

3GPP TSG RAN#102

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Views on Rel-19 Mobility enhancements (RAN2-led)

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Inter-CU LTM

Scenario extension

- In Rel-18, LTM (L1/L2 Triggered Mobility) is specified to reduce the interruption time for cell switch with the following mechanisms
 - Pre-configure UE with configurations of candidate cells before cell switch
 - Early TA acquisition before cell switch and inclusion of the TA value in cell switch command
 - L1/2 based measurement, reporting, and cell switch
- However, LTM has only focused on intra-CU mobility scenario in Rel-18
 - For inter-CU mobility, legacy L3 handover has to be performed
 - Consistent performance on data interruption is expected for both intra-CU and inter-CU mobility scenario
- Preconfigured UE dedicated resource cause huge resource wastage in LTM candidate cell
 - In Rel-18, UE may be pre-configured with dedicated CFRA and/or CG resource to access the LTM candidate cells
 - In Intra-CU LTM scenario, a gNB can inform a candidate cell by implementation to reserve the dedicated resource just before the candidate cell is changed as LTM target cell. Hence, the dedicated resource reservation will not cause resource wastage
 - In Inter-CU LTM scenario, serving cell and candidate cell are served by different gNBs. As the candidate cell can not know when a UE will perform LTM, it has to reserve the dedicated resource since it is prepared as LTM candidate. It leads to huge resource wastage in LTM candidate cells

- Potential enhancements for inter-CU LTM:
 - Security anchor relocation
 - Corresponding Xn signalling, e.g. to exchange the configuration of candidate cells
 - Shared CFRA and CG resource can be reserved by candidate cell(s) for multiple UEs instead of single UE
 - i.e. the serving cell allocates the resource to the UE for which LTM is triggered

Conditional LTM

HO robustness enh.

- Conditional reconfiguration is specified to provide robust cell switch of PCell and/or PSCell
 - Pre-configure UE with configurations of candidate cells before cell switch
 - Cell switch is triggered when UE determines the pre-configured execution condition is fulfilled
 - Fulfillment of execution condition is determined based on L3 measurement
 - Robust gain obtained via skipping measurement reporting and cell switch command
- Conditional LTM can be considered to improve robustness

- Potential enhancements for conditional LTM:
 - L1 measurement based execution condition
 - Corresponding procedure enhancement, e.g. early TA acquisition with UE based TA maintain

LTM enhancement

Data loss improvement

- Rel-18 LTM may cause severe data loss for RLC UM traffic
 - HARQ buffer flush and data loss of RLC UM traffic occurs when MAC reset is performed during LTM
 - LTM occurs more frequently than L3 handover since the L1 signal quality changes quickly
 - QoS of some traffic with stringent Packet Error Rate, e.g. Conversational Video(10^{-3}), can not be met with LTM
 - RLM AM may not be fit for some traffic with stringent latency requirement
- In order to improve the LTM performance and to extend its applicability, data loss improvement could be considered, e.g. not reset MAC for some scenarios

- Potential enhancements for data loss for RLC UM during LTM
 - Mechanisms to enable HARQ continuation, e.g. HARQ entity mapping between source and target cells
 - Continuation for some MAC timer/status, e.g. TAT, Bj value

LTM enhancement

Security for LTM cell switch command

- Rel-18 LTM have security issue for LTM cell switch command
 - Cell Switch Command MAC CE, which is used to trigger LTM, is not protected
 - An attacker can trigger UE to execute LTM by generating a fake Cell Switch Command easily
 - fake Cell Switch Command will cause big impact to UE and network
 - If a fake Cell Switch Command including a invalid target id is received, the UE behavior has not been specified and can not be unexpected
 - If a fake Cell Switch Command including a valid target id is received, the UE will handover to the candidate cell indicated by the attacker. It may cause performance degradation in both UE and network
- In order to deploy LTM more widely, some mechanisms to protect against such attacks must be introduced

- Potential enhancements on security for LTM cell switch command
 - Enable the UE to identify which handover commands are fake
 - Specify UE behavior upon the reception of a fake LTM cell switch command

Inter-cell CSI-RS/SRS

HO robustness enh.

- In Rel-17 ICBM, CSI-RS based beam measurement, TRS tracking and CSI measurement for candidate cell(s) is supported by setting the QCL source RS associated to cell(s) with additional PCI(s).
- While in Rel-18 LTM, only SSB-based L1-RSRP measurement and reporting for candidate cell(s) is allowed before LTM.
 - When UE accesses to the target cell, the data transmission can only be performed based on the coarse sync and spatial information leading to conservative scheduling before the procedure of CSI-RS based BM, TRS tracking and CSI measurement and reporting is completed.
- To further enhance system performance with LTM, CSI-RS based BM, TRS tracking and CSI measurement for candidate cell(s) performed before LTM shall be supported in Rel-19

- Potential enhancements for CSI based BM, TRS tracking, CSI measurement for candidate cell(s) before LTM
 - Early configurations, measurements and reporting for candidate cell(s) at least for intra-frequency scenario
 - Design measurement and reporting mechanism with low overhead and complexity including report content and container

- In Rel-18, LTM is performed based on L1 measurement on DL RS and suffers from:
 - Signaling overhead caused by delivering RS configurations of multiple candidate cells to UE and Frequent L1/L2 measurement reporting
 - Latency led by serial measurement across candidate spectrum frequencies with measurement gap and measurement reporting
- UL signaling has already been introduced for positioning:
 - Measurement on UL signaling will be used for positioning
 - Meanwhile, detailed design for UL SRS, e.g. power control, TA, have been already specified
- UL measurement based LTM could be considered, in order to:
 - Reduce signalling overhead and UE complexity especially for inter-freq. case
 - Improve measurement and reporting latency

- Potential enhancements for UL measurement based LTM:
 - Support configuration of UL signal (e.g. SRS) for candidate cell(s)
 - Procedure to exchange between gNBs on the configuration of UL signal and measurement results

LTM R18 Leftover

RRM aspects in RAN4

Following RRM leftover from R18 LTM can be considered in Rel-19:

- Low-layer (L1/L2) report of L3 measurement results:
 - In Rel-18, RAN4 concluded that UE can optionally support to report L3 measurement results in L1 report, and agreed no impact to RAN1/RAN2 design.
 - In order to support reporting L3 measurement results in L1/L2 report, some necessary signaling for report and reporting mechanism perspective should be defined.
- RRM requirements for SpCell switch with direct SCell activation.
- L1 measurement requirements enhancements with NCSG/NeedforGap.
 - Intra-f/inter-f L1 measurement requirements with NCSG.
 - Intra-f/inter-f L1 measurement requirements with NeedforGap
- LTM with NCD-SSB
 - L1 measurement requirements based on NCD-SSB
 - Cell switch delay requirements based on NCD-SSB
 - TCI pre-activation and early TA managements based on NCD-SSB

Conclusions

Potential WID scope for Rel-19 mobility enhancements

- **Proposal: Mobility enhancement is introduced as a Rel-19 RAN2-led WI.**
 - The detailed scope is listed as below.
 - The corresponding TU assignment per meeting is: RAN2[2TU], RAN1[1TU], RAN3[1TU], RAN4 RRM[1TU]

- Specify support for inter-CU LTM [RAN2, RAN1, RAN3]:
 - Security anchor relocation
 - Corresponding Xn signalling, e.g. to exchange the configuration of candidate cells
 - Shared CFRA and CG resource can be reserved by candidate cell(s) for multiple UEs instead of single UE
- Specify support for conditional LTM [RAN2, RAN3]:
 - L1 measurement based execution condition
 - Corresponding procedure enhancement, e.g. early TA acquisition with UE based TA maintain
- Specify enhancements for data loss for RLC UM during LTM [RAN2]
 - Mechanisms to enable HARQ continuation, e.g. HARQ entity mapping between source and target cells
 - Continuation for some MAC timer/status, e.g. TAT, Bj value
- Specify enhancements on security for LTM cell switch command [RAN2, RAN3]
 - Enable the UE to identify which handover commands are fake
 - Specify UE behavior upon the reception of a fake LTM cell switch command

- Specify enhancements for CSI based BM, TRS tracking, CSI measurement for candidate cell(s) before LTM [RAN1, RAN2]
 - Early configurations, measurements and reporting for candidate cell(s) at least for intra-frequency scenario
 - Design measurement and reporting mechanism with low overhead and complexity including report content and container
- Specify enhancements for UL measurement based LTM [RAN1, RAN2, RAN3]
 - Support configuration of UL signal (e.g. SRS) for candidate cell(s)
 - Procedure to exchange between gNBs on the configuration of UL signal and measurement results
- Specify corresponding RRM core requirements for LTM enhancements, as necessary [RAN4]
- Specify RRM leftover for LTM [RAN4]
 - Low-layer (L1/L2) report of L3 measurement results:
 - RRM requirements for SpCell switch with direct SCell activation.
 - L1 measurement requirements enhancements with NCSG/NeedforGap.
 - LTM with NCD-SSB

THANK YOU