE | Yes | It is straightforward that UE transmits the RRCReconfigurationComplete message at each LTM execution. |

**2.2 LTM completion determination**

### A: NW side to determine the UE arrival

Several companies want to clarify how the target cell NW side determines the UE arrival/LTM completion during LTM execution.

Please input your understanding on this LTM completion issue.

**Question 2a: do you agree, in RACH-based LTM, the target cell is aware of the UE’s arrival based on the reception of Msg1 in CFRA and on the reception of Msg3 in CBRA, like the legacy HO?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No?** | **Comments** |
| Apple | Yes |  |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| NEC | Yes | This is from targe DU perspective. |
| vivo | Yes with comments | In this meeting, RAN2 confirms shared preamble resource among multiple UEs is beneficial.  We are not sure whether the shared preamble solution can be applied to CFRA during LTM cell switch procedure. If yes, the target cell maybe can not be aware of the UE’s arrival based on the reception of Msg1 in CFRA, as the preamble is shared by multiple UEs.  We could wait for more progress on this one.  [Rapp]: Isn’t that one considered as CBRA? |
| ZTE | Yes |  |
| Panasonic | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Futurewei | Yes |  |
| Samsung | Yes | Regarding comments from Vivo, a set of RA preambles is provided by target DU to source DU and source DU uses these resources to initiate CFRA for early TA, however source DU does not use same RA preamble at the same time for RA procedure for two different UEs at the same time. The advantage if getting the set of RA preambles from target DU is that source DU does not have to ask source DU every time it initiates RA for early TA. Also target DU does use preamble from this set for CBRA. |
| Qualcomm | Yes |  |
| CMCC | Yes |  |
| CATT | Yes |  |
| ITRI | Yes |  |
| LGE | Yes |  |

**Question 2b: do you agree, in RACH-less LTM, the target cell is aware of the UE’s arrival based on reception of the first UL transmission from this UE?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No?** | **Comments** |
| Apple | Yes | For eg with MAC CE with pre-given identifier like C-RNTI |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| NEC | Yes | This is also from targe DU perspective. |
| vivo | Yes |  |
| ZTE | Yes |  |
| Panasonic | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Futurewei | Yes |  |
| Samsung | Yes |  |
| Qualcomm | Yes |  |
| CMCC | Yes |  |
| CATT | Yes |  |
| ITRI | Yes |  |
| LGE | Yes |  |

Then the following question would be the content of this first UL MAC PDU/transmission in RACH-less LTM.

The baseline can always be that any buffered DRB/SRB data can be sent by the first UL data based on LCP procedure. So, if the *ReconfigurationComplete* is to be sent in Question 1, there is no need to introduce any new explicitly manner (e.g. new MAC CE). Also, any other legacy pending MAC CEs or triggered SR can be sent upon LTM execution to target cell.

**Question 2c: In RACH-less LTM, what’s your understanding on the content of the first UL MAC PDU/transmission to indicate UE arrival? Do we need to introduce any new signaling to indicate UE arrival?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No** on the need of any new signaling**?** | **Comments** (please clarify your views on the content of the first UL transmission in RACH-less LTM) |
| Apple | Yes | For eg with MAC CE with pre-given identifier like C-RNTI |
| Ericsson | No | For RACH-less LTM, our understanding is the following:   * The UE has a grant provided in the LTM candidate cell configuration and thus it may already do the first UL transmission after receiving the LTM cell switch command. * The UE does not have a grant provided in the LTM candidate cell configuration. In this case the UE will listen to PDCCH in order to receive a grant from the network. After this the UE will do the first UL transmission.   In both cases the first UL tranmission will be the RRCReconfigurationComplete message and thus there is no need to specify any new signalling. |
| MediaTek | No | For RACH-less LTM, the grant for first UL transmission in target can be provided (1) in LTM candidate configuration, or (2) PDCCH monitored by UE  It is possible to have first UL transmission as UL data, but UE may not have UL data, and it may be hard to decide the grant size. Therefore, we prefer a simple, unified solution to always have *RRCReconfigurationComplete* as the first UL transmission |
| OPPO | No | RRCReconfigurationComplete message can be used for both RACH-less and RACH-based LTM. |
| Xiaomi | No | The *RRCReconfigurationComplete* message is sufficient. |
| NEC | No | C-RNTI MAC CE (as triggered as today) can be reused. |
| vivo | No | As we have commented in Q1, UE needs to send RRCReconfigurationComplete message at each LTM execution. Hence the first UL MAC PDU/transmission could include the RRCReconfigurationComplete message. |
| ZTE | No | If it’s agreed to always send RRCReconfigurationComplete message at each LTM execution, it’s simple to send the RRCReconfigurationComplete message in the first UL transmission for both RACH-based and RACH-less LTM. |
| Panasonic | No | *RRCReconfigurationComplete* can be used as the first UL transmission. |
| Huawei, HiSilicon | No | *RRCReconfigurationComplete* can be the baseline. |
| Futurewei | No | Agree with the above comments from Ericsson and MTK. |
| Samsung | No | No new signaling is needed. UL grant is dedicated to UE, so UE can just generate the UL MAC PDU as per current LCP procedure and transmit it. |
| Qualcomm | No | The first UL transmission may be an SR, an SRS, or a MAC PDU. The MAC PDU is an *RRCReconfigurationComplete* message. The target cell identifies the UE based on the resource used for the first UL transmission. No extra UE identification is needed. |
| CMCC | No | Similar to the LTE RACH-less handover, UE could send the C-RNTI to the target in the first UL MAC PDU/transmission. Share the same view with NEC, MAC CE could be reused. |
| CATT | No | *RRCReconfigurationComplete* can be baseline. |
| ITRI | No | Using the *RRCReconfigurationComplete* as the first UL transmission to indicate UE arrival is sufficient. |
| LGE | No | We prefer to follow the principle of LTE RACH-less handover. That is, RRCReconfigurationComplete message is the first UL transmission for RACH-less LTM. |

### B: UE side to determine the LTM completion

It is also important to clarify the UE side behavior on how to determine the LTM successful completion, which may be related the handling of LTM timer.

**Question 2d: do you agree, for RACH-based LTM, the UE considers that LTM execution procedure is successfully completed when the RACH is successfully completed?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No?** | **Comments** |
| Apple | Yes |  |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| NEC | Yes |  |
| vivo | Yes |  |
| ZTE | Yes |  |
| Panasonic | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Futurewei | Yes |  |
| Samsung | Yes |  |
| Qualcomm | Yes |  |
| CMCC | Yes |  |
| CATT | Yes |  |
| ITRI | Yes |  |
| LGE | Yes |  |

**Question 2e: do you agree, for RACH-less LTM, the UE considers that LTM execution procedure is successfully complete when the UE determines the NW has successfully received its first UL data?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No?** | **Comments** |
| Apple | Yes |  |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| NEC | Yes |  |
| vivo | No | The LTE RACH-skip handover procedure could be reused, i.e UE considers that LTM execution procedure is successfully complete when it receives a C-RNT addressed PDCCH for a new transmission from the target cell.  [Rapp]: I see following description in TS 36.300 from LTE RACH-less  “When the RACH-less HO is configured, after the UE has received uplink grant, the UE sends the RRCConnectionReconfigurationComplete message (C-RNTI) to confirm the handover, along with an uplink Buffer Status Report, and/or UL data, whenever possible, to the target eNB. The target eNB verifies the C-RNTI sent in the RRCConnectionReconfigurationComplete message. The target eNB can now begin sending data to the UE. The handover procedure is completed for the UE when the UE receives the UE contention resolution identity MAC control element from the target eNB.” |
| ZTE | Yes |  |
| Panasonic | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Futurewei | Yes |  |
| Samsung | Yes | We can agree this as principle. How the UE determines that the NW has successfully received its first UL data, needs to be specified. |
| Qualcomm | Yes |  |
| CATT | Yes |  |
| ITRI | Yes |  |
| LGE | Yes |  |

In addition, in RACH-less LTM cell switch, companies have different proposals on how the UE determines the NW acknowledge of its first UL data. Please clarify your view on how the UE determine this successful reception by NW, e.g. C-RNTI addressed PDCCH, new DL MAC CE, etc.

**Question 2f: In RACH-less LTM cell switch, how the UE determines the successful reception of its first UL data by NW.**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Option?** | **Comments** |
| Apple | Several | NDI toggle for UL grant, DL MAC CE etc.. RAN2 can decide on one.. C-RNTI addressed PDCCH might not provide confirmation at the UE that NW has received successfully… |
| Ericsson | Reception of the RRC reconfiguration complete message | Upon an LTM cell switch the UE will send the RRCReconfigurationComplete message and this message is sent over RLC AM. In this case the UE can determine that this message has been received by the network. |
| MediaTek | Reception of the RRC reconfiguration complete message |  |
| OPPO | Explicit DL message | Reception of new UL transmission scheduling for the same HARQ process as the one used for first UL transmission can be an option, i.e., UE determines the first UL has been succesfully trasnsmited if the NDI is toggled.  While the reception of new transmission scheduling can not be guarantted, waiting for the schedulling of new transmisison may lead to latency on declaring a LTM completion, thus an explicit DL message is required, e.g., Contention Resolution MAC CE as in LTE RACH -less HO. |
| Xiaomi | Several | It seems that both RAN1 and RAN2 can have several different solutions. We may consider the LTE RACH-less solution as the baseline for the gNB confirmation. |
| NEC | C-RNTI addressed PDCCH | If the UE receives the C-RNTI addressed PDCCH, this should serve as an implicit confirmation to the UE. Then the UE should assume that its first UL data has been received successfully by NW.  Also, agree with Ericsson on RLC acknowledgement for RRC reconfiguration complete, which is considered as (final) confirmation. |
| vivo | N/A | See our comment in Question 2e.  There is no need for UE to determine the successful reception of its first UL data by NW, as UE considers that LTM execution procedure is successfully complete when it receives a C-RNT addressed PDCCH for a new transmission from the target cell. |
| ZTE | C-RNTI addressed PDCCH | The reception of the DCI addressed to the new C-RNTI for the new transmission from the target cell can be taken as the implicit confirmation of the successful first UL transmission. |
| Panasonic | Reception of the RRC reconfiguration complete message |  |
| Futurewei | Reception of acknowledgement from the target cell | Regardless the initial UE transmission is scheduled by configured grant or by the target cell PDCCH, a low layer acknowledgement from the target cell is the best for minimized the delay. For example, if initial UL transmission is a RRC reconfiguration complete message, the target cell should acknowledge the successful reception of it at MAC layer. |
| Huawei, HiSilicon | Maybe C-RNTI addressed PDCCH  No strong view | Following are mentioned by above comments:  - Option 1: RLC ACK of RRC reconfiguration complete: please note this completion determination may be used to stop the T304 timer. Then, RLC ACK delay may casue T304 epxire with false detection of LTM failure.  - Option 2: PDCCH for new UL transmission: There may be the case UE without any new data to transmit/schedule, which cause some delay also. Even when there is no more new data, NW can always schedule UE for transmitting padding.  - Option 2a: Any C-RNTI addressed PDCCH: consider as variant of option 2.  - Option 3: DL Contention Resolution MAC CE: follwow LTE solution. It requires NW always transmit a new MAC CE. |
| Samsung | PDCCH addressed to C-RNTI |  |
| Qualcomm | Reception of *RRCReconfigurationComplete* message | This is the better option if we want to keep the LTM success and failure in RRC. |
| CMCC | C-RNTI in DL message | Share the similar view with Apple, C-RNTI addressed PDCCH may be inefficient. An explicit indication is needed. In LTE RACH-less HO, C-RNTI could be conveyed in the DL Contention Resolution MAC CE. Similarly, C-RNTI could be sent to the UE in DL message (e.g., MAC CE or DCI etc.) to complete the LTM. |
| CATT | Reuse LTE rach-less mechanism | From the MAC side, the reception of the UE Contention Resolution Identity MAC control element  - if the MAC entity is configured with *rach-Skip* or *rach-SkipSCG* and a UE Contention Resolution Identity MAC control element for this TTI has been received on the PDSCH indicated by the PDCCH of the SpCell addressed to the C-RNTI:  - indicate to upper layer the successful reception of a PDCCH transmission addressed to the C-RNTI.  From the RRC side, the reception of the indication of successful reception of a PDCCH transmission addressed to C-RNTI from the MAC  1> if MAC indicates the successful reception of a PDCCH transmission addressed to C-RNTI and if *rach-Skip* is configured:  2> stop timer T304; |
| ITRI | Reception of the RRC reconfiguration complete message |  |
| LGE | PDCCH addressed to C-RNTI | We prefer to follow the principle of LTE RACH-less handover.  In legacy LTE RACH-less handover, the UE transmits the RRCConnectionReconfigurationComplete message to the target cell when the RRCConnectionReconfiguration message including mobilityControlInfo and rach-Skip is received. Then, the UE stops T304 upon the successful reception of a PDCCH addressed to C-RNTI. |

**2.3 LTM failure handling**

### A: LTM supervisor timer

It seems companies have quite similar view on the T304-like timer for LTM.

**Question 3a: Do you agree with following behaviors of LTM supervisor timer?**

* **1: The UE starts the LTM supervisor timer, upon reception of the LTM cell switch MAC CE;**
* **2: The UE stops the LTM supervisor timer, upon successful completion of LTM cell switch;**
* **3: If the LTM supervisor timer expires, the UE considers LTM failure and initiates RRC re-establishment.**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No?** | **Comments** |
| Apple | Yes | Agree to all 3 |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| NEC | Yes with comment | Agree to 1 and 2. For 3, this is baseline and then Q3c should be discussed. |
| vivo | Yes |  |
| ZTE | Partially yes | Agree 1 and 2  For 3, we agree that the UE considers LTM failure if the the LTM supervisor timer expires. But whether to trigger RRC re-establishment can be further discussed.  Currently, RRC re-establishment procedure, which includes cell re-selection, shall cause relative long data interruption. So it is not preferred especially considering that LTM may be triggered more frequently than the legacy L3 HO. A new recovery procedure can be considered to use other pre-configured candidate cell configurations for fast recovery. |
| Panasonic | Yes | All 3 are reasonable. |
| Huawei, HiSilicon | Yes |  |
| Futurewei | Yes |  |
| Samsung | Yes |  |
| Qualcomm | Yes for 1,2 | For 3, whether to do re-establishment is based on Q3c |
| CMCC | Yes |  |
| CATT | Yes |  |
| ITRI | Yes |  |
| LGE | Yes |  |

**Question 3b: Do you think the LTM supervisor timer is RRC layer timer or MAC layer timer?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **RRC or MAC?** | **Comments** |
| Apple | MAC | RRC might not even be aware of the LTM cell switch MAC CE. |
| Ericsson | RRC | Our preference would be to have an RRC timer as a MAC timer may implicate a lot of cross-coordination between the MAC and RRC layers.  Further, when the LTM MAC CE command is received the MAC layer needs to indicate anyway this to the RRC layer, so the RRC is well aware on when a cell switch command is received.  In addition to this, for RACH-less case since the UE will need to send the RRCReconfigurationComplete message the RRC layer is already aware of when the timer needs to be stopped. |
| MediaTek | RRC | RRC anyway needs to informed of the LTM command, since UE performs RRC reconfiguration |
| OPPO | RRC |  |
| Xiaomi | RRC |  |
| NEC | RRC | As it would be good to have common behaviour for intra-DU and inter-DU LTM, RRC is more suitable which works with full MAC reset as well. |
| vivo | RRC | As mentioned by Ericsson, RRC is well aware on when a cell switch command is received. And the RRC re-establishment will be triggered by RRC if the LTM cell switch fails, RRC layer anyway needs to be informed. Besides, there is already an RRC timer for cell switch in legacy, it makes sense to reuse the existing timer. Otherwise, more interaction between MAC and RRC layer is needed. |
| ZTE | RRC | Agree with Ericsson and MediaTek. Anyway RRC needs to be informed about the reception of LTM cell switch command. |
| Panasonic | RRC |  |
| Huawei, HiSilicon | RRC |  |
| Futurewei | MAC | For fast LTM response based on the timer outcome and current RRC configuration. Inform RRC of the start and expiry of the timer could be performed in parallel but the LTM action should not be delayed by RRC. |
| Samsung | - | No strong view |
| Qualcomm | RRC | Assuming that LTM completion is based on successful transmission of RRC Reconfiguration Complete. If instead, LTM completion is based on reception of an UL grant, then a MAC timer is more reasonable. |
| CMCC | RRC | Anyway, this MAC CE carrying switch command is to trigger the appliance of RRC configuration. |
| CATT | - | It is straightforward to keep the timer in MAC due to it is started upon UE reception of the LTM MAC CE command.  But we can also accept it is started in RRC if majority prefer to.  But another issue we should discuss is how to inform the UE the timer value.  Considering the suitable timer value is related to whether RACH is performed upon LTM execution. If RACH is performed, the latency requirement is longer than RACH-less mechanism, longer timer value is preferred. However, NW couldn’t predict whether RACH/RACH-less LTEM is performed when NW pre-configure the LTM candidate configuration. How to indicate the UE the suitable timer value should be discussed. |
| ITRI | RRC |  |
| LGE | RRC | Since UE applies the RRC configuration of candidate cell upon receiving a cell switch command, RRC always aware of receiving the cell switch command. |

### B: LTM execution in failure case

It is also proposed to reuse the CHO like solution to handle the LTM failure case.

**Question 3c: Do you agree that, at RLF or LTM execution failure, if the UE performs cell selection and the selected cell is an LTM candidate cell, the UE can perform LTM execution to the selected cell (like CHO)?**

|  |  |  |
| --- | --- | --- |
| **Companies** | **Yes or No?** | **Comments** |
| Apple | No | LTM execution can also be from a CFRA or RACH less, and other target LTM cells might be ready, or pro-visioned for this UE yet. |
| Ericsson | In principle yes, but | We think that the baseline should be for the UE to trigger the RRC re-establishment.  If we want to go beyond this, of course there are different ways for the UE to do a fast recovery but more discussions are needed and all the options needs to be evaluated.  Probably is too early to reach an agreement on this. |
| MediaTek | Yes, but | It would be really nice if we can introduce LTM recovery using another candidate. In fact, CHO candidate can be used for HO/CHO failure recovery. But we can consider RRC re-establishment as baseline, if not easy to agree on details of such LTM recovery. |
| OPPO | Agree | CHO-like way can be followed. |
| Xiaomi | Yes | We can reuse the CHO procedure. |
| NEC | Yes | This is useful approach as in CHO. Then, we think RAN2 can further discuss a bit more enhancement, where the UE selects one of LTM candidate cell for which the UE detects good quality and already has the TA via early sync with higher priority. |
| vivo | Yes, but | We agree that RRC re-establishment could be the baseline, and other enhanced method could be further studied. |
| ZTE | See comments | We think the UE should be able to use the pre-configured LTM candidate cell for fast failure recovery, but the cell selection could be based on L1 measurements (i.e. as the triggering criteria for LTM), instead of L3 measurements (e.g. the cell re-selection during RRC re-establishment). Thus it’s preferred to define a new LTM recovery procedure without triggering RRC re-establishment. |
| Panasonic | FFS | More discussion is needed. |
| Huawei, HiSilicon | Yes | Based on the comments, maybe the proposal can be formulated in the high-level intention, like:  **At RLF or LTM execution failure, RAN2 intend to support fast recovery to a candidate cell by LTM execution (similar handling like CHO can be the starting point).** |
| Futurewei | Yes, with comments | Source cell RLM should be continued. It should be similar to CHO if the connection with the source cell is failed before the target cell switch/access is successful.  If the connection with the source cell is not dropped yet but LTM is failed, report the failure of current LTM attempt and performs the measurement per current configuration, and wait of source cell further instruction. |
| Samsung | Yes |  |
| Qualcomm | Yes | We can have similar behavior to CHO recovery. If the selected cell is a candidate LTM cell, the UE can complete LTM. If the selected cell is a candidate but is not prepared for RACH-less, the UE can use RACH-based access. |
| CMCC | Yes | Similar to the CHO recovery, LTM recovery could further reduce the interruption time caused by failure. Agree with Ericsson, details could be further discussed for the subsequence LTM. |
| CATT | Yes | For this case, CBRA should be triggered to indicate the target cell the configuration is applied. |
| ITRI | Yes | The CHO-Recovery scheme could be used for LTM failure case. |
| LGE | Yes | It’d be beneficial to support fast recovery based on LTM candidate cells as in recovery based on CHO candidate cells. As other companies mentioned, further discussion may be necessary to analyze various ways of recovery. |

**2.4 Coexistence with L3 handover**

Followings are proposed on the co-existence between L3 handover and LTM:

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| **R2-2303549**  Proposal 8a: While configured with LTM candidate cells, the UE can also execute any L3 handover command sent by the network.  Proposal 8b: It is up to NW to avoid any issue due to the case when UE receives the LTM MAC CE and RRCReconfiguration message in the same MAC PDU.  **R2-2303869**  Proposal 4-1: Both LTM and L3 HO independently configured and triggered by each anchor point.  **R2-2302830**  Proposal 1a: RAN2 to discuss the first race condition between delivering an RRC message to a UE and triggering inter-DU LTM by the UE.  Proposal 1b: RAN2 to discuss the dilemma of whether the CU should retransmit a missed RRC message to the UE via the new serving DU for the first race condition.  Proposal 2a: RAN2 to discuss the second race condition between processing an RRC message received right before LTM is triggered and execution of inter-DU LTM.  Proposal 2b: RAN2 to discuss how the UE determines whether to apply or discard the RRC message for the second race condition. RAN2 to discuss how the Gnb and the UE would stay in sync on the right UE behavior. |

It is good to discuss/conclude whether RAN2 needs to handle/specify anything to handle the collision/co-existence/race conditions.

**Question 4: Do you agree (basically no RAN2 work):**

1. **While configured with LTM candidate cells, the UE can also execute any L3 handover command sent by the network.**
2. **It is up to the network to avoid any issue due to the case when UE receives the LTM MAC CE and RRCReconfiguration message (e.g. L3 HO cmd) in the same MAC PDU. Mainly RAN3 work to address this. No UE behavior impact.**

If you have different understanding, please clarify what RAN2 needs to specify.

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| **Companies** | **Yes or No?** | **Comments** |
| Apple | Yes | agree |
| Ericsson | Yes but | The race condition is not only limited to the case on the the LTM cell switch and L3 HO command are received within the same MAC PDU. Therefore, the point 2 is not enterely correct.  However, we believe that RAN3 needs to discuss this and RAN2 may simply follow their agreements. |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| NEC | Yes | For 1, maybe it’s better to say “.. the UE shall execute L3 handover if it is sent by the network” or something like this. |
| vivo | Yes | It is up to RAN3 to discuss how to address the race issue. |
| ZTE | Yes | Agree with Ercisson that there may be other race condition, e.g. the DU triggers the LTM execution during the L3 HO preparation initiated by the CU. But It can be up to RAN3 discussion. |
| Panasonic | Yes |  |
| Huawei, HiSilicon | Yes | Based on the comment from Ericsson and ZTE, the bullet 2 can be update as:  **2. It is up to the network to avoid any issue due to the race condition between LTM execution and RRC Reconfiguration (e.g. L3 HO cmd) as to the same UE. Mainly RAN3 work to address this. No UE behavior impact.** |
| Futurewei | Yes |  |
| Samsung | Yes |  |
| Qualcomm | Yes, but | We wonder whether L3 HO execution triggers the release of the LTM candidate cells by default, or whether this has to be explicitly released within the L3 HO command. |
| CMCC | Yes | Wait for RAN3’s decision. |
| CATT | Yes |  |
| ITRI | Yes |  |
| LGE | Yes | Wait for RAN3 work about this issue. |

**2.5 RAN3 LS about inter-DU coordination**

Following approaches are asked by RAN3:

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| RAN3 has discussed the following two approaches to support inter-DU LTM cell switch during execution.  **Approach 1**: the serving gNB-DU triggers the execution by transmitting LTM cell switch command to the UE and then informs the gNB-CU of the serving cell switch.  **Approach 2**: the serving gNB-DU first requests information from target DU before triggering LTM cell switch command to the UE.  RAN3 would like to get feedback from RAN2 about the above-mentioned approaches, and provide suggestion if there is any other possibility identified. |

Based on the contributions, it seems majority are fine to assume at least approach 1 or both approach 1+2 to be supported. Then, the discussion can focus on whether we need approach 2 or whether approach 2 is necessary.

The technical observations are list below from contributions:

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| **R2-2303549**  Observation 1: Any checking/confirmation with target gNB-DU about the candidate cell can be done in the LTM preparation phase, rather than in the later cell switch decision phase.  Proposal 1a: RAN2 confirm the LTM cell switch decision (i.e. when to switch and which cell to switch to) is made by the gNB-DU in the intra-DU case and by the source gNB-DU in the inter-DU case.  Proposal 1b: In the cell switch decision phase, avoid CU-DU interactions (e.g. requesting information from target DU) to determine the content in the LTM MAC CE at the time of sending the cell switch command.  **R2-2302507**  Proposal 1: For RACH-less LTM of inter-DU case, the serving gNB-DU is not required to request information (e.g., the one to be included in LTM cell switch command) from target DU immediately before triggering LTM cell switch command to the UE.  **R2-2302804**  Proposal 4: From RAN2 perspective, source DU could trigger inter-DU LTM without requiring the target DU, i.e. as the extra exchange between source and target DUs leads to longer handover latency which beats the motivation of introducing the LTM and high potential RLF rate.  **R2-2302829**  Proposal 6: Only information that may be requested by the serving DU from the target DU is that information a serving DU would need to determine the content of the LTM MAC CE.  Observation 3a: The serving DU determines which candidate configuration index to include in the LTM MAC CE based on cell info included in the L1 measurement report. The CU shall provide a mapping of cell info to configuration indices to the serving DU during LTM preparation.  Observation 3b: The serving DU determines which TCI state of the candidate cell to include in the LTM MAC CE based on beam info received in the L1 measurement report. The CU shall provide TCI state configuration of the candidate cell to the serving DU during LTM preparation.  Observation 3c: The candidate DU proactively forwards the TA value to the serving DU during early TA acquisition if RAR reception from the candidate cell is not configured for the UE.  Proposal 1: Reply to RAN3 the following:   * For Approach 1:   + Approach 1 is feasible from RAN2 perspective but requires the following:     - * The serving DU needs to be configured by the CU during LTM preparation phase with a mapping b/w the candidate cell indication in the UE’s L1 measurement report and the corresponding candidate configuration index.       * The serving DU needs to receive from the CU during LTM preparation phase the UE’s TCI state configuration of the candidate cell.       * For RACH-less LTM, the candidate DU should proactively send the TA value to the serving DU for the case that RAR reception from the candidate cell is not configured during early TA acquisition.   + RAN2 respectfully requests RAN3 to handle the signaling for the above requirements. * For Approach 2:   + RAN2 could not identify an example of information that needs to be actively requested by the serving DU from the candidate DU prior to the triggering of LTM execution.   + RAN2 assumes that the serving DU does not defer the triggering of LTM if urgency to trigger LTM is indicated by the UE’s L1 measurement report to avoid sending the UE to RLF.   **R2-2303751**  In conclusion, Approach 2 supports TA acquisition/update by PDCCH ordered RACH without RAR reception, whereas Approach 1 may not.  From above, we observe that a cell switch command transmission at S-DU without CU confirmation (i.e. Approach 1) can cause race conditions that may lead to initiation of the RRC connection reestablisment procedure or confusion of RRC message processing at both UE and network.  Proposal 2. RAN2 supports Approach 2, i.e., the serving gNB-DU first requests information from target DU before triggering LTM cell switch command to the UE.  **R2-2304102**  [Observation 3 In approach 1, the candidate DU needs to be prepared for the UE arriving in target cell already after LTM candidate cell configuration.](#_Toc131756984)  [Observation 4 If only approach 1 is supported, we need to put restrictions on which dynamic information that can be included into the LTM cell switch command, also for the intra-DU case.](#_Toc131756985)  [Observation 5 Approach 2 for execution enables the CU and candidate DU to reject the execution and avoids race conditions between LTM and RRC procedures such as L3 mobility.](#_Toc131756986)  [Observation 6 In approach 2 for execution (LTM triggering with target candidate DU involvement), just as in the intra-DU case, it is possible to include dynamic information in the LTM cell switch command.](#_Toc131756987)  [Observation 7 In approach 2 for execution, just as in the intra-DU case, the target DU is aware of that the UE is about to arrive at the time LTM cell switch is executed. This enables the candidate DU to allocate resources in the target cell later.](#_Toc131756988)  [Observation 8 When using approach 2 for execution, the latency before LTM cell switch is triggered is increased with two F1AP round trip procedure delays.](#_Toc131756989)  [Observation 9 If approach 2 is specified, also approach 1 can be used by a network implementation, given this is supported by F1AP.](#_Toc131756990)  **R2-2303425**  Observation 14: The interaction between source DU, CU and candidate DU before triggering LTM execution, is similar to the legacy L3 handover preparation, which will cause additional latency, e.g. about 40ms.  Observation 15: The coordination on pre-allocated resources between source DU and candidate DU can be performed during LTM preparation phase or/and early synchronization phase (for inter-DU early RACH), which is not necessarily before triggering LTM execution.  Proposal 8: RAN2 understands that the coordination between source DU and candidate DU can be performed during LTM preparation phase or/and early synchronization phase, but the inter-DU coordination during LTM execution phase is not required, i.e. no need to request information from target DU before triggering LTM cell switch command to the UE. |

Some clarification on the approaches:

Approach 1 does not exclude the coordination between source DU and target DU. For example, TA acquisition may requires some source DU and target DU coordination (e.g. target DU informs the TA value to source DU). But “requesting to target DU immediately before” before transmitting LTM MAC CE is not needed.

Some contributions mention the race conditions, which is under discussion in RAN3. But it is not clear why it requires target DU involvement (rather than only CU).

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| **Approach 1**: the serving gNB-DU triggers the execution by transmitting LTM cell switch command to the UE and then informs the gNB-CU of the serving cell switch.  **Approach 2**: the serving gNB-DU first requests information from target DU before triggering LTM cell switch command to the UE. |

**Question 5: Do you agree RAN2 reply RAN3 that:**

1. **Approach 1 is the current RAN2 assumption;**
2. **with the clarification on approach 1 that some coordination between source DU and target DU may be needed before the cell switch decision by source DU, but the requesting from target DU immediately before triggering LTM cell switch command is not necessary/intended;**
3. **RAN2 will let RAN3 know if approach 2 is also needed based on future progress in RAN2.**

If you prefer approach 1, please indicate what information needs to be informed.

If you prefer approach 2, please indicate what information has to be to be requested from target DU, and clarify the time about the wording “before” (long time before or immediately before).

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| **Companies** | **Yes or No?** | **Comments** (better clarify your argument/concern rather than just indicating Y/N) |
| Apple | Pls see details.  We prefer approach #2 | #1 No, target needs to be informed before cell switch.  #2 ok, as long as the target DU is informed sometime in the past and target DU has acknowledged on admitting the UE.  #3 Yes.  Target DU needs to provide RACH resources, TA value or some identifier (like C-RNTI) that is used as identification of the UE at L2 level after cell switch. Without these info, source DU cannot trigget switch.  All of the above are needed for intra-DU, but since the DU is the same, there is no need to put it as a requirement.  [Rapp]: please clarify your understanding on time about the wording “before” (long time before or immediately before) in approach 2. |
| Ericsson | No with comments | As clarified in our paper, both approach 1 and approach 2 have pros and cons.  **Table 1. Comparison between the two execution approaches**   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | Latency before triggering | Dynamic information in LTM cell switch command | CU/candidate DU can reject execution | Avoids race conditions | Reservation of radio resources in target cell | Complexity | | Approach 1 | Almost no latency | Limited | No | Limited | Early | Low | | Approach 2 | Short to medium | Yes | Yes | Yes | Late | Low |   While approach 1 can be considered the baseline, we don’t see why to prevent a network implementation to use approach 2.  Also, good to be aware that approach 1 comes with a series of limitation that we would need to capture in the spec. Simple example are the SCell activation or SCG activation that cannot be provided in the LTM MAC CE.  Further, we don’t see the latency to be a problem. E.g., in approach 2 the candidate DU may provide the grant , RACH resources and other configuration to the UE, and it will also be aware that a UE is coming so is already prepared for the LTM cell switch command. Also, the serving DU may have a more conservative approach and start to contact the candidate DU a bit earlier on when the UE needs to be switched. All in all the latency may be exactly the same.  We don’t see big impact from the RAN2 specification point of view to support both approaches and we can just leave to the network to use one of them.  From the UE point of view, approach 1 and approach 2 are exactly the same so we don’t get how approach 1 and approach 2 impact the connectivity interruption.  [Huawei]: The point is RAN3 is asking RAN2 to decide by considering e.g. the latency performance, rather than asking about the feasibility.  If approach2 means the source DU cell switch trigger has to be hold, until the requesting/feedback is done via the up to 10ms F1AP delay, immediate before the need of switch, it may cause HO failure due to the delay. Of course, it has UE performance impact/difference. |
| MediaTek | Both acceptable | We may have Approach 1 as baseline. However, Approach 2 is also possible network implementation. From UE perspective, UE does not know what network really does. |
| OPPO |  | Agree with Ericsson.  From UE perspective, the two approaches are same. We prefer to leave it to NW for the approach selection. |
| Xiaomi | No strong view | We are open to both Option 1 and Option 2. However, if both options are chosen, we would prefer to have the common UE behaviors. |
| NEC | Yes | Approach 1 should be confirmed as the current assumption at first, because the target/intention of the LTM is extremely lower latency in cell switch. If some network ignaling is necessary upon the source cell decides to trigger the LTM, it may not give any latency reduction.  In Approach 1, the information to be sent from the source DU to the CU is the target information (e.g. PCI or LTM candidate ID).  For the point 3 on Approach 2, it is fine to add this, if other companies want. |
| Vivo | Yes | Since approach 1 provides less handover latency than apporach2, Approach 1 should be agreed as the baseline, and target DU could be informed by CU after source DU sends the LTM cell switch command.  As summarized by Rapporteur, before LTM, target DU needs to inform source DU about the TA value in target cell if early TA acquisition is applied. |
| ZTE | Yes | Approach 1 is preferred to avoid the LTM triggering latency caused by inter-DU interaction immediately before sending cell switch command.  In Approach 1, the only information to be sent from the source DU to the CU is the target cell ID information, e.g. candidate cell configuration index.  Whether approach 2 is required depends on which dynamic information shall be included in the LTM cell switch command. Currently, the cell switch command can include the candidate configuration index, beam indication and TA value (for early RACH without RAR). The candidate configuration index and beam indication are decided by the source DU according to L1 measurement report, so no need to coordinate with the target DU before sending cell switch command. The TA value (for early RACH without RAR) can also be achieved from the candidate DU during early sync phase. Thus, currently there is no need to interact with the target DU immediately before sending cell switch command to the UE.  If RAN2 decides to include more information into the cell switch command, e.g. BWP ID, Scell activation/deactivation, then we can further consider approach 2. |
| Panasonic | Both | Share views with Ericsson. |
| Futurewei | Agree | We prefer approach 1 since minimizing latency is the important factor to be considered for LTM. In inter-DU scenarios, negotiation between the source and target DU via backhaul and CU will introduce a lot of latency and will defeat the purpose of LTM. The motivation to have LTM is to let the RRC performs the negotiation first at the preparation phase, then cell switch execution is performed at low layer without the need of source/target negotiation. |
| Huawei, HiSilicon | Yes | Bullet 3 is not saying approach 2 is not feasible. It just saying whether approach 2 is necessary needs more further discussion in RAN2. RAN3 should not rush into to define the F1AP procedure for approach 2.  Again, RAN3 is not asking for the feasibility. RAN3 see the difficulty on the down-selection and then asked RAN2 to analyses on the requirement. |
| Samsung | - | Approach 2 is beneficial to obtain dynamic information such as CFRA resource, BWP ID(s), TA etc. |
| Qualcomm | Yes | Approach 2 implies that only after the LTM execution decision has been made, the source DU coordinates with the target DU before triggering LTM. **This immediate coordination may defer LTM triggering and thus risks that the source link degrades or even the UE goes to RLF**.  We are fine with coordination during the LTM preparation phase.  To support Approach 1, the following is needed (copied from our paper):   * The serving DU needs to be configured by the CU during LTM preparation phase with a mapping b/w the candidate cell indication in the UE’s L1 measurement report and the corresponding candidate configuration index. * The serving DU needs to receive from the CU during LTM preparation phase the UE’s TCI state configuration of the candidate cell.   For RACH-less LTM, the candidate DU should proactively send the TA value to the serving DU for the case that RAR reception from the candidate cell is not configured during early TA acquisition. |
| CMCC | Yes | Approach 1 could be the baseline. For the Approach 2, we think NW should ensure that this inter-node negotiation is triggered before the L1 measurement meets the condition for LTM. If so, this is also relevant to the L1 measurement report mechanism discussed in RAN1. If the negotiation is triggered upon the LTM condition, the latency caused by the negotiation needs to be considered. |
| CATT | Yes | Only support Approach 1. Source DU could inform the target DU the LTM execution, the TCI state ID the UE will apply.  Approach 2 will cause extra delay to LTM. And Approach 2 is not necessary as all the information (e.g. TCI state, TA value) to be included in the LTM cell switch command can be ready at source DU side when the LTM triggers |
| ITRI | Both | We share the same views with MediaTek. |
| LGE | Prefer Approach 2 | Approach 1 may not support PDCCH ordered RACH without RAR in Early TA phase because TA of candidate cell may not arrive in source DU from target DU before the cell switch command. Further, the race condition presented in Section 2.4 can occur with Approach 1. On the other hand, we don’t see blocking issues from adopting Approach 2. |

**2.6 Open issues collection for LTM procedure**

This question is to collect if there is **any other critical open issue** on the **LTM procedure**, in addition to the previous mentioned questions.

Any suggestion to update the procedural descriptions in 38.300 running CR is also welcome, **in additional to the above questions** (which may supposed to be somehow implemented in the stage2 description once agreed).

**Question 6: Any suggestion on any additional open issue for the LTM procedure:**

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| **Companies** | **If any, please clarify the suggested the open issue(s), which is not covered in previous sections, for LTM procedure.** |
| Apple | Handling LTM switch failure and link failure from the perspective of PDCP, if the target cell UE select is also a candidate LTM cell. |
| Xiaomi | In paper “R2-2302731 Security impacts of inter gNB-DU LTM Rakuten Symphony”, it seems that “Inter gNB-DU LTM HO with intra gNB gNB-CU-UP relocation” is also valid from RAN3 perspective. However, this may have the security issue requires lots of works and coordination amongst RAN2/RAN3/SA3. We think this scenario should be excluded in this Release, and can be discussed together while supporting inter-CU LTM. We can inform RAN3 about this if time allows us to do so in this RAN2 meeting.  [Rapp] See RAN2#119bis agreement “No security update support in Rel-18 with L1/L2 based mobility.” It means **LTM is not used when the cell switch requiring security update.** Please companies check if this is clear enough for the issue mentioned above. |
| CMCC | We have agreed that “ ICBM is one scenario considered for L1L2 mobility…”. We also need to specify if the UE could LTM to the cell which it has already ICBM in, that is, after ICBM, NW may switch the UE to the cell which the current serving beam belongs to. As far as we concerned, the spec. impact is limited (TCI state is not mandatory in the switch command) and the ping pong rate could be reduced. |
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# Conclusion and proposals

Based on the above summary, following proposals are given.

**Potential agreement for LTM procedure**

**TBD**

**Proposed resolution for RAN3 LS**

**TBD**

**Open Issues for LTM procedure**

**TBD**

**Potential updates to procedural descriptions in 38.300 running CR**

**TBD**

# Reference

1. [R2-2302458](file:///D:\Tdoc%20review\RAN2%23121bis\word\R2-2302458_R3-230889.docx) LS on Approaches during execution for inter-DU LTM (R3-230889; contact: Ericsson) RAN3 LS in
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10. R2-2303650 LTM stage-2 design models Lenovo
11. [R2-2303751](file:///D:\Tdoc%20review\RAN2%23121bis\word\R2-2303751.docx) Remaining issues of LTM execution procedure LG Electronics
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14. [R2-2303535](file:///D:\Tdoc%20review\RAN2%23121bis\word\R2-2303535%3fConsiderations%20on%20failure%20handling.doc) Considerations on failure handling CMCC