**3GPP TSG-RAN WG2 Meeting #128 *Draft R2-2410924***

**Orlando, USA, 18 - 22 November 2024**

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **38.321** | **CR** | **1968** | **rev** | **3** | **Current version:** | **18.3.0** |  |
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| *For* [***HE******LP***](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:*** | Miscellaneous corrections for LTM | | | | | | | | | |
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| ***Source to WG:*** | Huawei, HiSilicon | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_Mob\_enh2-Core | | | | |  | ***Date:*** | | | 2024-11-06 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | F |  | | | | | ***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 can be 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-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | There are miscellaneous issues for LTM:  1) According to 5.1.2 for 4-step RA, when the UE executes LTM for recovery as in 5.3.7.3 in TS 38.331, the UE uses common resources and performs CBRA so that resources in rach-ConfigDedicated are not used.  However:  - according to 5.1.1, the UE still selects the RA\_TYPE according to the resources in rach-ConfigDedicated e.g., 2-step could be selected while the CBRA resources do not support 2-step, so the UE cannot execute the RA  - according to 5.1.1a, the UE still considers fields in the dedicated resources for power ramping  - according to 5.1.2a for 2-step RA, the UE selects the RA preamble from the resources in rach-ConfigDedicated, which is inconsistent with the 4-step case  2) When there is a condition that CFRA resources were provided in the LTM cell switch MAC CE, there is no need to have an extra condition that the RA is is initiated for LTM cell switch  3) For RA triggered by PDCCH order for an LTM candidate cell, 5.1.1b says to select the set of RA resources corresponding to the cell, but it is mentioned nowhere in TS 38.321 that this refers to the resources for UL synchronization in TS 38.331, and not to the resources in rach-ConfigCommon in the candidate cell configuration  4) In 5.18.35, there is:  3> consider the SSB associated to the TCI state indicated by the TCI state ID field as the one used for configured uplink grant selection for the initial uplink transmission towards the candidate cell for RACH-less LTM cell switch (as in clause 5.8.2);  The wording "initial uplink transmission" is not aligned with other places ("first PUSCH transmission") and this bullet is entirely redundant with 5.8.2.  5) For LTM cell switch with RA, there is no indication to upper layers when LTM cell switch is complete, unlike for the RACH-less case, but such indication is expected in all cases in TS 38.331.  6) In 5.8.2, the UE is required to consider the SSB index of the SSB associated with the TCI state information in the MAC CE. This association is captured in TS 38.213 clause 21.1 but there is no reference to it. | | | | | | | | |
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| ***Summary of change:*** | | 1) Add the missing condition to exclude recovery  2) Remove the unnecessary condition  3) Add "configured in EarlyUL-SyncConfig"  4) Remove the inconsistent and unnecessary bullet in 5.18.35  5) In 5.1.5, add an indication to upper layer that LTM cell switch is complete.  6) In 5.8.2, add a reference to TS 38.213 clause 21.1  7) Correct a typo in 6.1.3.75  **Impact Analysis**  Impacted 5G architecture options:  NR, NR-DC  Impacted functionality:  LTM  Inter-operability:  If the network is implemented according to the CR and UE is not, the UE may use parameters from rach-ConfigDedicated even though it performs CBRA.  If UE is implemented according to the CR and the network is not, there is no inter-operability issue. | | | | | | | | |
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| ***Consequences if not approved:*** | | Inconsistent wordings remain in the specification and, for recovery using an LTM candidate configuration, the UE may use parameters from rach-ConfigDedicated even though it performs CBRA. | | | | | | | | |
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| ***Clauses affected:*** | | 5.1.1, 5.1.1a, 5.1.1b, 5.1.2a, 5.1.6, 5.18.35, 5.8.2, 6.1.3.75 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

# 5 MAC procedures

## 5.1 Random Access procedure

### 5.1.1 Random Access procedure initialization

The Random Access procedure described in this clause is initiated by a PDCCH order, by the MAC entity itself, or by RRC for the events in accordance with TS 38.300 [2]. There is only one Random Access procedure ongoing at any point in time in a MAC entity. The Random Access procedure on an SCell or an LTM candidate cell shall only be initiated by a PDCCH order with *ra-PreambleIndex* different from 0b000000.

NOTE 1: If a new Random Access procedure is triggered while another is already ongoing in the MAC entity, it is up to UE implementation whether to continue with the ongoing procedure or start with the new procedure (e.g. for SI request).

NOTE 2: If there was an ongoing Random Access procedure that is triggered by a PDCCH order while the UE receives another PDCCH order indicating the same Random Access Preamble, PRACH mask index and uplink carrier, the Random Access procedure is considered as the same Random Access procedure as the ongoing one and not initialized again.

When a Random Access procedure is initiated, UE selects a set of Random Access resources as specified in clause 5.1.1b and initialises the following parameters for the Random Access procedure according to the values configured by RRC for the selected set of Random Access resources:

- *prach-ConfigurationIndex*: the available set of PRACH occasions for the transmission of the Random Access Preamble for Msg1. These are also applicable to the MSGA PRACH if the PRACH occasions are shared between 2-step and 4-step RA types;

- *prach-ConfigurationPeriodScaling-IAB*: the scaling factor defined in TS 38.211 [8] and applicable to IAB-MTs, extending the periodicity of the PRACH occasions baseline configuration indicated by *prach-ConfigurationIndex*;

- *prach-ConfigurationFrameOffset-IAB*: the frame offset defined in TS 38.211 [8] and applicable to IAB-MTs, altering the ROs frame defined in the baseline configuration indicated by *prach-ConfigurationIndex*;

- *prach-ConfigurationSOffset-IAB*: the subframe/slot offset defined in TS 38.211 [8] and applicable to IAB-MTs, altering the ROs subframe or slot defined in the baseline configuration indicated by *prach-ConfigurationIndex*;

- *msgA-PRACH-ConfigurationIndex*: the available set of PRACH occasions for the transmission of the Random Access Preamble for MSGA in 2-step RA type;

- *preambleReceivedTargetPower*: initial Random Access Preamble power for 4-step RA type;

- *msgA-PreambleReceivedTargetPower*: initial Random Access Preamble power for 2-step RA type;

- *rsrp-ThresholdSSB*: an RSRP threshold for the selection of the SSB for 4-step RA type. If the Random Access procedure is initiated for beam failure recovery, *rsrp-ThresholdSSB* used for the selection of the SSB within *candidateBeamRSList* refers to *rsrp-ThresholdSSB* in *BeamFailureRecoveryConfig* IE;

- *rsrp-ThresholdCSI-RS*: an RSRP threshold for the selection of CSI-RS for 4-step RA type. If the Random Access procedure is initiated for beam failure recovery, *rsrp-ThresholdCSI-RS* is equal to *rsrp-ThresholdSSB* in *BeamFailureRecoveryConfig* IE;

- *msgA-RSRP-ThresholdSSB*: an RSRP threshold for the selection of the SSB for 2-step RA type;

- *rsrp-ThresholdSSB-SUL*: an RSRP threshold for the selection between the NUL carrier and the SUL carrier;

*- msgA-RSRP-Threshold*: an RSRP threshold for selection between 2-step RA type and 4-step RA type when both 2-step and 4-step RA type Random Access Resources are configured in the UL BWP;

*- rsrp-ThresholdMsg1-RepetitionNum2*: an RSRP threshold for Msg1 repetition with repetition number 2 (see clause 5.1.1b);

*- rsrp-ThresholdMsg1-RepetitionNum4*: an RSRP threshold for Msg1 repetition with repetition number 4 (see clause 5.1.1b);

*- rsrp-ThresholdMsg1-RepetitionNum8*: an RSRP threshold for Msg1 repetition with repetition number 8 (see clause 5.1.1b);

*- rsrp-ThresholdMsg3*: an RSRP threshold for Msg3 repetition (see clause 5.1.1b);

*- FeatureCombination*: feature or a combination of features associated with a set of Random Access resources;

*- featurePriorities*: priorities for features, such as (e)RedCap, Slicing, etc. (see clause 5.1.1d);

- *msgA-TransMax*: The maximum number of MSGA transmissions when both 4-step and 2-step RA type Random Access Resources are configured;

- *candidateBeamRSList*: a list of reference signals (CSI-RS and/or SSB) identifying the candidate beams for recovery and the associated Random Access parameters;

- *recoverySearchSpaceId*: the search space identity for monitoring the response of the beam failure recovery request;

- *powerRampingStep*: the power-ramping factor;

- *msgA-PreamblePowerRampingStep*: the power ramping factor for MSGA preamble;

- *powerRampingStepHighPriority*: the power-ramping factor in case of prioritized Random Access procedure;

- *scalingFactorBI*: a scaling factor for prioritized Random Access procedure;

- *ra-PreambleIndex*: Random Access Preamble;

- *ra-ssb-OccasionMaskIndex*: defines PRACH occasion(s) associated with an SSB in which the MAC entity may transmit a Random Access Preamble (see clause 7.4);

- *msgA-SSB-SharedRO-MaskIndex*: Indicates the subset of 4-step RA type PRACH occasions shared with 2-step RA type PRACH occasions for each SSB. If 2-step RA type PRACH occasions are shared with 4-step RA type PRACH occasions and *msgA-SSB-SharedRO-MaskIndex* is not configured, then all 4-step RA type PRACH occasions are available for 2-step RA type (see clause 7.4);

- *ssb-SharedRO-MaskIndex*: defines PRACH occasions, on which preambles are allocated for a feature or a combination of features, associated with an SSB in which the MAC entity may transmit a Random Access Preamble (see clause 7.4);

- *ra-OccasionList*: defines PRACH occasion(s) associated with a CSI-RS in which the MAC entity may transmit a Random Access Preamble;

- *ra-PreambleStartIndex*: the starting index of Random Access Preamble(s) for on-demand SI request;

- *startPreambleForThisPartition*: the first preamble associated with the set of Random Access Resources applicable to the Random Access procedure;

- *preambleTransMax*: the maximum number of Random Access Preamble transmission;

- *preambleTransMax-Msg1-Repetition*: the maximum number of Random Access Preamble transmissions with a given Msg1 repetition number before switching to Msg1 repetition with the next available higher Msg1 repetition number;

- *ssb-perRACH-OccasionAndCB-PreamblesPerSSB*: defines the number of SSBs mapped to each PRACH occasion for 4-step RA type and the number of contention-based Random Access Preambles mapped to each SSB;

- *msgA-CB-PreamblesPerSSB-PerSharedRO*: defines the number of contention-based Random Access Preambles for 2-step RA type mapped to each SSB when the PRACH occasions are shared between 2-step and 4-step RA types;

- *msgA-SSB-PerRACH-OccasionAndCB-PreamblesPerSSB*: defines the number of SSBs mapped to each PRACH occasion for 2-step RA type and the number of contention-based Random Access Preambles mapped to each SSB;

- *numberOfPreamblesPerSSB-ForThisPartition*: defines the number ofconsecutive preambles for a feature or a combination of features mapped to each SSB;

- *msgA-PUSCH-ResourceGroupA*: defines MSGA PUSCH resources that the UE shall use when performing MSGA transmission using Random Access Preambles group A;

- *msgA-PUSCH-ResourceGroupB*: defines MSGA PUSCH resources that the UE shall use when performing MSGA transmission using Random Access Preambles group B;

- *msgA-PUSCH-Resource-Index*: identifies the index of the PUSCH resource used for MSGA in case of contention-free Random Access with 2-step RA type;

- if *groupBconfigured* is configured, then Random Access Preambles group B is configured for 4-step RA type.

- Amongst the contention-based Random Access Preambles associated with an SSB (as defined in TS 38.213 [6]), the first *numberOfRA-PreamblesGroupA* included in *groupBconfigured* Random Access Preambles belong to Random Access Preambles group A. The remaining Random Access Preambles associated with the SSB belong to Random Access Preambles group B (if configured).

- if *groupB-ConfiguredTwoStepRA* is configured, then Random Access Preambles group B is configured for 2-step RA type.

- Amongst the contention-based Random Access Preambles for 2-step RA type associated with an SSB (as defined in TS 38.213 [6]), the first *numberOfRA-PreamblesGroupA* included in *GroupB-ConfiguredTwoStepRA* Random Access Preambles belong to Random Access Preambles group A. The remaining Random Access Preambles associated with the SSB belong to Random Access Preambles group B (if configured).

NOTE 3: If Random Access Preambles group B is supported by the cell Random Access Preambles group B is included for each SSB.

- if Random Access Preambles group B is configured for 4-step RA type:

- *ra-Msg3SizeGroupA*: the threshold to determine the groups of Random Access Preambles for 4-step RA type;

- *msg3-DeltaPreamble*: ∆*PREAMBLE\_Msg3* in TS 38.213 [6];

- *messagePowerOffsetGroupB*: the power offset for preamble selection included in *groupBconfigured*;

- *numberOfRA-PreamblesGroupA*: defines the number of Random Access Preambles in Random Access Preamble group A for each SSB included in *groupBconfigured*.

- if Random Access Preambles group B is configured for 2-step RA type:

- *msgA-DeltaPreamble*: ∆*MsgA\_PUSCH* in TS 38.213 [6];

- *messagePowerOffsetGroupB*: the power offset for preamble selection included in *GroupB-ConfiguredTwoStepRA*;

- *numberOfRA-PreamblesGroupA*: defines the number of Random Access Preambles in Random Access Preamble group A for each SSB included in *GroupB-ConfiguredTwoStepRA*;

- *ra-MsgA-SizeGroupA*: the threshold to determine the groups of Random Access Preambles for 2-step RA type.

- the set of Random Access Preambles and/or PRACH occasions for SI request, if any;

- the set of Random Access Preambles and/or PRACH occasions for beam failure recovery request, if any;

- the set of Random Access Preambles and/or PRACH occasions for reconfiguration with sync, if any;

- *ra-ResponseWindow*: the time window to monitor RA response(s) (SpCell only);

- *ra-ContentionResolutionTimer*: the Contention Resolution Timer (SpCell only);

- *msgB-ResponseWindow*: the time window to monitor RA response(s) for 2-step RA type (SpCell only).

In addition, the following information for related Serving Cell is assumed to be available for UEs:

- if Random Access Preambles group B is configured:

- if the Serving Cell for the Random Access procedure is configured with supplementary uplink as specified in TS 38.331 [5], and SUL carrier is selected for performing Random Access Procedure:

- PCMAX,f,c of the SUL carrier as specified in TS 38.101-1 [14], TS 38.101-2 [15], and TS 38.101-3 [16].

- else:

- PCMAX,f,c of the NUL carrier as specified in TS 38.101-1 [14], TS 38.101-2 [15], and TS 38.101-3 [16].

The following UE variables are used for the Random Access procedure:

- *PREAMBLE\_INDEX*;

- *PREAMBLE\_TRANSMISSION\_COUNTER*;

- *PREAMBLE\_POWER\_RAMPING\_COUNTER*;

- *PREAMBLE\_POWER\_RAMPING\_STEP*;

- *PREAMBLE\_RECEIVED\_TARGET\_POWER*;

- *PREAMBLE\_BACKOFF*;

- *PCMAX*;

- *SCALING\_FACTOR\_BI*;

- *TEMPORARY\_C-RNTI*;

- *RA\_TYPE*;

- *POWER\_OFFSET\_2STEP\_RA*;

- *MSGA\_PREAMBLE\_POWER\_RAMPING\_STEP*.

When the Random Access procedure is initiated on a Serving Cell or for an LTM candidate cell, the MAC entity shall:

1> flush the Msg3 buffer;

1> flush the MSGA buffer;

1> set the *PREAMBLE\_TRANSMISSION\_COUNTER* to 1;

1> if the Random Access procedure is initiated on a Serving Cell; or

1> if the Random Access procedure is initiated by the PDCCH order for an LTM candidate cell and the PDCCH order indicates preamble initial transmission; or

1> if the Random Access procedure is initiated by the PDCCH order for an LTM candidate cell, which is different from the cell to which the UE performed the last Random Access Preamble transmission, and the PDCCH order indicates preamble re-transmission:

2> set the *PREAMBLE\_POWER\_RAMPING\_COUNTER* to 1;

1> set the *PREAMBLE\_BACKOFF* to 0 ms;

1> set *POWER\_OFFSET\_2STEP\_RA* to 0 dB;

1> if the carrier to use for the Random Access procedure is explicitly signalled:

2> select the signalled carrier for performing Random Access procedure;

2> set the *PCMAX* to PCMAX,f,c of the signalled carrier.

1> else if the carrier to use for the Random Access procedure is not explicitly signalled; and

1> if the Serving Cell for the Random Access procedure is configured with supplementary uplink as specified in TS 38.331 [5]; and

1> if the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdSSB-SUL*:

2> select the SUL carrier for performing Random Access procedure;

2> set the *PCMAX* to PCMAX,f,c of the SUL carrier.

1> else:

2> select the NUL carrier for performing Random Access procedure;

2> set the *PCMAX* to PCMAX,f,c of the NUL carrier.

NOTE 4: Void.

1> perform the BWP operation as specified in clause 5.15, except when the Random Access procedure is initiated by the PDCCH order for an LTM candidate cell;

1> select the set of Random Access resources applicable to the current Random Access procedure according to clause 5.1.1b;

1> if the Random Access procedure is initiated by PDCCH order and if the *ra-PreambleIndex* explicitly provided by PDCCH is not 0b000000; or

1> if the Random Access procedure was initiated for SI request (as specified in TS 38.331 [5]) and the Random Access Resources for SI request have been explicitly provided by RRC; or

1> if the Random Access procedure was initiated for SpCell beam failure recovery (as specified in clause 5.17) and if the contention-free Random Access Resources for beam failure recovery request for 4-step RA type have been explicitly provided by RRC for the BWP selected for Random Access procedure; or

1> if the Random Access procedure was initiated for reconfiguration with sync not initiated for recovery using an LTM candidate configuration as specified in TS 38.331 [5] clause 5.3.7.3 and if the contention-free Random Access Resources for 4-step RA type have been explicitly provided in *rach-ConfigDedicated* for the BWP selected for Random Access procedure; or

1> if the contention-free Random Access Resources have been explicitly provided in the LTM Cell Switch Command MAC CE:

2> set the *RA\_TYPE* to *4-stepRA*.

1> else if the BWP selected for Random Access procedure is configured with both 2-step and 4-step RA type Random Access Resources within the selected set of Random Access resources (as specified in clause 5.1.1b) and the RSRP of the downlink pathloss reference is above *msgA-RSRP-Threshold*; or

1> if the BWP selected for Random Access procedure is only configured with 2-step RA type Random Access resources within the selected set of Random Access resources according to clause 5.1.1b; or

1> if the Random Access procedure was initiated for reconfiguration with sync not initiated for recovery using an LTM candidate configuration as specified in TS 38.331 [5] clause 5.3.7.3 and if the contention-free Random Access Resources for 2-step RA type have been explicitly provided in *rach-ConfigDedicated* for the BWP selected for Random Access procedure:

2> set the *RA\_TYPE* to *2-stepRA*.

1> else:

2> set the *RA\_TYPE* to *4-stepRA*.

1> perform initialization of variables specific to Random Access type as specified in clause 5.1.1a;

1> if *RA\_TYPE* is set to *2-stepRA*:

2> perform the Random Access Resource selection procedure for 2-step RA type (see clause 5.1.2a).

1> else:

2> perform the Random Access Resource selection procedure (see clause 5.1.2).

### 5.1.1a Initialization of variables specific to Random Access type

The MAC entity shall:

1> if *RA\_TYPE* is set to *2-stepRA*:

2> set *PREAMBLE\_POWER\_RAMPING\_STEP* to *msgA-PreamblePowerRampingStep*;

2> set *SCALING\_FACTOR\_BI* to 1;

2> apply *preambleTransMax* included in the *RACH-ConfigGenericTwoStepRA*;

2> if the Random Access procedure was initiated for reconfiguration with sync not initiated for recovery using an LTM candidate configuration as specified in TS 38.331 [5] clause 5.3.7.3 or for SCG activation; and

2> if *cfra-TwoStep* is configured for the selected carrier:

3> if *msgA-TransMax* is configured in the *cfra-TwoStep*:

4> apply *msgA-TransMax* configured in the *cfra-TwoStep*.

2> else if *msgA-TransMax* is included in the *RACH-ConfigCommonTwoStepRA*:

3> apply *msgA-TransMax* included in the *RACH-ConfigCommonTwoStepRA*.

2> if the Random Access procedure was initiated for SpCell beam failure recovery (as specified in clause 5.17); and

2> if *beamFailureRecoveryConfig* is configured for the active UL BWP of the selected carrier; and

2> if *ra-PrioritizationTwoStep* is configured in the *beamFailureRecoveryConfig*:

3> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority* included in the *ra-PrioritizationTwoStep* in *beamFailureRecoveryConfig*;

3> if *scalingFactorBI* is configured in the *ra-PrioritizationTwoStep* in *beamFailureRecoveryConfig*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if the Random Access procedure was initiated for reconfiguration with sync not initiated for recovery using an LTM candidate configuration as specified in TS 38.331 [5] clause 5.3.7.3 or for SCG activation; and

2> if *rach-ConfigDedicated* is configured for the selected carrier; and

2> if *ra-PrioritizationTwoStep* is configured in the *rach-ConfigDedicated*:

3> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority* included in the *ra-PrioritizationTwoStep* in *rach-ConfigDedicated*;

3> if *scalingFactorBI* is configured in *ra-PrioritizationTwoStep* in the *rach-ConfigDedicated*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if both *ra-PrioritizationForSlicingTwoStep* for a *NSAG-ID* and *ra-PrioritizationForAccessIdentityTwoStep* are configured for the selected carrier; and

2> if the MAC entity is provided by upper layers with both this *NSAG-ID* and Access Identity 1 or 2; and

2> if for at least one of these Access Identities the corresponding bit in the *ra-PrioritizationForAI* is set to *one*:

3> if *enableRA-PrioritizationForSlicing* is set to *true*:

4> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForSlicingTwoStep* for this *NSAG-ID*:

5> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

4> if *scalingFactorBI* is configured in the *ra-PrioritizationForSlicingTwoStep* for this *NSAG-ID*:

5> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

3> else if *enableRA-PrioritizationForSlicing* is set to *false*:

4> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForAccessIdentityTwoStep*:

5> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

4> if *scalingFactorBI* is configured in the *ra-PrioritizationForAccessIdentityTwoStep*:

5> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if *ra-PrioritizationForSlicingTwoStep* for a *NSAG-ID* is configured for the selected carrier; and

2> if the MAC entity is provided by upper layers with this *NSAG-ID*:

3> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForSlicingTwoStep* for this *NSAG-ID*:

4> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

3> if *scalingFactorBI* is configured in the *ra-PrioritizationForSlicingTwoStep* for this *NSAG-ID*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if *ra-PrioritizationForAccessIdentityTwoStep* is configured for the selected carrier; and

2> if the MAC entity is provided by upper layers with Access Identity 1 or 2; and

2> if for at least one of these Access Identities the corresponding bit in the *ra-PrioritizationForAI* is set to *one*:

3> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForAccessIdentityTwoStep*:

4> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

3> if *scalingFactorBI* is configured in the *ra-PrioritizationForAccessIdentityTwoStep*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> set *MSGA\_PREAMBLE\_POWER\_RAMPING\_STEP* to *PREAMBLE\_POWER\_RAMPING\_STEP*.

1> else (i.e. *RA\_TYPE* is set to *4-stepRA*):

2> set *PREAMBLE\_POWER\_RAMPING\_STEP* to *powerRampingStep*;

2> set *SCALING\_FACTOR\_BI* to 1;

2> set *preambleTransMax* to *preambleTransMax* included in the *RACH-ConfigGeneric*;

2> if the Random Access procedure was initiated for SpCell beam failure recovery (as specified in clause 5.17); and

2> if *beamFailureRecoveryConfig* is configured for the active UL BWP of the selected carrier:

3> start the *beamFailureRecoveryTimer*, if configured;

3> apply the parameters *powerRampingStep*, *preambleReceivedTargetPower*, and *preambleTransMax* configured in the *beamFailureRecoveryConfig*.

2> if the Random Access procedure was initiated for beam failure recovery (as specified in clause 5.17); and

2> if *beamFailureRecoveryConfig* is configured for the active UL BWP of the selected carrier; and

2> if *ra-Prioritization* is configured in the *beamFailureRecoveryConfig*:

3> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority* included in the *ra-Prioritization* in *beamFailureRecoveryConfig*;

3> if *scalingFactorBI* is configured in *ra-Prioritization* in the *beamFailureRecoveryConfig*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if the Random Access procedure was initiated for reconfiguration with sync not initiated for recovery using an LTM candidate configuration as specified in TS 38.331 [5] clause 5.3.7.3 or for SCG activation; and

2> if *rach-ConfigDedicated* is configured for the selected carrier; and

2> if *ra-Prioritization* is configured in the *rach-ConfigDedicated*:

3> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority* included in the *ra-Prioritization* in *rach-ConfigDedicated*;

3> if *scalingFactorBI* is configured in *ra-Prioritization* in the *rach-ConfigDedicated*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if both *ra-PrioritizationForSlicing* for a *NSAG-ID* and *ra-PrioritizationForAccessIdentity* are configured for the selected carrier; and

2> if the MAC entity is provided by upper layers with both this *NSAG-ID* and Access Identity 1 or 2; and

2> if for at least one of these Access Identities the corresponding bit in the *ra-PrioritizationForAI* is set to *one*:

3> if *enableRA-PrioritizationForSlicing* is set to *true*:

4> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForSlicing* for this *NSAG-ID*:

5> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

4> if *scalingFactorBI* is configured in the *ra-PrioritizationForSlicing* for this *NSAG-ID*:

5> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

3> else if *enableRA-PrioritizationForSlicing* is set to *false*:

4> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForAccessIdentity*:

5> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

4> if *scalingFactorBI* is configured in the *ra-PrioritizationForAccessIdentity*:

5> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if *ra-PrioritizationForSlicing* for a *NSAG-ID* is configured for the selected carrier; and

2> if the MAC entity is provided by upper layers with this *NSAG-ID*:

3> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForSlicing* for this *NSAG-ID*:

4> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

3> if *scalingFactorBI* is configured in the *ra-PrioritizationForSlicing* for this *NSAG-ID*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> else if *ra-PrioritizationForAccessIdentity* is configured for the selected carrier; and

2> if the MAC entity is provided by upper layers with Access Identity 1 or 2; and

2> if for at least one of these Access Identities the corresponding bit in the *ra-PrioritizationForAI* is set to *one*:

3> if *powerRampingStepHighPriority* is configured in the *ra-PrioritizationForAccessIdentity*:

4> set *PREAMBLE\_POWER\_RAMPING\_STEP* to the *powerRampingStepHighPriority*.

3> if *scalingFactorBI* is configured in the *ra-PrioritizationForAccessIdentity*:

4> set *SCALING\_FACTOR\_BI* to the *scalingFactorBI*.

2> if *RA\_TYPE* is switched from *2-stepRA* to *4-stepRA* during this Random Access procedure:

3> set *POWER\_OFFSET\_2STEP\_RA* to (*PREAMBLE\_POWER\_RAMPING\_COUNTER* – 1) × (*MSGA\_PREAMBLE\_POWER\_RAMPING\_STEP* – *PREAMBLE\_POWER\_RAMPING\_STEP*).

NOTE: If *enableRA-PrioritizationForSlicing* is not configured in *BWP-UplinkCommon* and if both the provided *NSAG-ID* and the provided Access Identity whose corresponding bit in the *ra-PrioritizationForAI* is set to *one* are configured with *ra-Prioritization* either in *RACH-ConfigCommon* or *RACH-ConfigCommonTwoStepRA*, it is up to UE implementation how to determine the values of *PREAMBLE\_POWER\_RAMPING\_STEP* and *SCALING\_FACTOR\_BI*.

### 5.1.1b Selection of the set of Random Access resources for the Random Access procedure

The MAC entity shall:

1> if the BWP selected for Random Access procedure is configured with both set(s) of Random Access resources with *msg3-Repetitions* set to *true* and set(s) of Random Access resources without *msg3-Repetitions* set to *true* and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg3*; or

1> if the BWP selected for Random Access procedure is only configured with the set(s) of Random Access resources with *msg3-Repetitions* set to *true*:

2> assume Msg3 repetition is applicable for the current Random Access procedure.

1> else:

2> assume Msg3 repetition is not applicable for the current Random Access procedure.

1> if contention-free Random Access Resources have been provided for this Random Access procedure in the LTM Cell Switch Command MAC CE and a non-zero Msg1 repetition number is indicated in the LTM Cell Switch Command MAC CE:

2> assume that Msg1 repetition is applicable and that the Msg1 repetition number applicable for the current Random Access procedure is the Msg1 repetition number indicated in the LTM Cell Switch Command MAC CE.

1> else if contention-free Random Access Resources have been provided for this Random Access procedure and a Msg1 repetition number is indicated in *rach-ConfigDedicated*:

2> assume Msg1 repetition is applicable and Msg1 repetition number applicable for the current Random Access procedure is the Msg1 repetition number indicated in *rach-ConfigDedicated*.

1> else if contention free Random Access Resources have not been provided for this Random Access procedure and the BWP selected for the Random Access procedure is configured with set(s) of Random Access resources with *msg1-Repetitions* set to *true* and set(s) of Random Access resources without *msg1-Repetitions* set to *true*:

2> if the BWP selected for the Random Access procedure is configured with set(s) of Random Access resources associated with Msg1 repetition number 8 and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg1-RepetitionNum8*:

3> assume Msg1 repetition is applicable and Msg1 repetition number applicable for the current Random Access procedure includes 8.

2> if the BWP selected for the Random Access procedure is configured with set(s) of Random Access resources associated with Msg1 repetition number 4 and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg1-RepetitionNum4*:

3> assume Msg1 repetition is applicable and Msg1 repetition number applicable for the current Random Access procedure includes 4.

2> if the BWP selected for the Random Access procedure is configured with set(s) of Random Access resources associated with Msg1 repetition number 2 and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg1-RepetitionNum2*:

3> assume Msg1 repetition is applicable and Msg1 repetition number applicable for the current Random Access procedure includes 2.

2> else if the RSRP of the downlink pathloss reference is not less than any configured *rsrp-ThresholdMsg1-RepetitionNumX*:

3> assume Msg1 repetition is not applicable for the current Random Access procedure.

1> else ifthe BWP selected for Random Access procedure is configured only with the set(s) of Random Access resources with *msg1-Repetitions* set to *true*:

2> assume Msg1 repetition is applicable for the current Random Access procedure;

2> if at least one of *rsrp-ThresholdMsg1-RepetitionNumX* is configured:

3> if *rsrp-ThresholdMsg1-RepetitionNum8* is configured and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg1-RepetitionNum8*;

4> assume Msg1 repetition number applicable for the current Random Access procedure includes 8.

3> if *rsrp-ThresholdMsg1-RepetitionNum4* is configured and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg1-RepetitionNum4*:

4> assume Msg1 repetition number applicable for the current Random Access procedure includes 4.

3> if *rsrp-ThresholdMsg1-RepetitionNum2* is configured and the RSRP of the downlink pathloss reference is less than *rsrp-ThresholdMsg1-RepetitionNum2*:

4> assume Msg1 repetition number applicable for the current Random Access procedure includes 2.

3> else if the RSRP of the downlink pathloss reference is not less than any configured *rsrp-ThresholdMsg1-RepetitionNumX*:

4> assume Msg1 repetition number applicable for the current Random Access procedure is the lowest Msg1 repetition number configured for this BWP.

2> else (none of *rsrp-ThresholdMsg1-RepetitionNumX* is configured):

3> assume Msg1 repetition number applicable for the current Random Access procedure is the Msg1 repetition number that configured for this BWP.

NOTE 1: Void.

1> if neither contention-free Random Access Resources nor Random Access Resources for SI request have been provided for this Random Access procedure and one or more of the features including (e)RedCap and/or Slicing and/or SDT and/or MSG3 repetition and/or MSG1 repetition is applicable for this Random Access procedure:

NOTE 2: The applicability of SDT is determined by MAC entity according to clause 5.27. The applicability of *NSAG-ID* is determined by upper layers when the Random Access procedure is initiated. The applicability of (e)RedCap is also determined by upper layers when Random Access procedure is initiated and it is applicable to the Random Access procedures initiated by PDCCH orders and any Random Access procedure initiated by the MAC entity.

NOTE 3: SDT is not applicable for the Random Access procedure initiated by upper layers for MT-SDT.

2> if none of the sets of Random Access resources are available for any feature applicable to the current Random Access procedure (as specified in clause 5.1.1c):

3> select the set(s) of Random Access resources that are not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else if there is one set of Random Access resources available which can be used for indicating all features triggering this Random Access procedure:

3> select this set of Random Access resources for this Random Access procedure.

2> else if there are more than one set of Random Access resources available which can be used for indicating all features triggering this Random Access procedure and Msg1 repetition is applicable for this Random Access procedure:

3> select the set of Random Access resources that associated with highest repetition number among the sets of Random Access resources.

2> else (i.e. there are one or more sets of Random Access resources available that are configured with indication(s) for a subset of all features triggering this Random Access procedure):

3> select a set of Random Access resources from the available set(s) of Random Access resources based on the priority order indicated by upper layers as specified in clause 5.1.1d for this Random Access Procedure.

1> else if this Random Access procedure is initiated by PDCCH order with the *PRACH association indicator* field in DCI set to 1 and *SSB-MTC-AdditionalPCI* is configured by upper layers, as specified in clause 7.3.1.2.1 of TS 38.212 [9]:

2> select the set of Random Access resources corresponding to the *additionalPCI* associated with active TCI states.

1> else if this Random Access procedure is initiated by PDCCH order for an LTM candidate cell:

2> select the set of Random Access resources configured in *EarlyUL-SyncConfig* corresponding to the cell indicated by the field *Cell indicator* in the PDCCH order as specified in TS 38.212 [9].

1> else if contention-free Random Access Resources have been provided for this Random Access procedure by PDCCH order:

2> if RedCap is applicable for the current Random Access procedure:

3> if there is one set of Random Access resources available that is only configured with RedCap indication:

4> select this set of Random Access resources for this Random Access procedure.

3> else:

4> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else if eRedCap is applicable for the current Random Access procedure:

3> if there is one set of Random Access resources available that is only configured with eRedCap indication:

4> select this set of Random Access resources for this Random Access procedure.

3> else if there is one set of Random Access resources available that is only configured with RedCap indication:

4> select this set of Random Access resources for this Random Access procedure.

3> else:

4> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else:

3> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

1> else if contention-free Random Access Resources have been provided for this Random Access procedure in the LTM Cell Switch Command MAC CE:

2> if RedCap is applicable for this Random Access procedure:

3> if a non-zero Msg1 repetition number is indicated in the LTM Cell Switch Command MAC CE:

4> select the set of Random Access resources that is only configured with RedCap indication and Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

3> else:

4> if there is one set of Random Access resources available that is only configured with RedCap indication:

5> select this set of Random Access resources for this Random Access procedure.

4> else:

5> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else if eRedCap is applicable for this Random Access procedure:

3> if a non-zero Msg1 repetition number is indicated in the LTM Cell Switch Command MAC CE:

4> select the set of Random Access resources that is only configured with eRedCap indication and Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

3> else:

4> if there is one set of Random Access resources available that is only configured with eRedCap indication:

5> select this set of Random Access resources for this Random Access procedure.

4> else if there is one set of Random Access resources available that is only configured with RedCap indication:

5> select this set of Random Access resources for this Random Access procedure.

4> else:

5> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else:

3> if a non-zero Msg1 repetition number is indicated in the LTM Cell Switch Command MAC CE:

4> select the set of Random Access resources that is only configured with Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

3> else:

4> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

1> else if contention-free Random Access Resources have been provided for this Random Access procedure in *rach-ConfigDedicated*:

2> if RedCap is applicable for this Random Access procedure:

3> if Msg1 repetition number is indicated in *rach-ConfigDedicated*:

4> select the set of Random Access resources that is only configured with RedCap indication and Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

3> else:

4> if there is one set of Random Access resources available that is only configured with RedCap indication:

5> select this set of Random Access resources for this Random Access procedure.

4> else:

5> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else if eRedCap is applicable for this Random Access procedure:

3> if Msg1 repetition number is indicated in *rach-ConfigDedicated*:

4> select the set of Random Access resources that is only configured with eRedCap indication and Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

3> else:

4> if there is one set of Random Access resources available that is only configured with eRedCap indication:

5> select this set of Random Access resources for this Random Access procedure.

4> else if there is one set of Random Access resources available that is only configured with RedCap indication:

5> select this set of Random Access resources for this Random Access procedure.

4> else:

5> select the set of Random Access resources that not is associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else:

3> if Msg1 repetition number is indicated in *rach-ConfigDedicated*:

4> select the set of Random Access resources that is only configured with Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

3> else:

4> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

1> else if contention-free Random Access Resources have been provided for this Random Access procedure in the *BeamFailureRecoveryConfig*:

2> if RedCap is applicable for this Random Access procedure:

3> if there is one set of Random Access resources available that is only configured with RedCap indication:

4> select this set of Random Access resources for this Random Access procedure.

3> else:

4> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else if eRedCap is applicable for this Random Access procedure:

3> if there is one set of Random Access resources available that is only configured with eRedCap indication:

4> select this set of Random Access resources for this Random Access procedure.

3> else if there is one set of Random Access resources available that is only configured with RedCap indication:

4> select this set of Random Access resources for this Random Access procedure.

3> else:

4> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

2> else:

3> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for this Random Access procedure.

1> else if Random Access resources for SI request have been provided for this Random Access procedure:

2> if Random Access Resources associated with Msg1 repetition for SI request and Msg1 repetition number have been provided for this Random Access procedure:

3> ifthe BWP selected for Random Access procedure is indicated by *initialUplinkBWP-RedCap*:

4> if RedCap is applicable for the current Random Access procedure:

5> select the set of Random Access Resources that is only configured with RedCap indication and Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

4> else if eRedCap is applicable for the current Random Access procedure:

5> if there is one set of Random Access resources available that is only configured with RedCap indication and Msg1 repetition indication and associated with the indicated Msg1 repetition number:

6> select this set of Random Access resources for this Random Access procedure.

5> else:

6> select the set of Random Access Resources that is only configured with eRedCap indication and Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

3> else:

4> select the set of Random Access resources that is only configured with Msg1 repetition indication and associated with the indicated Msg1 repetition number for this Random Access procedure.

2> else:

3> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for the current Random Access procedure.

1> else:

2> select the set of Random Access resources that is not associated with any feature indication (as specified in clause 5.1.1c) for the current Random Access procedure.

### 5.1.2a Random Access Resource selection for 2-step RA type

If the selected *RA\_TYPE* is set to *2-stepRA*, the MAC entity shall:

1> if the Random access procedure was not initiated for recovering using an LTM candidate configuration as specified in TS 38.331 [5] clause 5.3.7.3 and if the contention-free 2-step RA type Resources associated with SSBs have been explicitly provided in *rach-ConfigDedicated* and at least one SSB with SS-RSRP above *msgA-RSRP-ThresholdSSB* amongst the associated SSBs is available:

2> select an SSB with SS-RSRP above *msgA-RSRP-ThresholdSSB* amongst the associated SSBs;

2> set the *PREAMBLE\_INDEX* to a *ra-PreambleIndex* corresponding to the selected SSB.

1> else (i.e. for the contention-based Random Access Preamble selection):

2> if at least one of the SSBs with SS-RSRP above *msgA-RSRP-ThresholdSSB* is available:

3> select an SSB with SS-RSRP above *msgA-RSRP-ThresholdSSB*.

2> else:

3> select any SSB.

2> if contention-free Random Access Resources for 2-step RA type have not been configured and if Random Access Preambles group has not yet been selected during the current Random Access procedure:

3> if Random Access Preambles group B for 2-step RA type is configured:

4> if the potential MSGA payload size (UL data available for transmission plus MAC subheader and, where required, MAC CEs) is greater than the *ra-MsgA-SizeGroupA* and the pathloss is less than *PCMAX* (of the Serving Cell performing the Random Access Procedure) – *msgA-PreambleReceivedTargetPower* – *msgA-DeltaPreamble* – *messagePowerOffsetGroupB*; or

4> if the Random Access procedure was initiated for the CCCH logical channel and the CCCH SDU size plus MAC subheader is greater than *ra-MsgA-SizeGroupA*:

5> select the Random Access Preambles group B.

4> else:

5> select the Random Access Preambles group A.

3> else:

4> select the Random Access Preambles group A.

2> else if contention-free Random Access Resources for 2-step RA type have been configured and if Random Access Preambles group has not yet been selected during the current Random Access procedure:

3> if Random Access Preambles group B for 2-step RA type is configured; and

3> if the transport block size of the MSGA payload configured in the *rach-ConfigDedicated* corresponds to the transport block size of the MSGA payload associated with Random Access Preambles group B:

4> select the Random Access Preambles group B.

3> else:

4> select the Random Access Preambles group A.

2> else (i.e. Random Access preambles group has been selected during the current Random Access procedure):

3> select the same group of Random Access Preambles as was used for the Random Access Preamble transmission attempt corresponding to the earlier transmission of MSGA.

2> select a Random Access Preamble randomly with equal probability from the 2-step RA type Random Access Preambles associated with the selected SSB and the selected Random Access Preambles group;

2> set the *PREAMBLE\_INDEX* to the selected Random Access Preamble.

1> determine the next available PRACH occasion from the PRACH occasions corresponding to the selected SSB permitted by the restrictions given by the *msgA-SSB-SharedRO-MaskIndex* if configured, or *ra-ssb-OccasionMaskIndex* if configured, or *ssb-SharedRO-MaskIndex* if configured (the MAC entity shall select a PRACH occasion randomly with equal probability among the consecutive PRACH occasions allocated for 2-step RA type according to clause 8.1 of TS 38.213 [6] regardless the FR2 UL gap, corresponding to the selected SSB; the MAC entity may take into account the possible occurrence of measurement gaps and MUSIM gaps when determining the next available PRACH occasion corresponding to the selected SSB);

1> if the Random Access Preamble was not selected by the MAC entity among the contention-based Random Access Preamble(s):

2> select a PUSCH occasion from the PUSCH occasions configured in *msgA-CFRA-PUSCH* corresponding to the PRACH slot of the selected PRACH occasion, according to *msgA-PUSCH-Resource-Index* corresponding to the selected SSB;

2> determine the UL grant and the associated HARQ information for the MSGA payload in the selected PUSCH occasion;

2> deliver the UL grant and the associated HARQ information to the HARQ entity.

1> else:

2> select a PUSCH occasion corresponding to the selected preamble and PRACH occasion according to clause 8.1A of TS 38.213 [6];

2> determine the UL grant for the MSGA payload according to the PUSCH configuration associated with the selected Random Access Preambles group and determine the associated HARQ information;

2> if the selected preamble and PRACH occasion is mapped to a valid PUSCH occasion as specified in clause 8.1A of TS 38.213 [6]:

3> deliver the UL grant and the associated HARQ information to the HARQ entity.

1> perform the MSGA transmission procedure (see clause 5.1.3a).

NOTE 1: To determine if there is an SSB with *SS-RSRP* above *msgA-RSRP-ThresholdSSB*, the UE uses the latest unfiltered *L1-RSRP* measurement.

NOTE 2: If an (e)RedCap UE in RRC\_IDLE or RRC\_INACTIVE mode is configured with a BWP indicated by *initialDownlinkBWP-RedCap* which is not associated with any SSB, SS-RSRP measurement is performed based on the SSB associated with the BWP indicated by *initialDownlinkBWP*. If an (e)RedCap UE in RRC\_INACTIVE mode is configured with SDT and with a BWP indicated by *initialDownlinkBWP-RedCap* which is associated with NCD-SSB, SS-RSRP measurement can also be performed based on this NCD-SSB during SDT.

NOTE 3: If an (e)RedCap UE in RRC\_IDLE or RRC\_INACTIVE mode is configured with a BWP indicated by *initialDownlinkBWP-RedCap* which is not associated with any SSB for RACH, it is up to the UE implementation to perform a new RSRP measurements before Msg1/MsgA retransmission.

### 5.1.6 Completion of the Random Access procedure

Upon completion of the Random Access procedure, the MAC entity shall:

1> discard any explicitly signalled contention-free Random Access Resources for 2-step RA type and 4-step RA type except the 4-step RA type contention-free Random Access Resources for beam failure recovery request, if any;

1> flush the HARQ buffer used for transmission of the MAC PDU in the Msg3 buffer and the MSGA buffer.

Upon successful completion of the Random Access procedure initiated for DAPS handover, the target MAC entity shall:

1> indicate the successful completion of the Random Access procedure to the upper layers.

Upon successful completion of the Random Access procedure initiated for LTM cell switch, the MAC entity shall:

1 > indicate the successful completion of the LTM cell switch to upper layers.

## 5.8 Transmission and reception without dynamic scheduling

### 5.8.2 Uplink

There are two types of transmission without dynamic grant:

- configured grant Type 1 where an uplink grant is provided by RRC, and stored as configured uplink grant;

- configured grant Type 2 where an uplink grant is provided by PDCCH, and stored or cleared as configured uplink grant based on L1 signalling indicating configured uplink grant activation or deactivation.

Type 1 and Type 2 are configured by RRC for a Serving Cell per BWP. Multiple configurations can be active simultaneously in the same BWP. For Type 2, activation and deactivation are independent among the Serving Cells. For the same BWP, the MAC entity can be configured with both Type 1 and Type 2.

A multi-PUSCH configured grant has multiple consecutive configured uplink grants within a *periodicity*. Both Type 1 and Type 2 can be configured for a multi-PUSCH configured grant by RRC.

Only configured grant Type 1 can be configured for CG-SDT or for RACH-less LTM cell switch or for RACH-less handover. CG-SDT can only be configured on initial BWP.

RRC configures the following parameters when the configured grant Type 1 is configured:

- *cs-RNTI*: CS-RNTI for retransmission;

- *cg-SDT-CS-RNTI*: CS-RNTI for CG-SDT retransmission;

- *cg-SDT-RSRP-ThresholdSSB*: an RSRP threshold configured for SSB selection for CG-SDT;

- *cg-RRC-RSRP-ThresholdSSB*: an RSRP threshold configured for SSB selection for RACH-less handover;

- *periodicity*: periodicity of the configured grant Type 1;

- *timeDomainOffset*: Offset of a resource with respect to SFN = *timeReferenceSFN* in time domain;

- *timeDomainAllocation*: Allocation of configured uplink grant in time domain which contains *startSymbolAndLength* (i.e. *SLIV* in TS 38.214 [7]) or *startSymbol* (i.e. *S* in TS 38.214 [7]);

- *nrofHARQ-Processes*: the number of HARQ processes for configured grant;

- *harq-ProcID-Offset*: offset of HARQ process for configured grant configured with *cg-RetransmissionTimer* for operation with shared spectrum channel access;

- *harq-ProcID-Offset2*: offset of HARQ process for configured grant not configured with *cg-RetransmissionTimer*;

- *timeReferenceSFN*: SFN used for determination of the offset of a resource in time domain. The UE uses the closest SFN with the indicated number preceding the reception of the configured grant configuration;

- *timeReferenceH-SFN*: H-SFN used for determination of the offset of a resource in time domain. The UE uses the closest H-SFN with the indicated number preceding the reception of the configured grant configuration.

RRC configures the following parameters when the configured grant Type 2 is configured:

- *cs-RNTI*: CS-RNTI for activation, deactivation, and retransmission;

- *periodicity*: periodicity of the configured grant Type 2;

- *nrofHARQ-Processes*: the number of HARQ processes for configured grant;

- *harq-ProcID-Offset*: offset of HARQ process for configured grant configured with *cg-RetransmissionTimer* for operation with shared spectrum channel access;

- *harq-ProcID-Offset2*: offset of HARQ process for configured grant not configured with *cg-RetransmissionTimer*.

RRC configures the following parameter when retransmissions on configured uplink grant is configured:

- *cg-RetransmissionTimer*: the duration after a configured grant (re)transmission of a HARQ process when the UE shall not autonomously retransmit that HARQ process;

- *cg-SDT-RetransmissionTimer*: the duration after a configured grant (re)transmission of a HARQ process of the initial CG-SDT transmission with CCCH message when the UE shall not autonomously retransmit the HARQ process;

- *cg-RRC-RetransmissionTimer*: the duration after a configured grant (re)transmission of a HARQ process of the initial transmission of RACH-less handover and RACH-less LTM cell switch when the UE shall not autonomously retransmit the HARQ process.

RRC configures the following parameter when a multi-PUSCH configured grant is configured:

*- nrofSlotsInCG-Period*: the number of configured uplink grants in a *periodicity* of a multi-PUSCH configured grant.

RRC configures the following parameter when UTO-UCI (as specified in clause 9.3 in TS 38.213 [6]) is configured for a configured grant:

*- nrofBitsInUTO-UCI*: number of bits in a UTO-UCI bitmap.

For a configured uplink grant, the MAC entity shall:

1> if its associated configured grant is configured with UTO-UCI and it has not been indicated to the lower layers as unused for PUSCH transmission; or

1> if its associated configured grant is not configured with UTO-UCI:

2> if it is associated with a multi-PUSCH configured grant and meets the validity conditions specified in the clause 6.1 in TS 38.214 [7]; or

2> if it is not associated with a multi-PUSCH configured grant:

3> consider it available for use.

The MAC entity shall not include the UL-SCH resource of a configured uplink grant not available for use in its procedures (e.g. in clause 5.4.4).

For a configured grant configured with UTO-UCI, the MAC entity determines if a configured uplink grant which is within the subsequent *nrofBitsInUTO-UCI* valid occasions of its associated configured grant configuration is going to be used for PUSCH transmission by considering at least the amount of buffered data that can be transmitted on the available occasions of the associated configured grant and other available UL-SCH resources. Upon this determination, the MAC entity sends an indication to lower layers, for use in the procedure for reporting UTO-UCI.

Upon configuration of a configured grant Type 1 for a BWP of a Serving Cell by upper layers, the MAC entity shall:

1> store the uplink grant provided by upper layers as a configured uplink grant for the indicated BWP of the Serving Cell;

1> initialise or re-initialise the configured uplink grant to start in the symbol according to *timeDomainOffset*, *timeReferenceSFN*, and *S* (derived from *SLIV* or provided by *startSymbol* as specified in TS 38.214 [7]), and to reoccur with *periodicity*.

If *cg-SDT-PeriodicityExt* (as defined in TS 38.331 [5]) is not configured, after an uplink grant is configured for a configured grant Type 1, the MAC entity shall consider sequentially that the configured uplink grant, or the first configured uplink grant in a multi-PUSCH configured grant, in the Nth (N ≥ 0) *periodicity* occurs in the symbol for which:

[(SFN × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  
 + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  
 (*timeReferenceSFN* × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + *timeDomainOffset* × *numberOfSymbolsPerSlot* + S + N × *periodicity*)  
 modulo (1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)

If *cg-SDT-PeriodicityExt* (as defined in TS 38.331 [5]) is configured, after an uplink grant is configured for a configured grant Type 1, the MAC entity shall consider sequentially that the configured uplink grant, or the first configured uplink grant in a multi-PUSCH configured grant, in the Nth (N ≥ 0) *periodicity* occurs in the symbol for which:

[(H-SFN × *numberOfSFNperH-SFN* + SFN) × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  
 ((*timeReferenceH-SFN* × *numberOfSFNperH-SFN + timeReferenceSFN*)  
 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + *timeDomainOffset* × *numberOfSymbolsPerSlot* + S + N × *periodicity*)  
 modulo (1024 × 1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)

For a multi-PUSCH configured grant Type 1, the Mth (1 < M ≤ *nrofSlotsInCG-Period*) configured uplink grant within a *periodicity* occurs (M-1) × *numberOfSymbolsPerSlot* symbols after the symbol in which the first configured uplink grant in that *periodicity* occurs.

For an uplink grant configured for configured grant Type 1 for CG-SDT on the selected uplink carrier as in clause 5.27, when CG-SDT is triggered and not terminated, for each configured uplink grant valid according to TS 38.214 [7] for which the above formula is satisfied, the MAC entity shall:

1> if, after initial transmission for CG-SDT with CCCH message has been performed according to clause 5.4.1, PDCCH addressed to the MAC entity's C-RNTI has not been received:

2> if the SSB corresponding to the configured UL grant has the same SSB index as the SSB selected for initial transmission for CG-SDT with CCCH message (i.e., retransmission of initial transmission of CG-SDT):

3> select this SSB;

3> indicate the SSB index corresponding to the configured uplink grant to the lower layer;

3> consider this configured uplink grant as valid.

1> else if at least one SSB configured for CG-SDT with SS-RSRP above *cg-SDT-RSRP-ThresholdSSB* is available:

2> if at least one SSB corresponding to the configured uplink grant with SS-RSRP above the *cg-SDT-RSRP-ThresholdSSB* is available:

3> if this is the initial transmission of CG-SDT with CCCH message after the CG-SDT procedure is initiated as in clause 5.27 (i.e., initial transmission for CG-SDT):

4> select an SSB with SS-RSRP above *cg-SDT-RSRP-ThresholdSSB* amongst the SSB(s) associated with the configured uplink grant.

3> else if PDCCH addressed to C-RNTI has been received after the initial transmission of CG-SDT with CCCH message (i.e., subsequent new transmission for CG-SDT):

4> if SS-RSRP of the SSB selected for the previous transmission for CG-SDT is above *cg-SDT-RSRP-ThresholdSSB* and this SSB is associated with this configured uplink grant:

5> select this SSB.

4> else if SS-RSRP of the SSB selected for the previous transmission for CG-SDT is not above *cg-SDT-RSRP-ThresholdSSB*:

5> select an SSB with SS-RSRP above *cg-SDT-RSRP-ThresholdSSB* amongst the SSB(s) associated with the configured uplink grant.

3> if SSB is selected above:

4> indicate the SSB index to the lower layer;

4> consider this configured uplink grant as valid.

1> else:

2> consider this configured uplink grant as not valid.

2> if PDCCH addressed to C-RNTI after the initial transmission of the CG-SDT with CCCH message has been received:

3> if there is data available for transmission for at least one RB configured for SDT:

4> initiate Random Access procedure in clause 5.1.

NOTE 1: Void.

For an uplink grant configured for configured grant Type 1 for RACH-less LTM cell switch, when there is an ongoing RACH-less LTM cell switch procedure, for each configured uplink grant valid according to TS 38.214 [7] for which the above formula is satisfied, the MAC entity shall:

1> if an SSB corresponding to the configured UL grant has the same SSB index as the SSB associated with the TCI state indicated by the UL TCI state ID field, if present, or by the TCI state ID field otherwise, in the LTM Cell Switch Command MAC CE, as specified in clause 21.1 in TS 38.213 [6]:

2> select the SSB associated with the TCI state indicated by LTM Cell Switch Command MAC CE.

2> indicate the SSB index to the lower layer;

2> consider this configured uplink grant as valid.

1> else:

2> consider this configured uplink grant as not valid.

NOTE 1a: When there is an ongoing RACH-less LTM cell switch, the configured grant Type 1 which is not specifically configured for LTM (see *cg-LTM-Configuration* in TS 38.331 [5]) is not used.

NOTE 1b: After completion of LTM cell switch, the UE stops using the grant configured for RACH-less LTM cell switch (see *cg-LTM-Configuration* in TS 38.331 [5]).

For the uplink grant configured for configured grant Type 1 for RACH-less handover, if the configured uplink grant is valid according to TS 38.214 [7] for which the above formula is satisfied, the MAC entity shall:

1> if, after the initial transmission of RACH-less handover has been performed according to clause 5.4.1 and 5.33, RACH-less handover is not successfully completed:

2> if the SSB corresponding to the configured UL grant has the same SSB index as the SSB selected for the initial transmission of RACH-less handover (i.e., retransmission of initial transmission of RACH-less handover):

3> select this SSB;

3> indicate the SSB index corresponding to the configured uplink grant to the lower layer;

3> consider this configured uplink grant as valid.

1> else if at least one SSB corresponding to the configured uplink grant with SS-RSRP above *cg-RRC-RSRP-ThresholdSSB* is available:

2> select an SSB with SS-RSRP above *cg-RRC-RSRP-ThresholdSSB* amongst the SSB(s) associated with the configured uplink grant;

2> indicate the selected SSB index to the lower layer;

2> consider this configured uplink grant as valid.

1> else:

2> consider this configured uplink grant as not valid;

2> initiate Random Access procedure in clause 5.1.

NOTE 1A: When the UE determines if there is an SSB with SS-RSRP above *cg-RRC-RSRP-ThresholdSSB* or *cg-SDT-RSRP-ThresholdSSB*, the UE uses the latest unfiltered L1-RSRP measurement.

After an uplink grant is configured for a configured grant Type 2, the MAC entity shall consider sequentially that the configured uplink grant, or the first configured uplink grant in a multi-PUSCH configured grant, in the Nth (N ≥ 0) *periodicity* occurs in the symbol for which:

[(SFN × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)  
 + (slot number in the frame × *numberOfSymbolsPerSlot*) + symbol number in the slot] =  
 [(SFNstart time × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*  
 + slotstart time × *numberOfSymbolsPerSlot* + symbolstart time) + N × *periodicity*]  
 modulo (1024 × *numberOfSlotsPerFrame* × *numberOfSymbolsPerSlot*)

where SFNstart time, slotstart time, and symbolstart time are the SFN, slot, and symbol, respectively, of the first transmission opportunity of PUSCH where the configured uplink grant was (re-)initialised.

For a multi-PUSCH configured grant Type 2, the Mth (1 < M ≤ *nrofSlotsInCG-Period*) configured uplink grant within the same *periodicity* occurs (M-1) × *numberOfSymbolsPerSlot* symbols after the symbol in which the first configured uplink grant in that *periodicity* occurs.

If *cg-nrofPUSCH-InSlot* or *cg-nrofSlots* is configured for a configured grant Type 1 or Type 2, the MAC entity shall consider the uplink grants occur in those additional PUSCH allocations as specified in clause 6.1.2.3 of TS 38.214 [7].

NOTE 2: In case of unaligned SFN across carriers in a cell group, the SFN of the concerned Serving Cell is used to calculate the occurrences of configured uplink grants.

When the configured uplink grant is released by upper layers, all the corresponding configurations shall be released and all corresponding uplink grants shall be cleared.

The MAC entity shall:

1> if at least one configured uplink grant confirmation has been triggered and not cancelled; and

1> if the MAC entity has UL resources allocated for new transmission:

2> if, in this MAC entity, at least one configured uplink grant is configured by *configuredGrantConfigToAddModList*:

3> instruct the Multiplexing and Assembly procedure to generate a Multiple Entry Configured Grant Confirmation MAC CE as defined in clause 6.1.3.31.

2> else:

3> instruct the Multiplexing and Assembly procedure to generate a Configured Grant Confirmation MAC CE as defined in clause 6.1.3.7.

2> cancel all triggered configured uplink grant confirmation(s).

For a configured grant Type 2, the MAC entity shall clear the configured uplink grant(s) immediately after first transmission of Configured Grant Confirmation MAC CE or Multiple Entry Configured Grant Confirmation MAC CE which confirms the configured uplink grant deactivation.

Retransmissions use:

- repetition of configured uplink grants; or

- received uplink grants addressed to CS-RNTI; or

- configured uplink grants with *cg-RetransmissionTimer*, *cg-RRC-RetransmissionTimer* or *cg-SDT-RetransmissionTimer* configured.

## 5.18 Handling of MAC CEs

### 5.18.35 LTM Cell Switch Command

The network may instruct the UE to perform LTM cell switch procedure by sending the LTM Cell Switch Command MAC CE described in clause 6.1.3.75.

The MAC entity shall:

1> if the MAC entity receives an LTM Cell Switch Command MAC CE on a Serving Cell:

2> indicate to upper layers that the LTM cell switch procedure is triggered and the Target Configuration ID included in the LTM Cell Switch Command MAC CE;

2> if the MAC reset operation as specified in clause 5.12 is performed, as requested by upper layers:

3> if Timing Advance Command value (hexa-decimal) is not set as FFF:

4> process the received Timing Advance Command (see clause 5.2);

4> consider the RACH-less LTM cell switch to be ongoing;

4> if the MAC entity is associated with the SCG:

5> indicate to upper layers to skip the Random Access procedure for this LTM cell switch.

3> else if the UE is configured with UE-based Timing Advance measurement as specified in TS 38.331 [5] and the UE has successfully measured the Timing Advance for the SpCell of the indicated LTM target configuration:

4> process the measured Timing Advance (see clause 5.2);

4> consider the RACH-less LTM cell switch to be ongoing.

4> if the MAC entity is associated with the SCG:

5> indicate to upper layers to skip the Random Access procedure for this LTM cell switch.

3> indicate to lower layers the information regarding the TCI state information included in the LTM Cell Switch Command MAC CE.

# 6 Protocol Data Units, formats and parameters

#### 6.1.3.75 LTM Cell Switch Command MAC CE

The LTM Cell Switch Command MAC CE is identified by MAC subheader with eLCID as specified in Table 6.2.1-1b. It has a variable size with following fields (Figure 6.1.3.75-1):

- R: Reserved bit, set to 0;

- Target Configuration ID: This field indicates the index of candidate target configuration to apply for LTM cell switch, corresponding to *ltm-CandidateId* minus 1as specified in TS 38.331 [5]. The length of the field is 3 bits;

- Timing Advance Command: This field indicates whether the TA is valid for the LTM target cell (i.e. the SpCell corresponding to the target configuration indicated by Target Configuration ID field). If the value of this field is set to FFF, this field indicates that no valid timing adjustment is available for the PTAG of the LTM target cell; otherwise, this field indicates the index value *TA* used to control the amount of timing adjustment that the MAC entity has to apply in TS 38.213 [6], and that the UE can skip the Random Access procedure for this LTM cell switch. If *tag-Id-ptr* is configured for the TCI state indicated by the UL TCI state ID field, if present, or by the TCI state ID field otherwise, in the LTM target cell and *tag-Id-ptr* is set to value *n1*, this field indicates the TA for the TAG indicated by the *tag2-Id* of the LTM target cell; otherwise, this field indicates the TA for the TAG indicated by the *tag-id* of the LTM target cell. The length of the field is 12 bits;

- TCI state ID: This field indicates and activates the TCI state for the LTM target cell (i.e. the SpCell of the target configuration indicated by the Target Configuration ID field). The TCI state is identified by *TCI-StateId* in *ltm-DL-OrJointTCI-StateToAddModList* as specified in TS 38.331 [5]. If the value of *unifiedTCI-StateType* in the *ltm-TCI-Info* of the configuration indicated by Target Configuration ID fieldis *joint*, this field is for joint TCI state, otherwise, this field is for downlink TCI state. The length of the field is 7 bits;

- UL TCI state ID: This field indicates and activates the uplink TCI state for the LTM target cell (i.e. the SpCell of the target configuration indicated by the Target Configuration ID field). The UL TCI state is identified by *TCI-UL-StateId* in *ltm-UL-TCI-StateToAddModList* as specified in TS 38.331 [5]. The octet containing this field (i.e. this field and the two reserved bits in the same octet) is included if the value of *unifiedTCI-StateType* in the *ltm-TCI-Info* of the configuration indicated by Target Configuration ID fieldis *separate*. The length of the field is 6 bits;

- C: This field indicates the presence of the contention-free Random Access Resources fields. If the value of this field is set to 1, the following fields are present: Random Access Preamble index field, S/U field, SS/PBCH index field, PRACH Mask index field, Repetition number field and the reserved bits in the same octet. If the value of this field is set to 0, these fields are absent.

- S/U: This field indicates which UL carrier to transmit the PRACH of the contention-free Random Access Resources. If the value of this field is set to 1, SUL is used; otherwise, NUL is used. The length of the field is 1 bit;

- Random Access Preamble index: This field indicates the Random Access Preamble index of the contention-free Random Access Resources. This field should not be set to 0b000000. The length of the field is 6 bits;

- SS/PBCH index: This field indicates the SS/PBCH that shall be used to determine the RACH occasion for the PRACH transmission of the contention-free Random Access Resources. The length of the field is 6 bits;

- PRACH Mask index: This field indicates the RACH occasion(s) associated with the SS/PBCH indicated by 'SS/PBCH index' for the PRACH transmission of the contention-free Random Access Resources. It indicates a subset of RACH occasion(s) from the *rach-ConfigDedicated* for the UL carrier (indicated by S/U field), (if provided, otherwise it indicates a subset of RACH occasion(s) from the *rach-ConfigCommon* for the UL carrier (indicated by S/U field) in the UL BWP configuration of *firstActiveUplinkBWP-Id* as specified in TS 38.331 [5]. When the repetition number field is not set to 0, the UE ignores this field. The length of the field is 4 bits;

- Repetition number: This field indicates the Msg1 repetition number to be applied to the contention-free Random Access. If this field is set to 0, Msg1 repetition number does not apply. If this field is set to 1, the Msg1 repetition number is 2. If this field is set to 2, the Msg1 repetition number is 4. If this field is set to 3, the Msg1 repetition number is 8. The length of the field is 2 bits.

NOTE 1: A non-zero Msg1 repetition number value may only be included in the LTM Cell Switch Command MAC CE when the LTM target cell configuration has contention-based Random Access Resources with a *FeatureCombinationPreambles* with the same Msg1 repetition number value and *featureCombination* indicating only *msg1-Repetitions*.



Figure 6.1.3.75-1: LTM Cell Switch Command MAC CE

NOTE 2: If UE receives the LTM Cell Switch Command MAC CE with a Target Configuration ID value not matching any configured *ltm-CandidateId* minus 1, as specified in TS 38.331 [5], the procedure of handling LTM Cell Switch Command MAC CE in clause 5.18.35 does not apply.