**3GPP TSG-RAN WG2 Meeting #122 R2-230xxxx**

Incheon, Korea, May 22~ May 26, 2023

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
|  |
|  | **38.300** | **CR** | **Draft CR** | **rev** | **-** | **Current version:** | **17.4.0** |  |
|  |
| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **x** | Core Network |  |

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|  |
| ***Title:***  | 38.300 running CR for introduction of NR further mobility enhancements |
|  |  |
| ***Source to WG:*** | MediaTek Inc., vivo |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | NR\_mob\_enh2-Core |  | ***Date:*** | 2023-6 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** | This CR introduces the support of Rel-18 L1/L2-triggerd mobility (LTM). |
|  |  |
| ***Summary of change:*** | Introduction of LTM, including general description, and illustration for component of mobility latency. Agreements up to R2#122 are reflected in the draft so far.  |
|  |  |
| ***Consequences if not approved:*** | Rel-18 LTM are not supported in NR.  |
|  |  |
| ***Clauses affected:*** | TBD |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 38.331 CR TBDTS 38.321 CR TBD |
| ***affected:*** |  | **x** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **x** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

*Start of change*

3.1 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1], in TS 36.300 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1] and TS 36.300 [2].

5GC 5G Core Network

5GS 5G System

5QI 5G QoS Identifier

A-CSI Aperiodic CSI

AGC Automatic Gain Control

AKA Authentication and Key Agreement

AMBR Aggregate Maximum Bit Rate

AMC Adaptive Modulation and Coding

AMF Access and Mobility Management Function

ARP Allocation and Retention Priority

BA Bandwidth Adaptation

BCCH Broadcast Control Channel

BCH Broadcast Channel

BFD Beam Failure Detection

BH Backhaul

BL Bandwidth reduced Low complexity

BPSK Binary Phase Shift Keying

C-RNTI Cell RNTI

CAG Closed Access Group

CAPC Channel Access Priority Class

CBRA Contention Based Random Access

CCE Control Channel Element

CD-SSB Cell Defining SSB

CFR Common Frequency Resource

CFRA Contention Free Random Access

CG Configured Grant

CHO Conditional Handover

CIoT Cellular Internet of Things

CLI Cross Link interference

CMAS Commercial Mobile Alert Service

CORESET Control Resource Set

CP Cyclic Prefix

CPA Conditional PSCell Addition

CPC Conditional PSCell Change

DAG Directed Acyclic Graph

DAPS Dual Active Protocol Stack

DFT Discrete Fourier Transform

DCI Downlink Control Information

DCP DCI with CRC scrambled by PS-RNTI

DL-AoD Downlink Angle-of-Departure

DL-SCH Downlink Shared Channel

DL-TDOA Downlink Time Difference Of Arrival

DMRS Demodulation Reference Signal

DRX Discontinuous Reception

E-CID Enhanced Cell-ID (positioning method)

EHC Ethernet Header Compression

ePWS enhancements of Public Warning System

ETWS Earthquake and Tsunami Warning System

FS Feature Set

FSA ID Frequency Selection Area Identity

G-CS-RNTI Group Configured Scheduling RNTI

G-RNTI Group RNTI

GFBR Guaranteed Flow Bit Rate

GIN Group ID for Network selection

GNSS Global Navigation Satellite System

GSO Geosynchronous Orbit

H-SFN Hyper System Frame Number

HAPS High Altitude Platform Station

HRNN Human-Readable Network Name

IAB Integrated Access and Backhaul

IFRI Intra Frequency Reselection Indication

I-RNTI Inactive RNTI

INT-RNTI Interruption RNTI

KPAS Korean Public Alarm System

L2 Layer-2

L3 Layer-3

LDPC Low Density Parity Check

LEO Low Earth Orbit

LTM L1/L2-Triggered Mobility

MBS Multicast/Broadcast Services

MCE Measurement Collection Entity

MCCH MBS Control Channel

MDBV Maximum Data Burst Volume

MEO Medium Earth Orbit

MIB Master Information Block

MICO Mobile Initiated Connection Only

MFBR Maximum Flow Bit Rate

MMTEL Multimedia telephony

MNO Mobile Network Operator

MPE Maximum Permissible Exposure

MRB MBS Radio Bearer

MT Mobile Termination

MTCH MBS Traffic Channel

MTSI Multimedia Telephony Service for IMS

MU-MIMO Multi User MIMO

Multi-RTT Multi-Round Trip Time

MUSIM Multi-Universal Subscriber Identity Module

NB-IoT Narrow Band Internet of Things

NCD-SSB Non Cell Defining SSB

NCGI NR Cell Global Identifier

NCL Neighbour Cell List

NCR Neighbour Cell Relation

NCRT Neighbour Cell Relation Table

NGAP NG Application Protocol

NGSO Non-Geosynchronous Orbit

NID Network Identifier

NPN Non-Public Network

NR NR Radio Access

NSAG Network Slice AS Group

NTN Non-Terrestrial Network

P-MPR Power Management Maximum Power Reduction

P-RNTI Paging RNTI

PCH Paging Channel

PCI Physical Cell Identifier

PDC Propagation Delay Compensation

PDCCH Physical Downlink Control Channel

PDSCH Physical Downlink Shared Channel

PEI Paging Early Indication

PH Paging Hyperframe

PLMN Public Land Mobile Network

PNI-NPN Public Network Integrated NPN

PO Paging Occasion

PRACH Physical Random Access Channel

PRB Physical Resource Block

PRG Precoding Resource block Group

PRS Positioning Reference Signal

PS-RNTI Power Saving RNTI

PSS Primary Synchronisation Signal

PTM Point to Multipoint

PTP Point to Point

PTW Paging Time Window

PUCCH Physical Uplink Control Channel

PUSCH Physical Uplink Shared Channel

PWS Public Warning System

QAM Quadrature Amplitude Modulation

QFI QoS Flow ID

QMC QoE Measurement Collection

QoE Quality of Experience

QPSK Quadrature Phase Shift Keying

RA Random Access

RA-RNTI Random Access RNTI

RACH Random Access Channel

RANAC RAN-based Notification Area Code

REG Resource Element Group

RIM Remote Interference Management

RLM Radio Link Monitoring

RMSI Remaining Minimum SI

RNA RAN-based Notification Area

RNAU RAN-based Notification Area Update

RNTI Radio Network Temporary Identifier

RQA Reflective QoS Attribute

RQoS Reflective Quality of Service

RS Reference Signal

RSRP Reference Signal Received Power

RSRQ Reference Signal Received Quality

RSSI Received Signal Strength Indicator

RSTD Reference Signal Time Difference

RTT Round Trip Time

SCS SubCarrier Spacing

SD Slice Differentiator

SDAP Service Data Adaptation Protocol

SDT Small Data Transmission

SFI-RNTI Slot Format Indication RNTI

SHR Successful Handover Report

SIB System Information Block

SI-RNTI System Information RNTI

SLA Service Level Agreement

SMC Security Mode Command

SMF Session Management Function

SMTC SS/PBCH block Measurement Timing Configuration

S-NSSAI Single Network Slice Selection Assistance Information

SNPN Stand-alone Non-Public Network

SNPN ID Stand-alone Non-Public Network Identity

SPS Semi-Persistent Scheduling

SR Scheduling Request

SRAP Sidelink Relay Adaptation Protocol

SRS Sounding Reference Signal

SRVCC Single Radio Voice Call Continuity

SS Synchronization Signal

SSB SS/PBCH block

SSS Secondary Synchronisation Signal

SSSG Search Space Set Group

SST Slice/Service Type

SU-MIMO Single User MIMO

SUL Supplementary Uplink

TA Timing Advance

TB Transport Block

TCE Trace Collection Entity

TNL Transport Network Layer

TPC Transmit Power Control

TRP Transmit/Receive Point

TRS Tracking Reference Signal

U2N UE-to-Network

UCI Uplink Control Information

UDC Uplink Data Compression

UE-Slice-MBR UE Slice Maximum Bit Rate

UL-AoA Uplink Angles of Arrival

UL-RTOA Uplink Relative Time of Arrival

UL-SCH Uplink Shared Channel

UPF User Plane Function

URLLC Ultra-Reliable and Low Latency Communications

VR Virtual Reality

V2X Vehicle-to-Everything

Xn-C Xn-Control plane

Xn-U Xn-User plane

XnAP Xn Application Protocol

*Next change*

9.2.3.x LTM

9.2.3.x.1 General

LTM is a procedure in which a gNB receives L1 measurement reports from UEs, and on their basis the gNB changes UEs’ serving cell(s) by a cell switch command through a MAC CE, which indicates an LTM candidate cell configuration that the gNB previously prepared and provided to the UE through RRC signalling. Then cell switch is triggered, by selecting the indicated LTM candidate cell configuration as the target configuration by the gNB. An LTM candidate cell configuration can only be added, modified and released by network via RRC signaling. The LTM procedure can be used to reduce the mobility latency as described in Annex X.

LTM supports early TA acquisition, i.e. the UE performs TA acquisition of candidate cell(s) before receiving the cell switch command. Early TA acquisition of the candidate cell (s) can rely on CFRA [or UE-based TA measurement].

Editor’s note: RAN1 confirmed the working assumption to support UE-based TA measurement (UE derives TA based on Rx timing difference between current serving cell and candidate cell as well as TA value for the current serving cell) and sent LS to RAN4 to clarify the feasibility of supporting this mechanism.

LTM allowes the UE to skip random access procedure towards the target cell at cell switch (i.e. RACH-less LTM). The UE determines to trigger RACH-less LTM if a TA value is indicated in the cell switch command. For RACH-less LTM, both dynamic grant and configured grant can be used for the first Ul data transmission to the target cell. If dynamic grant is used, the UE monitors PDCCH for dynamic scheduling from the target cell upon LTM cell switch. If configured grant is used, the UE selects the configured grant occasion, which is associated with the beam indicated in the cell swith command.

Editor’s note: FFS if the following TA values can be given to the UE: value 0, value indicating that the UE shall apply the TA of the one source cell.

Editors’ note: FFS later whether some optimization should be applied e.g. for release.

Editor’s note: upon cell switch decision, R2 assumes that the source DU informs the target DU about the selected beam, so that the target DU can start scheduling dynamic UL grant.

The following principles apply to LTM:

- Each LTM candidate cell configuration can be provided as delta configuration on top of a reference configuration, which is used to form a complete candidate cell configuration. The reference configuration can be managed separately, and a UE stores the reference configuration as a separate configuration.

- When a complete candidate cell configuration is applied, it replaces the current UE configuration at the time of cell switch. Although the reconfiguration procedure makes replacement, it doesn’t necessarily reset MAC, RLC or PDCP layer.

- User plane is continued without reset (e.g. intra-DU LTM), if it is configured in RRC signaling, with the target to avoid data loss and the additional delay of data recovery.

- Security is not updated in LTM.

- Subsequent LTM between LTM candidate cell configurations (i.e., UE does not release other LTM candidate cell configurations after LTM is triggered) can be performed without RRC reconfiguration.

LTM supports both intra-gNB-DU and intra-gNB-CU inter-gNB-DU mobility. LTM also supports inter-frequency mobility, including mobility to inter-frequency cell that is not a current serving cell. The following scenarios are supported:

- PCell change in non-CA scenario,

- PCell change without SCell change in CA scenario,

- PCell change with SCell change(s) in CA scenario, including the following cases:

a) The target PCell/target SCell(s) is not a current serving cell (CA-to-CA scenario with PCell change)

b) The target PCell is a current SCell

c) The target SCell is the current PCell.

- Dual connectivity scenario, at least for the PSCell change without MN involvement case, i.e. intra-SN.

ICBM is also supported, but is not a prerequisite for using LTM.

Editor’s note: The design for intra-DU and inter-DU L1/L2-based mobility should share as much commonality as reasonable. FFS which aspects need to be different.

Editor’s note: FFS whether ASN.1 decoding and validity/compliance check of candidate cell configuration are performed upon reception of the candidate cells configuration, and if this needs to be specified.

Timer based LTM cell switch failure procedure is supported. The UE starts the LTM supervisor timer upon reception of the cell switch command and stops the timer upon successful completion of LTM cell switch. The UE considers LTM cell switch failure and initiates RRC connection re-establishment procedure if the timer expires. At RLF or LTM cell switch failure, fast recovery to a candidate cell by LTM execution is supported.

Editor’s note: The above procedure is for MCG, FFS on SCG switch case. FFS on the detailed procedure for fast recovery.

Provided with LTM candidate cell configuration(s), the UE can also execute any L3 handover command sent by the network. It could be up to the network to avoid any issue due to the race condition between LTM execution and L3 handover execution, e.g. avoiding sending LTM cell switch command and L3 handover command in the same TB.

9.2.3.x.2 C-plane handling

Cell switch trigger is conveyed in a MAC CE, which contains at least a candidate configuration index together with beam indication.

Editor’s note: FFS if it should be possible to perform SCell activation/deactivation (amongst SCells associated with the candidate configuration) simultaneously with the LTM triggering MAC CE.

UE may perform CBRA or CFRA at cell switch. UE may also skip random access procedure (and perform RACH-less LTM) if UE doesn’t need to acquire TA for the target cell during cell switch..

Editor’s note: FFS if the CFRA resources can be provide via MAC CE.

The overall procedure for LTM is shown in Figure x below. Subsequent LTM is done by repeating the early synchronization, LTM execution, and LTM completion steps without releasing other LTM candidate cell configurations after each LTM completion.



**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. The UE may perform DL synchronization 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.

4b. The UE may perform early TA acquisition with candidate cell(s) before receiving the cell switch command. This is done via CFRA triggered by a PDCCH order from the source cell, following which the UE sends preamble towards a candidate cell. The information that identifies the allocated CFRA resource can be indicated in the PDCCH order to enable shared preamble resource among multiple UEs. In order to minimize the data interruption of the source cell due to CFRA towards the candidate cell(s), the UE doesn’t receive RAR for the purpose of TA value acquisition and the TA value of the candidate cell is indicated in the cell switch command. The UE doesn’t maintainthe TA timer for the candidate cell and relies on network implementation to guarantee the TA validity.

Editor’s note: RAN2 doesn’t see a need for a solution with RAR in for Rel-18.

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 completes the LTM cell swith procedure [by sending *RRCReconfigurationComplete* message to target cell]. For RACH-based LTM, the UE considers that LTM execution procedure is successfully completed when the random access procedure is successfully completed. For RACH-less LTM, the UE considers that LTM execution procedure is successfully completed when the UE determines that the network has successfully received its first UL data.

Editor notes: R2 assumes *RRCReconfigurationComplete* message is always sent at each LTM execution.

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

9.2.3.x.3 U-plane handling

In LTM, whether the UE performs MAC reset, re-establishes RLC, performs data recovery with PDCP during cell swith is explicitly controlled by the network through RRC signalling. The PDCP data recovery procedure can be applied to the RLC AM bearers for inter-DU LTM cell switch.

Editor’s note: FFS which MAC function can be continued during MAC partial reset, e.g. HARQ, BSR, etc..

Editor’s note: For UE processing, the following (not exhaustive) is assumed to be performed after receiving the cell switch command:

* MAC/RLC reset (when configured)
* RF retuning (e.g. needed for inter-frequency), baseband retuning

Editor’s note: FFS how the UE determine the BWPs (for DL and UL) to be used upon the execution of L1/L2 inter-cell mobility.

9.2.3.x.4 Data Forwarding

*End of change*

# Annex X (informative):

# X.1 Components of Mobility Latency

HO interruption time for L1/L2-based inter-cell mobility is the time from UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell.

Editor’s note: FFS if TRS tracking after HO and CSI RS measurement should also be included, i.e. the time to use a high-performance beam.

Editor’s note: To reduce HO interruption time, investigate e.g. solutions to reduce the time for UE reconfiguration (already in the WID), downlink and uplink synchronization after handover decision (other parts of dynamic switch not precluded).

Editor’s note: Measurement delay can/may be considered in this work.

The components of mobility latency is illustrated in Figure X.1-1.



Figure X.1-1: Components of Mobility Latency

Each component of mobility latency is described in table Table X.1-1.

Table X.1-1: Components of Mobility Latency

|  |  |  |
| --- | --- | --- |
| **Component** | **Meaning** | **Value** |
| TRRC | Processing time for *RRCReconfiguration* carrying candidate configurations | Up to [10] ms |
| Tprocessing,1 /Tprocessing,2 | Time for UE processing, before and after cell switch command, respectively. This may include L2/3 reconfiguration, RF retuning, baseband retuning, security update if needed, etc. | Up to [20] ms for same FRUp to [40] ms for different FR |
| Tmeas | Measurement delay (from target appears to cell switch command) | - |
| Tcmd | Time for processing L1/L2-command (HARQ and parsing) | Up to [5] ms |
| Tsearch | Time required to search the target cell | 0ms (if cell is known)Up to [60] ms (if cell is unknown) |
| TΔ | Time for fine tracking and acquiring full timing information | SMTC periodicity (typ. [20] ms) |
| Tmargin | Time for SSB or CSI-RS post-processing | Up to [2] ms |
| TIU | interruption uncertainty in acquiring the first available PRACH occasion in the new cell | Typ. [15] ms |
| TRAR | Time for RAR delay | Typ. [4] ms |
| Tfirst-data | Time for UE performs the first DL/UL reception/ transmission on the indicated beam of the target cell, after RAR | - |

# Annex - RAN2 agreements

Green highlight – agreement captured in stage-2 specifications

Blue highlight – agreement captured as editor’s notes

No highlight – agreement with no direct impact on specifications

## RAN2#119-e

L1/L2-based inter-cell mobilty

* Assumption: HO interruption time for L1/L2-based inter-cell mobility is the time from UE receives the cell switch command to UE performs the first DL/UL reception/transmission on the indicated beam of the target cell. FFS if TRS tracking after HO and CSI RS measurement should also be included, i.e. the time to use a high-performance beam (can be clarified further).
* Assumption: To reduce HO interruption time, investigate e.g. solutions to reduce the time for UE reconfiguration (already in the WID), downlink and uplink synchronization after handover decision (other parts of dynamic switch not precluded).
* Confirm to Support L1/L2-based inter-cell mobility for inter-DU scenario (as well as intra-DU scenarios).
* The design for intra-DU and inter-DU L1/L2-based mobility should share as much commonality as reasonable. FFS which aspects need to be different.
* R2 assumes that L2 is continued whenever possible (e.g. intra-DU), without Reset, with the target to avoid data loss, and the additional delay of data recovery.
* ICBM is one scenario considered for L1L2 mobility, but is not the only one, and is not a prerequisite for using L1L2 mobility.
* RAN2 to consider preparation of target cell configurations capable of dynamic switching without need for full configuration.
* Measurement delay can/may be considered in this work
* Assume that we rely on L1 measurements to trigger L1L2 mobility (still measurement for preparation could be L3, FFS)
* R2 will initially focus on PCell mobility.
* R2 assumption: Rel-18 L1/L2 mobility includes both non-CA (PCell only) and CA scenarios (PCell and SCell). This includes the following cases

a) the target PCell/target SCell(s) is not a current serving cell (CA 🡪 CA scenario with PCell change)

b) FFS the target PCell is a current SCell

c) FFS the target SCell is the current PCell.

* DC scenarios are FFS (e.g. PSCell mobility may be a low hanging fruit FFS).
* Current options on the table: to configure a L1/L2 inter-cell mobility candidate cell:

a. One RRCReconfiguration message for candidate target cell

b. One CellGroupConfig IE for each candidate target cell

c. One SpCellConfig IE for each candidate target cell

NR-DC with selective activation cell of groups

* The selective activation of cell groups should correspond to support of subsequent conditional changes (CPC) after a cell group change (normal or conditional). CPA FFS.
* Initial focus on SCG
* There is interest to support delta configuration, to reduce the signalling overhead (FFS if some other objective should be achieved)
* FFS how many subsequent conditional changes are targeted (and what is the impact of such assumption).
* FFS whether there is a security issue: e.g. to determine vertical or horizontal key derivation, e.g. security parameters re-used as part of subsequent CG switch (for the case when UE goes back to a previous cell, maybe in another SN), and FFS on the procedure/method with which the UE derives the SN security, e.g. based on a prior MN config (without RRC CPC config at the time of SN switch).

CHO with one or multiple candidate SCGs

* Observation: Current RAN2 Stage-3 specifications can support CHO including target MCG and target SCG in Rel-17.
* CHO configuration referring to or including CPC/CPA configuration (intended to be applicable together) can be supported.
* FFS: When triggering CHO, UE perform CPC/CPA configuration to start CPC/CPA evaluation, FFS if CHO evaluation and CPC/CPA evaluation is concurrent or sequential.

## RAN2#119bis-e

L1/L2-mobility: Terminology

* RAN2 to use “LTM” as term for the L1/L2-triggered mobility.
* Use the term “cell switch” for the procedure of triggering change of cells via the LTM feature
* Use the term “Subsequent” LTM for the case when cell switch between L1/L2 mobility candidates is done without RRC reconfiguration in between.

L1L2-mobility: Target Performance Enhancements

* No security update support in Rel-18 with L1/L2 based mobility.
* FFS whether ASN.1 decoding and validity/compliance check of candidate cell configuration are performed upon reception of the candidate cells configuration. FFS if this need to be specified.
* For UE processing, the following (not exhaustive) is assumed to be performed after receiving the cell switch command:

MAC/RLC reset (when configured)

RF retuning (e.g. needed for inter-frequency), baseband retuning

* R2 assumes that the following items may be discussed by RAN1 and RAN4 (and may be scenario specific):

- Whether to perform DL synchronization to candidate/target cell before receiving the cell switch command. R2 assumes this is feasible at least for the case that the target cell is already an active serving cell.

- Whether to support of performing TRS tracking and CSI measurement of candidate/target cell before/by cell switch command

* L1L2 based mobility supports the following CA scenarios:

PCell change without SCell change

PCell change with SCell change

* Support NR-DC scenario in L1L2 based mobility, at least for the PSCell change without MN involvement case, i.e. intra-SN.

L1/L2-mobility: RRC

* A L1/L2 inter-cell mobility candidate (target) configuration is received within an RRC message before the L1/L2 dynamic switch is triggered.
* RAN2 continues the discussion on the RRC models by focusing on Model 1 and Model 2 and stage-3 details.

a. Model 1: One RRCReconfiguration message (or FFS RRCReconfiguration IEs) for each candidate target configuration

b. Model 2: One CellGroupConfig IE (FFS additional IEs) for each candidate target configuration

* RAN2 assumes that sequential L1L2 cell change between Candidates without RRC reconfiguration can be supported.
* RAN2 assumes that candidate cell configuration can only be modified / released by Network (FFS later whether some optimization should be applied e.g. for release).
* For L1L2 mobility will support that candidate configurations are delta configurations on top of a reference configuration. FFS if the reference configuration is a separate reference configuration or e.g. the current configuration.
* For L1L2 mobility, Target Pcell/SCell can be current SCell/PCell, i.e., current SCell/PCell can be configured as candidates.
* FFS how the UE determine the BWPs (for DL and UL) to be used upon the execution of L1/L2 inter-cell mobility

L1/L2-mobility: Dynamic switch

* RAN2 assumes L1/2 mobility trigger information is conveyed in a MAC CE, FFS if the MAC CE or a DCI is used for the actual triggering.
* RAN2 assumes the MAC CE for L1/2 mobility trigger contains at least a candidate configuration index.
* FFS if it should be possible to perform SCell activation/deactivation (amongst SCells associated with the candidate configuration) simultaneously with L1 L2 mobility trigger MAC CE (if so, FFS how this is determined).
* RAN2 assumes that both RACH-based (CFRA, CBRA) and RACH-less procedures for L1 L2 mobility switch may be supported. RACH-less if the UE doesn’t need to acquire TA during the cell switch. RAN2 understands that the feasibility of RACH-less may depend on RAN1, and expect that RAN1 is working on this.
* RAN2 assumes RACH resource for CFRA for L1 L2 dynamic switch may be provided in RRC configuration (or potentially by MAC CE FFS).
* FFS if the MAC CE can indicate TCI state(s) (or other beam info) to activate for the target Cell(s), dep on RAN1 progress.
* R2 assumes that at L1L2 cell switch: Whether the UE performs partial or full MAC reset (FFS what partial reset is, e.g. to avoid data loss), re-establish RLC, perform data recovery with PDCP is explicitly controlled by the network. R2 assumes that this can be configured by RRC. FFS if MAC CE indication(s) is/are needed.

L1/L2-mobility: L1 enhnacements for inter-cell beam management

* RAN2 assumes that RAN1 will drive discussions on L1 measurement enhancements, if any. If RAN1 identifies the need for e.g. event reporting, filtering etc, RAN2 can then be involved if needed.
* Inter-freq L1L2 mobility: R2 Confirms that For L1L2 mobility inter-freq scenarios in general should be supported (including mobility to inter-frequency cell that is not a current serving cell), including the support of inter-frequency L1 measurements, if feasible by R4 and R1.
* RAN2 assumes that whether to use the unified TCI framework as the baseline for beam indication for L1L2 mobility is up to RAN1 (RAN2 observes that L1/L2 mobility need to support inter-freq cases).

NR-DC with selective activation cell of groups

* Baseline procedure to support subsequent secondary cell group change (FFS if UE keeps all configurations or if those are indicated by the network, FFS support of nested configs):

a. Step 1: when the execution condition of a CPC candidate PScell is met, a UE performs the execution of CPC towards this candidate PScell.

b. Step 2: After finishing the PSCell addition or change, the UE doesn’t release conditional configuration of other candidate PSCells for subsequent CPC, the UE continues evaluating the execution conditions of other candidate PScells.

c. Step 3: When the execution condition of a candidate PScell is met, the UE performs the execution of CPC towards this candidate PSCell.

* Confirm that “CPA” selective activation of cell groups will be supported for this WI objective
* Confirm that we aim to support delta configuration, i.e. that there need to be a known reference.
* RAN2 aim to support selective activation of cell groups without RRC reconfiguration with respect to security (FFS, need to consult with SA3 at some point in time).

## RAN2#120

LTM: RRC

* RAN2 to confirm that the CellGroupConfig IE is (mandatory) needed within an LTM candidate cell configuration.
* The RadioBearerConfig IE can be optionally supported in an LTM candidate configuration
* The MeasConfig IE can be optionally supported in an LTM candidate configuration.
* The OtherConfig IE is not required to be part of the LTM candidate cell configuration.
* The LTM candidate cell configuration should be designed as a To AddMod/ToRelease structure.
* The LTM candidate cell configuration ASN.1 structure comprises at least a CellGroupConfig IE and a configuration ID.

**On Delta Configuration**

* A UE stores the reference configuration as a separate configuration.
* The reference configuration is managed separately

LTM: Cell switch

* The MAC CE agreed to carry LTM related information for cell switch is used for LTM triggering of the cell switch.
* LTM cell switch is supervised by a timer
* UE arrival in the target cell need to be indicated (somehow)

## RAN2#121

LTM: RRC

* Agreed: Usage of reference configuration:

**- Candidate delta configuration is applied on top of the reference configuration to form a complete candidate configuration (FFS if done at cell switch or before the cell switch)**

**- The complete candidate configuration is applied and replacing the current UE configuration (at the time of reconfiguration execution/cell switch), by a RRC reconfiguration procedure that makes replacements of configuration but doesn’t necessarily reset RLC or PDCP.**

**- To support reconfigurations that requires reset of RLC PDCP, this should be possible (in principle same a full config)**

**- FFS if more than RLC PDCP should be kept and how much of “replacing” need to be specified.**

**- FFS if the reference configuration can be derived from the current UE configuration at some point of time.**

* Potentially: R2 assumes that LTM without a separate reference configuration (if agreed) could work something like this:

- **Alt A: The candidate configuration (which need to be complete) is applied and replacing the current UE configuration (at the time of reconfiguration execution/cell switch), by a RRC reconfiguration procedure that makes replacements of configuration but doesn’t necessarily reset RLC or PDCP. (Same procedure as above)**

**- Alt B: The candidate configuration (which can be a delta config) is applied to the current UE configuration (at the time of reconfiguration execution/cell switch), by legacy RRC reconfiguration procedure (it is assumed that the network need to coordinate if subsequent reconfigurations shall work, FFS feasibility).**

* agree to use Model 1: One *RRCReconfiguration* message for each candidate target configuration *RRCReconfiguration* to configure target candidate cells
* Reference config can be empty
* In the RRC procedures, the candidate delta configuration is applied on top of the reference configuration to form a complete candidate configuration when the UE receives the LTM configuration (before the LTM cell switch). UE implementation can postpone that step to the reception of the LTM cell switch command. FFS Discuss early vs late compliance check.
* In the RRC procedures, the complete candidate configuration is applied and replacing the current UE configuration (at the time of reconfiguration execution/cell switch), by a RRC reconfiguration procedure that makes replacements of configuration but doesn’t necessarily reset MAC, RLC or PDCP. FFS whether we can rely on a modified version of the reconfiguration procedure with fullconfig flag set. FFS how to make sure the procedures work in case the LTM candidate configuration is a complete configuration.

LTM: Cell Switch

* No consensus to support HARQ continuation (and in order to resume discussion some new input may be needed, e.g. quantitative evidence of a serious problem).
* To determine if to reset L2 or not is based on RRC configuration (e.g. set of cells. FFS if separate for RLC, MAC, PDCP).

NR-DC with selective activation of cell groups

* Assume to support the following scenarios of SCG selective activation:
	+ - SN initiated intra-SN SCG selective activation
		- MN initiated inter-SN SCG selective activation
		- SN initiated inter-SN SCG selective activation
* It is assumed that if the UE need to be able to return to a current SCG by conditional procedure, then the network could explicitly configure a candidate configuration for that cell.
* In SCG selective activation, the CPC/CPA configurations of the UE should be released after Pcell change, at least for inter MN (by explicit indication from network, FFS other case).
* R2 assumes that a CPA conditional configuration can be used for CPC (but with different triggering conditions)
* For inter-SN CPC, MN should provide the reference configuration to all candidate T-SNs (in order to generate the T-SN candidate configuration).
* R2 understands that A target SN may include an indication in SN Addition Request Ack for each candidate target PSCell, denoting whether the associated SCG configuration is a delta with respect to the reference SCG configuration.
* RAN2 agrees to support the simultaneous evaluation of CHO and CPC in Rel-18
* The UE should not need to unpack any of the nested conditionalconfiguration containers in order to measure, acc to agreement above

## RAN2#121bis-e

General and Stage-2

* From RAN2 perspective, to enable shared preamble resource among multiple UEs, it is beneficial that the information that identifies the allocated CFRA resource (i.e., SS/PBCH index, RACH occasion, and Random Access Preamble index) can be indicated in the PDCCH order (as legacy intra-cell PDCCH order).
* RRC RACH configuration for early TA acquisition (e.g., including whether RAR needs to be received) is specific per target cell and is signalled separately (separate IEs) from the candidate cell configuration (the part that need to be applied at cell switch).
* R2 assumes that Early TA RACH option 3 (with RAR from candidate cell) is not needed in Rel-18.
* With the assumption that the UE will skip RACH in the target cell if a TA value is given in the cell switch command: It is FFS if the following TA values can be given to the UE:

- Value 0,

- Value indicating that the UE shall apply the TA of one source cell.

* R2 assumes RRCReconfigurationComplete message is always sent at each LTM execution.
* In RACH-based LTM, the target cell is aware of the UE’s arrival based on the reception of preamble in CFRA and on the reception of Msg3/MsgA in CBRA, like the legacy HO.
* 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
* In RACH-less LTM, RRCReconfigurationComplete can be the content of the first UL MAC PDU/transmission to indicate UE arrival, i.e. no need to introduce any new signaling to indicate UE arrival (for the MCG-switch case)
* For RACH-based LTM, the UE considers that LTM execution procedure is successfully completed when the RACH is successfully completed.
* 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.
* Following behaviors of LTM supervisor timer are agreed:

- 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 for MCG expires, as baseline, the UE considers LTM failure and initiates RRC re-establishment. (SCG switch case FFS)

* LTM supervisor timer is RRC layer timer.
* At RLF or LTM execution failure (for MCG), RAN2 intend to support fast recovery to a candidate cell by LTM execution.
* While configured with LTM candidate cells, the UE can also execute any L3 handover command sent by the network. R2 assumes that is could be up to the network to avoid any issue due to the race condition between LTM execution and RRC Reconfiguration (e.g. L3 HO cmd), e.g. avoid sending LTM switch cmd and L3 HO cmd in the same TB.

LTM RRC

* Discuss terminology for the TS in the RRC stage-3 discussions when/if needed (not at current meeting).
* Whether the Reference configuration is a complete configuration or not is up to the network implementation.
* Reference configuration + LTM candidate configuration (in combination) has to be a complete configuration.
* The reference configuration is always explicitly signalled (not automatically derived from any other config, e.g. current).
* Confirm that only the replacement procedure (the “full config without L2 reset”) is supported for Execution of LTM cell switch.
* The UE may perform early decoding and early validity check. FFS whether Early validity check triggers early re-establishment. FFS the possible timing, FFS subset of cells, FFS if need to specify anything or just up to UE impl, FFS if other signalling to notify network is needed.

Initial agreements, from RAN2 point of view (may be dep on RAN1 progress).

* The location of RS configuration for SSB-based measurements of candidate cells is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells. The RS configuration, per RAN1 agreement, can include PCI or logical ID, SMTC location, frequency location, and SCS.
* RAN2 assumes that the location of configurations of TCI states for the candidate cells (used before/at cell switch) is external to the ServingCellConfig(s) of current serving cells and external to the configuration of the LTM candidate cells (same location as RS configuration).
* RAN2 assumes that For L1 measurements of LTM candidate cells, the reporting configuration is placed inside the ServingCellConfig of current serving cell(s).

 *Chair: the agreements above may need to be further evaluated, e.g. wrt subsequent LTM switches.*

* RAN2 assumes that whether filtering, hysteresis, and time-to-trigger are needed for LTM specific L1 measurements is up to RAN1.
* FFS if the LTM specific L1 measurements of an LTM candidate SCell is independent of its activation status.
* Whether to assume L1/L2 signaling to control or change L1 measurement/reporting for LTM needs further discussion (parts may be discussed in RAN1). RAN2 assumes that such control would be limited to certain aspect that need frequent update and restricted by RRC configuration.

NR-DC with selective activation cell of groups

* For the reference configuration for SCG Selective Activation, aim at following similar design as LTM.
* For inter-SN SCG Selective Activation, the RRC reconfiguration message containing the Rel-18 CPC configurations provided to the UE is in MN format.
* For MN initiated inter-SN SCG selective activation, source MN generates the execution conditions for the initial CPAC.

FFS on the following options for subsequent CPC:

Option 1: Source MN generates the execution conditions for all subsequent CPC.

Option 2: Candidate SN may generate execution conditions for subsequent CPC.

* For SN initiated inter-SN SCG selective activation, source SN generates the execution conditions for the initial CPC.
FFS if Candidate SN may generate/modify execution conditions for subsequent CPC
* Assume for now that there is only one reference configuration.
* The following may be included in the initial RRC reconfiguration message containing the Rel-18 CPC configurations:
1. Reference SCG configuration (Optionality FFS). Assume as for LTM Reference configuration may be empty.

FFS whether MCG configuration is included.

FFS RRC model for the reference configuration.

1. Initial List of candidate target PSCells (this list can be updated by the network, e.g., cells may be added or removed) with associated target SCG configurations. FFS whether the MCG configurations associated with the target SCG configurations are included.

3. The execution conditions associated with each candidate target PSCell.

a. For MN initiated procedure, execution conditions based on event A4 are supported. FFS whether A3/A5 are supported.

b. For SN initiated procedure, execution conditions based on events A3/A5 are supported.

* UE will keep R18 CPC configurations after CPC execution. It should be possible to release a CPC candidate explicitly by RRC reconfiguration procedure.

CHO including target MCG and candidate SCGs for CPC CPA in NR-DC

For the CHO+CPC case:

* When both CHO and CPC conditions are met, both CHO and CPC cell change is executed.
* Baseline: The UE waits until both CHO and CPC conditions are met (always). (furthermore, it is assumed that if needed the network can provide a complementary CHO-only configuration, to avoid failures in deployments where failure would otherwise be likely to happen).
* Alternative: FFS if When CHO condition is met, but CPC condition is not met, CHO execution is triggered (and somehow source SCG can be released). IF allowed in the new configuration the UE may continue evaluation of CPC/CPA conditions.

## RAN2#122

General and Stage-2

* Dynamic grant can be used for RACH-less LTM, for the first UL data transmission to the target cell:

- the UE monitors PDCCH for dynamic scheduling from the target cell, upon LTM cell switch.

- upon cell switch decision, R2 assumes that the source DU informs the target DU about the selected beam, so that the target DU can start scheduling dynamic UL grant.

* Configured grant can be used for RACH-less LTM, for the first UL data transmission to the target cell, the UE selects the configured grant occasion, which is associated with the beam indicated in the LTM MAC CE (as set by source cell). FFS further optimization

For early TA acquisition for candidate Cells

* For PDCCH ordered early TA acquisition without RAR, there is no need for UE to maintain the TA timer for candidate cell (i.e. it is NW implementation to determine the TA validity), TA is given in the cell switch MAC CE (when available in the network).
* RAN2 doesn’t see a need for a solution with RAR in for Rel-18.
* Observation: Without RAR (without UE maintaining TA), the UE will need to do RACH for link recovery and/or conditional (if supported), which is acceptable in Rel-18
* The UE determines to trigger RACH-less cell switch in MAC layer, if the LTM cell switch MAC CE provides the TA value (no RAR is assumed).
* We send LS to R1

Can use legacy behaviour:

* P2: RAN2 assumes that network implementation allows speedy data recovery for RLC AM bearer at intra-DU LTM cell switch without specification impact.
* P3: The PDCP data recovery procedure can be applied to the RLC AM bearers for inter-DU LTM cell switch.

After discussion

* Will not support HARQ continue at LTM cell switch in this release.

RRC

For L1 measurements for LTM

* The RS configuration is provided to the UE per LTM candidate cell.
* RAN2 assumes that Each candidate DU needs to know the RS configuration of each candidate DUs in order to provide the LTM candidate configuration.
* RAN2 assumes that The CU transmits to each C-DU the RS configuration of S-DU (if this is an LTM candidate cell) and/or other C-DUs, to generate the corresponding L1 configuration for LTM.
* RAN2 assumes C-DU generates the RS configuration and send to the CU. The CU transmits to the Source DU the RS configuration per LTM candidate cell and the associated LTM candidate (when the CU receives LTM candidate configuration(s) from the C-DU). It is up to RAN3 whether the RS configuration is sent before (or at the same time of) the C-DU creates the LTM candidate configuration (and whether is semi-statis or UE associated).
* The RS configuration and/or CSI resource configuration for measuring LTM candidate cells is included in the LTM-Config IE and is a separate configuration, e.g. outside of the LTM candidate configuration.
* CSI reports for LTM candidates (neighbour cell reports for the purpose of LTM cell switch) are configured by the serving cell in an IE that is like CSI-ReportConfig for LTM within the ServingCellConfig since this is the cell in which the report is to be transmitted.
* RAN2 assumes the following about CSI measurement reporting for LTM (final decision up to RAN1):

a. UE reports all measured LTM candidate cells in a single report; or

b. UE reports one or a subset of measured LTM candidate cell(s) in a report.

* RAN2 to send an LS to RAN1 RAN3 RAN4, offline. Can also consider whether we should ask questions, continue in the offline [005]
* Remove the duplicate action text. With this change LS out is Approved in R2-2306898

Cell Switch

* If the TA maintenance etc for candidate cell(s) in the UE is needed, the TA(s) associated with candidate cell(s) can be maintained during LTM (TDB exactly which cells decide stage-3).
* For non-TA parts, we do MAC reset, which overrides earlier agreements on partial MAC reset. As earlier agreed RLC-AM can continue at LTM cell switch (intended for intra-DU).

NR-DC with selective activation cell of groups

* For SN-initiated SCG selective activation, candidate SN generates execution conditions for subsequent CPC.
* FFS if it shall be possible to do something like MN-initiated CPA/CPC where Candidate SN generate execution conditions for subsequent CPC
* The UE shall skip the condition evaluation for a candidate which is a current PScell.
* The reference configuration is provided to all candidates involved in preparation, FFS which node initially generates it. Assume it can be provided in MN initiated and in SN initiated procedures.
* Will not spend specific efforts for supporting nested configurations for candidate cell configuration.
* Rapporteur take initiative on naming offline
* Terminology is “Subsequent CPAC”

CHO including target MCG and candidate SCGs for CPC CPA in NR-DC

* P3: The CHO execution conditions (for candidate PCells) and CPA/CPC execution conditions (for candidate PSCells) are provided based on the source MeasConfig.
* P4: For CHO execution conditions, the source MN determines the execution conditions on candidate PCells, based on the source MCG MeasConfig.
* P5: For CPA/CPC execution conditions, the candidate MN determines the parameters of the execution conditions for candidate PSCells (e.g. event A4 threshold).
* P6: The candidate MN informs the source MN about the prepared candidate PSCells and parameters of the associated execution conditions (e.g. event A4 threshold). According to the received information from the candidate MN, the source MN generates the corresponding execution conditions based on the source MCG MeasConfig to the UE.
* FFS how, if to support event A3/A5.
* P8: For CHO with candidate SCGs for CPA/CPC, the RRCReconfigurtaion message in one CHO container includes one MCG configuration and one SCG configuration (i.e. similar to Rel-17 CHO with SCG configuration).
* P9: The execution conditions associated with one CHO container includes both CHO execution condition(s) and CPA/CPC execution condition(s), i.e. triggering conditions on both candidate PCell and candidate PSCell.
* P10: If there are multiple candidate PSCells associated with one candidate PCell, the NW can provide multiple CHO configurations for the same candidate PCell, i.e. each one contains one MCG configuration (for the same candidate PCell) and one SCG configuration (for different candidate PSCell).
* P12: When the CPA/CPC execution condition is met but no CHO execution condition is met, the UE continues to evaluate both CHO and CPA/CPC execution conditions.
* For CHO+CPC we only consider execution when BOTH conditions are met.
* (When the CHO execution condition is met but no CPC execution condition is met, if there is an available CHO-only or Rel-17 CHO with SCG configuration for which the CHO condition is met, the UE performs the CHO-only or Rel-17 CHO with SCG execution, and THUS the network can handle such situation by providing proper configurations).