**3GPP TSG-RAN2 Meeting #110-e *R2-2005756***

**Online, , 1st Jun 2020 - 12th Jun 2020**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
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|  | **36.300** | **CR** | **1284** | **rev** | **1** | **Current version:** | **16.1.0** |  |
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| *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:***  | Corrections to even further mobility enhancement in E-UTRAN |
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| ***Source to WG:*** | China Telecom |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | LTE\_feMob-Core |  | ***Date:*** | 2020-05-21 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-16 |
|  | *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-12 (Release 12)Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
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| ***Reason for change:*** | to capture updates from RAN2#109bis-e |
|  |  |
| ***Summary of change:*** | 1. add the discription of non-DAPS DRBs in 10.1.2.1.2 which has been aggreed in CR R2-2003858.
2. changes to RLF to make the text clear in 10.1.6
3. add notes according to the following agreements in 10.1.2.1, 10.1.2.1a

- Update section 9.2.3.4.2 of TS 38.300 with a NOTE: ‘’source gNB can reconfigure the UE even after providing CHO configuration for candidate target cells’’ .-LTE DAPS+ LTE RACH-less is not allowed1. corrections to some wording details.
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| ***Consequences if not approved:*** | Missing details and unclear text remains. |
|  |  |
| ***Clauses affected:*** | 3.1, 10.1.2.1, 10.1.2.1a, 10.1.6 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.331TS 36.306TS 36.321TS 36.323 |
| ***affected:*** |  | **X** |  Test specifications |  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications |  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

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| Start of changes |

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

**Access Control:** the process that checks whether a UE is allowed to access and to be granted services in a closed cell.

**Aerial UE communication**: functionality enabling Aerial UE function as defined in 23.17.

**Anchor carrier**: in NB-IoT, a carrier where the UE assumes that NPSS/NSSS/NPBCH/SIB-NB for FDD or NPSS/NSSS/NPBCH for TDD are transmitted.

**Carrier frequency**: center frequency of the cell.

**Cell:** combination of downlink and optionally uplink resources. The linking between the carrier frequency of the downlink resources and the carrier frequency of the uplink resources is indicated in the system information transmitted on the downlink resources.

**Cell Group**: in dual connectivity, a group of serving cells associated with either the MeNB or the SeNB.

**CHO candidate cell: a** candidate cell for CHO, for which UE has been configured with a CHO configuration.

**Conditional Handover (CHO): a** handover procedure that is executed only when execution condition(s) are met.

**Control plane CIoT 5GS Optimisation**: Enables support of efficient transport of user data (IP, Ethernet and Unstructured) or SMS messages over control plane via the AMF without triggering user-plane resource establishment, as defined in TS 24.501 [91]. In the context of this specification, a NB-IoT UE that only supports Control plane CIoT 5GS Optimisation is a UE that does not support User plane CIoT 5GS Optimisation and NG-U data transfer but may support other CIoT 5GS Optimisations.

**Control plane CIoT EPS optimisation**: Enables support of efficient transport of user data (IP, non-IP or SMS) over control plane via the MME without triggering data radio bearer establishment, as defined in TS 24.301 [20]. In the context of this specification, a NB-IoT UE that only supports Control plane CIoT EPS optimisation is a UE that does not support User plane CIoT EPS optimisation and S1-U data transfer but may support other CIoT EPS optimisations.

**CSG Cell:** a cell broadcasting a CSG indicator set to true and a specific CSG identity.

**CSG ID Validation:** the process that checks whether the CSG ID received via handover messages is the same as the one broadcast by the target E-UTRAN.

**CSG member cell:** a cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN and for which the CSG whitelist of the UE includes an entry comprising cell's CSG ID and the respective PLMN identity.

**DAPS Handover:** a handover procedure that maintains the source eNB connection after reception of RRC message for handover and until releasing the source cell after successful random access to the target eNB.

**DCN-ID:** DCN identity identifies a specific dedicated core network (DCN).

**Dual Connectivity**: mode of operation of a UE in RRC\_CONNECTED, configured with a Master Cell Group and a Secondary Cell Group.

**en-gNB**: as defined in TS 37.340 [76].

**E-RAB:** an E-RAB uniquely identifies the concatenation of an S1 Bearer and the corresponding Data Radio Bearer. When an E-RAB exists, there is a one-to-one mapping between this E-RAB and an EPS bearer of the Non Access Stratum as defined in [17].

**Frequency layer**: set of cells with the same carrier frequency.

**FeMBMS:** further enhanced multimedia broadcast multicast service.

**FeMBMS/Unicast-mixed cell**: cell supporting MBMS transmission and unicast transmission as SCell.

**Handover**: procedure that changes the serving cell of a UE in RRC\_CONNECTED.

**Hybrid cell**: a cell broadcasting a CSG indicator set to false and a specific CSG identity. This cell is accessible as a CSG cell by UEs which are members of the CSG and as a normal cell by all other UEs.

**Local Home Network**: as defined in TS 23.401 [17].

**LTE bearer**: in LTE-WLAN Aggregation, a bearer whose radio protocols are located in the eNB only to use eNB radio resources only.

**LWA bearer**: in LTE-WLAN Aggregation, a bearer whose radio protocols are located in both the eNB and the WLAN to use both eNB and WLAN resources.

**LWAAP PDU**: in LTE-WLAN Aggregation, a PDU with DRB ID generated by LWAAP entity for transmission over WLAN.

**Make-Before-Break HO/SeNB change**: maintaining source eNB/SeNB connection after reception of RRC message for handover or change of SeNB before the initial uplink transmission to the target eNB during handover or change of SeNB.

**Master Cell Group**: in dual connectivity, a group of serving cells associated with the MeNB, comprising of the PCell and optionally one or more SCells.

**Master eNB**: in dual connectivity, the eNB which terminates at least S1-MME.

**MBMS-dedicated cell**: cell dedicated to MBMS transmission.

**MBMS/Unicast-mixed cell**: cell supporting both unicast and MBMS transmissions.

**MCG bearer**: in dual connectivity, a bearer whose radio protocols are only located in the MeNB to use MeNB resources only.

**Membership Verification:** the process that checks whether a UE is a member or non-member of a hybrid cell.

**Multi-Connectivity**: Mode of operation whereby a multiple Rx/Tx UE in the connected mode is configured to utilise radio resources amongst E-UTRA and/or NR provided by multiple distinct schedulers connected via non-ideal backhaul.

**NB-IoT:** NB-IoT allows access to network services via E-UTRA with a channel bandwidth limited to 200 kHz.

**NB-IoT UE**: a UE that uses NB-IoT.

**ng-eNB:** node providing E-UTRA user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**Non-anchor carrier**: in NB-IoT, a carrier where the UE does not assume that NPSS/NSSS/NPBCH/SIB-NB for FDD or NPSS/NSSS/NPBCH for TDD are transmitted.

**NR:** NR radio access

**NR sidelink communication**: AS functionality enabling at least V2X Communication as defined in TS 23.287 [93], between two or more nearby UEs, using NR technology but not traversing any network node.

**PLMN ID Check:** the process that checks whether a PLMN ID is the RPLMN identity or an EPLMN identity of the UE.

**Power saving mode**: mode configured and controlled by NAS that allows the UE to reduce its power consumption, as defined in TS 24.301 [20], TS 23.401 [17], TS 23.682 [57].

**Primary PUCCH group:** a group of serving cells including PCell whose PUCCH signalling is associated with the PUCCH on PCell.

**Primary Timing Advance Group**: Timing Advance Group containing the PCell. In this specification, Primary Timing Advance Group refers also to Timing Advance Group containing the PSCell unless explicitly stated otherwise.

**ProSe-enabled Public Safety UE:** a UE that the HPLMN has configured to be authorized for Public Safety use, and which is ProSe-enabled and supports ProSe procedures and capabilities specific to Public Safety. The UE may, but need not, have a USIM with one of the special access classes {12, 13, 14}.

**ProSe Per-Packet Priority:** a scalar value associated with a protocol data unit that defines the priority handling to be applied for transmission of that protocol data unit.

**ProSe UE-to-Network Relay:** a UE that provides functionality to support connectivity to the network for Remote UE(s).

**ProSe UE-to-Network Relay Selection:** Process of identifying a potential ProSe UE-to Network Relay, which can be used for connectivity services (e.g. to communicate with a PDN).

**ProSe UE-to-Network Relay Reselection:** process of changing previously selected ProSe UE-to-Network Relay and identifying potential a new ProSe UE-to-Network Relay, which can be be used for connectivity services (e.g. to communicate with PDN).

**Public Safety ProSe Carrier:** carrier frequency for public safety sidelink communication and public safety sidelink discovery.

**PUCCH group:** either primary PUCCH group or a secondary PUCCH group.

**PUCCH SCell:** a Secondary Cell configured with PUCCH.

**RACH-less HO/SeNB change**: skipping random access procedure during handover or change of SeNB.

**Receive Only Mode:** See TS 23.246 [48].

**Remote UE:** a ProSe-enabled Public Safety UE, that communicates with a PDN via a ProSe UE-to-Network Relay.

**SCG bearer**: in dual connectivity, a bearer whose radio protocols are only located in the SeNB to use SeNB resources.

**Secondary Cell Group**: in dual connectivity, a group of serving cells associated with the SeNB, comprising of PSCell and optionally one or more SCells.

**Secondary eNB**: in dual connectivity, the eNB that is providing additional radio resources for the UE but is not the Master eNB.

**Secondary PUCCH group:** a group of SCells whose PUCCH signalling is associated with the PUCCH on the PUCCH SCell.

**Secondary Timing Advance Group**: Timing Advance Group containing neither the PCell nor PSCell.

**Short Processing Time**: For 1 ms TTI length, the operation with short processing time in UL data transmission and DL data reception.

**Short TTI:** TTI length based on a slot or a subslot.

**Sidelink**: UE to UE interface for sidelink communication, V2X sidelink communication and sidelink discovery. The Sidelink corresponds to the PC5 interface as defined in TS 23.303 [62].

**Sidelink Control period**: period over which resources are allocated in a cell for sidelink control information and sidelink data transmissions. The Sidelink Control period corresponds to the PSCCH period as defined in TS 36.213 [6].

**Sidelink communication**: AS functionality enabling ProSe Direct Communication as defined in TS 23.303 [62], between two or more nearby UEs, using E-UTRA technology but not traversing any network node. In this version, the terminology "sidelink communication" without "V2X" prefix only concerns PS unless specifically stated otherwise.

**Sidelink discovery**: AS functionality enabling ProSe Direct Discovery as defined in TS 23.303 [62], using E-UTRA technology but not traversing any network node.

**Split bearer**: in dual connectivity, a bearer whose radio protocols are located in both the MeNB and the SeNB to use both MeNB and SeNB resources.

**Split LWA bearer**: in LTE-WLAN Aggregation, a bearer whose radio protocols are located in both the eNB and the WLAN to use both eNB and WLAN radio resources.

**Switched LWA bearer**: in LTE-WLAN Aggregation, a bearer whose radio protocols are located in both the eNB and the WLAN but uses WLAN radio resources only.

**Timing Advance Group**: a group of serving cells that is configured by RRC and that, for the cells with an UL configured, use the same timing reference cell and the same Timing Advance value.

**User plane CIoT 5GS Optimisation**: Enables support for change from 5GMM-IDLE mode to 5GMM-CONNECTED mode without the need for using the Service Request procedure, as defined in TS 24.501 [91].

**User plane CIoT EPS optimisation**: Enables support for change from EMM-IDLE mode to EMM-CONNECTED mode without the need for using the Service Request procedure, as defined in TS 24.301 [20].

**V2X sidelink communication**: AS functionality enabling V2X Communication as defined in TS 23.285 [72], between nearby UEs, using E-UTRA technology but not traversing any network node.

**WLAN Termination**: the logical node that terminates the Xw interface on the WLAN side.

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| Start of next changes |

### 10.1.2 Mobility Management in ECM-CONNECTED/CM-CONNECTED

#### 10.1.2.0 General

The Intra-E-UTRAN-Access Mobility Support for UEs in ECM-CONNECTED/CM-CONNECTED handles all necessary steps for

- Handover procedures, like processes that precede the final HO decision on the source network side (control and evaluation of UE and eNB measurements taking into account certain UE specific roaming and access restrictions), preparation of resources on the target network side, commanding the UE to the new radio resources and finally releasing resources on the (old) source network side. It contains mechanisms to transfer context data between evolved nodes, and to update node relations on C-plane and U-plane. A CHO (for more details, see 10.1.2.1a) configuration may be also included in the handover procedures.

- DC specific procedures, like processes that precede the final decision for a certain configuration of a SeNB (control and evaluation of UE and network side measurements), preparation of respective resources on the network side of a SeNB, commanding the UE to the new radio resources configuration for a second connection and, if applicable, finally releasing resources of a SeNB. It contains mechanisms to transfer UE- and bearer-context data between involved nodes, and to update node relations on C-plane and U-plane.

In E-UTRAN RRC\_CONNECTED state, network-controlled UE-assisted handovers and DC specific activities are performed and various DRX cycles are supported.

The UE makes measurements of attributes of the serving and neighbour cells to enable the process:

- There is no need to indicate neighbouring cells to enable the UE to search and measure a cell i.e. E-UTRAN relies on the UE to detect the neighbouring cells;

- For the search and measurement of inter-frequency neighbouring cells, at least the carrier frequencies need to be indicated;

- The E-UTRAN signals reporting criteria for event-triggered and periodical reporting;

- An NCL can be provided by the serving cell by RRC dedicated signalling to handle specific cases for intra- and inter-frequency neighbouring cells. This NCL contains cell specific measurement parameters (e.g. cell specific offset) for specific neighbouring cells;

- Black lists can be provided to prevent the UE from measuring specific neighbouring cells.

For the UE measuring discovery signals (i.e. CRS and/or CSI-RS) of the serving and neighbour cells, the E-UTRAN indicates the measurement configuration to the UE, including the measurement timing configuration of the discovery signals.

Depending on whether the UE needs transmission/reception gaps to perform the relevant measurements, measurements are classified as gap assisted or non-gap assisted. A non-gap assisted measurement is a measurement on a cell that does not require transmission/reception gaps to allow the measurement to be performed. A gap assisted measurement is a measurement on a cell that does require transmission/reception gaps to allow the measurement to be performed. Gap patterns (as opposed to individual gaps) are configured and activated by RRC.

In the text and figure(s) in the following clauses, intra-E-UTRA HO description is applicable for both intra-EPC and intra-5GC cases. In addition, the following differences are applicable for intra-5GC:

- ng-eNB should be considered instead of eNB;

- 5GC should be considered instead of EPC, and NG interface should be considered instead of S1 interface;

- Xn interface should be considered instead of X2 interface and the messages sent between ng-eNBs over Xn are defined in TS 38.423 [86];

- AMF should be considered intead of MME, and UPF should be considered instead of Serving Gateway;

- PDU session information should be considered instead of E-RAB QoS, and the QoS flow to DRB mapping rules applied to the UE should be forwarded to the target ng-eNB;

- For the messages sent between MME and Serving Gateway, and between MME and eNB, use AMF/UPF/ng-eNB respectively;

- The data forwarding defined in clause 9.2.3.2.3 in TS 38.300 [79] should be applied instead of clause 10.1.2.3;

- The Dual Connectivity operation in clause 10.1.2.8 is not applicable to intra-5GC mobility. The corresponding Dual Connectivity operations for 5GC are described in TS 37.340 [76].

#### 10.1.2.1 Handover

The intra E-UTRAN HO of a UE in RRC\_CONNECTED state is a UE-assisted network-controlled HO, with HO preparation signalling in E-UTRAN:

- Part of the HO command comes from the target eNB and is transparently forwarded to the UE by the source eNB;

- To prepare the HO, the source eNB passes all necessary information to the target eNB (e.g. E-RAB attributes and RRC context):

- When CA is configured and to enable SCell selection in the target eNB, the source eNB can provide in decreasing order of radio quality a list of the best cells and optionally measurement result of the cells.

- When DC is configured, the source MeNB provides the SCG configuration (in addition to the MCG configuration) to the target MeNB.

- Both the source eNB and UE keep some context (e.g. C-RNTI) to enable the return of the UE in case of HO failure;

- If RACH-less HO is not configured, the UE accesses the target cell via RACH following a contention-free procedure using a dedicated RACH preamble or following a contention-based procedure if dedicated RACH preambles are not available:

- the UE uses the dedicated preamble until the handover procedure is finished (successfully or unsuccessfully);

- If RACH-less HO is configured, the UE accesses the target cell via the uplink grant preallocated to the UE in the RRC message. If the UE does not receive the preallocated uplink grant in the RRC message from the source eNB, the UE monitors the PDCCH of the target cell;

- If DAPS handover is configured, the UE continues the downlink user data reception from the source eNB until releasing the source cell and continues the uplink user data transmission to the source eNB until successful random access procedure to the target eNB. Upon reception of the handover command, the UE:

- Creates a MAC entity for target cell;

- Establishes the RLC entity and an associated DTCH logical channel for target cell for each DRB configured with DAPS;

- For the DRB(s) configured with DAPS, reconfigures the PDCP entity to configure DAPS with separate security and ROHC functions for source and target and associates them with the RLC entities configured for source and target respectively;

- Retains rest of the source link configurations until release of the source.

NOTE: The handling on RLC and PDCP for DRBs without DAPS is same as in normal handover.

- If the access towards the target cell (using RACH or RACH-less procedure) is not successful within a certain time, the UE initiates radio link failure recovery using a suitable cell except in DAPS handover or CHO scenarios:

- When DAPS handover fails, the UE falls back to source cell configuration, resumes the connection with source cell, and reports the DAPS handover failure via the source without triggering RRC connection re-establishment if the source link is still available; Otherwise, RRC re-establishment is performed;

- When initial CHO execution attempt fails or HO fails, if network configured the UE to try CHO after HO/CHO failure and the UE performs cell selection to a CHO candidate cell, the UE attempts CHO execution to that cell; Otherwise, RRC re-establishment is performed.

- No ROHC context is transferred at handover;

- No UDC context is transferred at handover;

- ROHC context can be kept at handover within the same eNB.

##### 10.1.2.1.1 C-plane handling

The preparation and execution phase of the HO procedure is performed without EPC involvement, i.e. preparation messages are directly exchanged between the eNBs. The release of the resources at the source side during the HO completion phase is triggered by the eNB. In case an RN is involved, its DeNB relays the appropriate S1 messages between the RN and the MME (S1-based handover) and X2 messages between the RN and target eNB (X2-based handover); the DeNB is explicitly aware of a UE attached to the RN due to the S1 proxy and X2 proxy functionality (see clause 4.7.6.6). The figure below depicts the basic handover scenario where neither MME nor Serving Gateway changes:



Figure 10.1.2.1.1-1: Intra-MME/Serving Gateway HO

Below is a more detailed description of the intra-MME/Serving Gateway HO procedure:

0 The UE context within the source eNB contains information regarding roaming and access restrictions which were provided either at connection establishment or at the last TA update.

1 The source eNB configures the UE measurement procedures according to the roaming and access restriction information and e.g. the available multiple frequency band information. Measurements provided by the source eNB may assist the function controlling the UE's connection mobility.

2 A MEASUREMENT REPORT is triggered and sent to the eNB.

3 The source eNB makes decision based on MEASUREMENT REPORT and RRM information to hand off the UE.

4 The source eNB issues a HANDOVER REQUEST message to the target eNB passing necessary information to prepare the HO at the target side (UE X2 signalling context reference at source eNB, UE S1 EPC signalling context reference, target cell ID, KeNB\*, RRC context including the C-RNTI of the UE in the source eNB, AS-configuration, E-RAB context and physical layer ID of the source cell + short MAC-I for possible RLF recovery). UE X2 / UE S1 signalling references enable the target eNB to address the source eNB and the EPC. The E-RAB context includes necessary RNL and TNL addressing information, and QoS profiles of the E-RABs.

5 Admission Control may be performed by the target eNB dependent on the received E-RAB QoS information to increase the likelihood of a successful HO, if the resources can be granted by target eNB. The target eNB configures the required resources according to the received E-RAB QoS information and reserves a C-RNTI and optionally a RACH preamble. The AS-configuration to be used in the target cell can either be specified independently (i.e. an "establishment") or as a delta compared to the AS-configuration used in the source cell (i.e. a "reconfiguration").

6 The target eNB prepares HO with L1/L2 and sends the HANDOVER REQUEST ACKNOWLEDGE to the source eNB. The HANDOVER REQUEST ACKNOWLEDGE message includes a transparent container to be sent to the UE as an RRC message to perform the handover. The container includes a new C-RNTI, target eNB security algorithm identifiers for the selected security algorithms, may include a dedicated RACH preamble, and possibly some other parameters i.e. access parameters, SIBs, etc. If RACH-less HO is configured, the container includes timing adjustment indication and optionally a preallocated uplink grant. The HANDOVER REQUEST ACKNOWLEDGE message may also include RNL/TNL information for the forwarding tunnels, if necessary.

NOTE 1: As soon as the source eNB receives the HANDOVER REQUEST ACKNOWLEDGE, or as soon as the transmission of the handover command is initiated in the downlink, data forwarding may be initiated.

Steps 7 to 16 provide means to avoid data loss during HO and are further detailed in 10.1.2.1.2 and 10.1.2.3.

7 The target eNB generates the RRC message to perform the handover, i.e. *RRCConnectionReconfiguration* message including the *mobilityControlInformation*, to be sent by the source eNB towards the UE. The source eNB performs the necessary integrity protection and ciphering of the message.

The UE receives the *RRCConnectionReconfiguration* message with necessary parameters (i.e. new C-RNTI, target eNB security algorithm identifiers, and optionally dedicated RACH preamble, target eNB SIBs, etc.) and is commanded by the source eNB to perform the HO. If RACH-less HO is configured, the *RRCConnectionReconfiguration* includes timing adjustment indication and optionally preallocated uplink grant for accessing the target eNB. If preallocated uplink grant is not included, the UE should monitor PDCCH of the target eNB to receive an uplink grant. The UE does not need to delay the handover execution for delivering the HARQ/ARQ responses to source eNB.

If Make-Before-Break HO is configured, the connection to the source cell is maintained after the reception of *RRCConnectionReconfiguration* message with *mobilityControlInformation* before the UE executes initial uplink transmission to the target cell.

NOTE 2: If Make-Before-Break HO is configured, the source eNB decides when to stop transmitting to the UE.

NOTE 3: The UE can be configured with Make-Before-Break HO and RACH-less HO simultaneously.

In case of DAPS HO, the UE does not detach from the source cell upon receiving the *RRCConnectionReconfiguration* message. The UE releases the source SRB resources, security configuration of the source cell and stops DL/UL reception/transmission with the source upon receiving an explicit release from the target node.

NOTE 4: DAPS HO and RACH-less HO cannot be configured simultaneously.

NOTE 5: DAPS HO and CHO cannot be configured simultaneously.

NOTE 6: DAPS HO cannot be configured with DC configuration simultaneously.

8 The source eNB sends the SN STATUS TRANSFER message to the target eNB to convey the uplink PDCP SN receiver status and the downlink PDCP SN transmitter status of E-RABs for which PDCP status preservation applies (i.e. for RLC AM). The uplink PDCP SN receiver status includes at least the PDCP SN of the first missing UL SDU and may include a bit map of the receive status of the out of sequence UL SDUs that the UE needs to retransmit in the target cell, if there are any such SDUs. The downlink PDCP SN transmitter status indicates the next PDCP SN that the target eNB shall assign to new SDUs, not having a PDCP SN yet. The source eNB may omit sending this message if none of the E-RABs of the UE shall be treated with PDCP status preservation.

9 If RACH-less HO is not configured, after receiving the *RRCConnectionReconfiguration* message including the *mobilityControlInformation* , UE performs synchronisation to target eNB and accesses the target cell via RACH, following a contention-free procedure if a dedicated RACH preamble was indicated in the *mobilityControlInformation*, or following a contention-based procedure if no dedicated preamble was indicated. UE derives target eNB specific keys and configures the selected security algorithms to be used in the target cell.

If RACH-less HO is configured, UE performs synchronisation to target eNB. UE derives target eNB specific keys and configures the selected security algorithms to be used in the target cell.

10 If RACH-less HO is not configured, the target eNB responds with UL allocation and timing advance.

10a If RACH-less HO is configured and the UE did not get the periodic pre-allocated uplink grant in the *RRCConnectionReconfiguration* message including the *mobilityControlInfo*, the UE receives uplink grant via the PDCCH of the target cell. The UE uses the first available uplink grant after synchronization to the target cell.

11 When the RACH-less HO is not configured and the UE has successfully accessed the target cell, the UE sends the *RRCConnectionReconfigurationComplete* message (C-RNTI) to confirm the handover, along with an uplink Buffer Status Report, and/or UL data, whenever possible, to the target eNB, which indicates that the handover procedure is completed for the UE. The target eNB verifies the C-RNTI sent in the *RRCConnectionReconfigurationComplete* message. The target eNB can now begin sending data to the UE.

 When the RACH-less HO is configured, after the UE has received uplink grant, the UE sends the *RRCConnectionReconfigurationComplete* message (C-RNTI) to confirm the handover, along with an uplink Buffer Status Report, and/or UL data, whenever possible, to the target eNB. The target eNB verifies the C-RNTI sent in the *RRCConnectionReconfigurationComplete* message. The target eNB can now begin sending data to the UE. The handover procedure is completed for the UE when the UE receives the UE contention resolution identity MAC control element from the target eNB.

12 The target eNB sends a PATH SWITCH REQUEST message to MME to inform that the UE has changed cell.

13 The MME sends a MODIFY BEARER REQUEST message to the Serving Gateway.

14 The Serving Gateway switches the downlink data path to the target side. The Serving gateway sends one or more "end marker" packets on the old path to the source eNB and then can release any U-plane/TNL resources towards the source eNB.

15 The Serving Gateway sends a MODIFY BEARER RESPONSE message to MME.

16 The MME confirms the PATH SWITCH REQUEST message with the PATH SWITCH REQUEST ACKNOWLEDGE message.

17 By sending the UE CONTEXT RELEASE message, the target eNB informs success of HO to source eNB and triggers the release of resources by the source eNB. The target eNB sends this message after the PATH SWITCH REQUEST ACKNOWLEDGE message is received from the MME.

18 Upon reception of the UE CONTEXT RELEASE message, the source eNB can release radio and C-plane related resources associated to the UE context. Any ongoing data forwarding may continue.

When an X2 handover is used involving HeNBs and when the source HeNB is connected to a HeNB GW, a UE CONTEXT RELEASE REQUEST message including an explicit GW Context Release Indication is sent by the source HeNB, in order to indicate that the HeNB GW may release of all the resources related to the UE context.

##### 10.1.2.1.2 U-plane handling

The U-plane handling during the Intra-E-UTRAN-Access mobility activity for UEs in ECM-CONNECTED takes the following principles into account to avoid data loss during HO:

- During HO preparation U-plane tunnels can be established between the source eNB and the target eNB. There is one tunnel established for uplink data forwarding and another one for downlink data forwarding for each E-RAB for which data forwarding is applied. In the case of a UE under an RN performing handover, forwarding tunnels can be established between the RN and the target eNB via the DeNB.

- During HO execution, user data can be forwarded from the source eNB to the target eNB. The forwarding may take place in a service and deployment dependent and implementation specific way.

- Forwarding of downlink user data from the source to the target eNB should take place in order as long as packets are received at the source eNB from the EPC or the source eNB buffer has not been emptied.

- During HO completion:

- The target eNB sends a PATH SWITCH message to MME to inform that the UE has gained access and MME sends a MODIFY BEARER REQUEST message to the Serving Gateway, the U-plane path is switched by the Serving Gateway from the source eNB to the target eNB.

- The source eNB should continue forwarding of U-plane data as long as packets are received at the source eNB from the Serving Gateway or the source eNB buffer has not been emptied.

For **RLC-AM bearers**:

- During normal HO not involving Full Configuration:

- For in-sequence delivery and duplication avoidance, PDCP SN is maintained on a bearer basis and the source eNB informs the target eNB about the next DL PDCP SN to allocate to a packet which does not have a PDCP sequence number yet (either from source eNB or from the Serving Gateway).

- For security synchronisation, HFN is also maintained and the source eNB provides to the target one reference HFN for the UL and one for the DL i.e. HFN and corresponding SN.

- In both the UE and the target eNB, a window-based mechanism is needed for duplication detection.

- The occurrence of duplicates over the air interface in the target eNB is minimised by means of PDCP SN based reporting at the target eNB by the UE. In uplink, the reporting is optionally configured on a bearer basis by the eNB and the UE should first start by transmitting those reports when granted resources in the target eNB. In downlink, the eNB is free to decide when and for which bearers a report is sent and the UE does not wait for the report to resume uplink transmission.

- The target eNB re-transmits and prioritizes all downlink PDCP SDUs forwarded by the source eNB (i.e. the target eNB should send data with PDCP SNs from X2 before sending data from S1), with the exception of PDCP SDUs of which the reception was acknowledged through PDCP SN based reporting by the UE.

- The UE re-transmits in the target eNB all uplink PDCP SDUs starting from the first PDCP SDU following the last consecutively confirmed PDCP SDU i.e. the oldest PDCP SDU that has not been acknowledged at RLC in the source, excluding the PDCP SDUs of which the reception was acknowledged through PDCP SN based reporting by the target.

- During HO involving Full Configuration:

- The following description below for RLC-UM bearers also applies for RLC-AM bearers. Data loss may happen.

For **RLC-UM bearers**:

- The PDCP SN and HFN are reset in the target eNB.

- No PDCP SDUs are retransmitted in the target eNB.

- The target eNB prioritizes all downlink PDCP SDUs forwarded by the source eNB if any (i.e. the target eNB should send data with PDCP SNs from X2 before sending data from S1).

- The UE PDCP entity does not attempt to retransmit any PDCP SDU in the target cell for which transmission had been completed in the source cell. Instead UE PDCP entity starts the transmission with other PDCP SDUs.

For DAPS handover:

DRBs can be configured as DAPS or non-DAPS. For DRBs configured with DAPS, following procedure is used.

Downlink:

- Source eNB is responsible for allocating DL PDCP SNs until it sends the last SN STATUS TRANSFER message to the target eNB, after that target eNB will start allocating DL PDCP SNs.

- Upon allocation of DL PDCP SNs by Source eNB, it starts scheduling downlink data on source radio link and also starts forwarding DL PDCP SDUs along with assigned PDCP SNs to target eNB.

Editor's note: FFS whether the above two bullets will be removed for being left to RAN3 or updated based on RAN3 discussion.

- Source eNB and target eNB will perform ROHC header compression, ciphering and adding PDCP header separately.

- During handover execution period UE will continue to receive downlink data from both source eNB and target eNBs until source eNB connection is released by an explicit release command from target eNB.

- UE DAPS PDCP will maintain separate security and ROHC header decompression associated with source and target eNB, while also maintaining common reordering function, duplicate detection, discard function and PDCP SDUs in- sequence delivery to upper layers and PDCP SN continuity will be supported for both RLC AM and UM DRBs configured with DAPS.

Uplink:

- UE will transmit UL data to source eNB until the random access procedure towards the target eNB has been successfully completed. Afterwards the UE switches its UL data transmission to target eNB.

- After switching its UL data transmissions to target eNB, UE will continue to send UL layer 1 CSI feedback, HARQ feedback, layer 2 RLC feedback, ROHC feedback, HARQ data re-transmissions and RLC data re-transmission to source eNB.

- UE maintains separate security and ROHC header compressor context for uplink transmissions towards source and target eNBs. UE maintain common UL PDCP SN allocation and PDCP SN continuity will be supported for both RLC AM and UM DRBs configured with DAPS when UE switches UL data transmission from source to target eNB.

- Source eNB and Target eNBs will maintain their own security and ROHC header decompressor contexts to process UL data received from UE.

For DRBs not configured with DAPS, upon UE receiving DAPS handover command message, UE stops transmission and reception of data from source cell and keeps source cell non-DAPS DRB configuration. When DAPS handover to target cell fails and if source cell link is available then UE will revert back to source cell configuration prior to the reception of DAPS handover command(including RLC, PDCP state variables and buffers).

Upon receiving DAPS handover command message, UE suspends source cell SRBs, stops sending and receiving any RRC control plane signalling towards source cell and establishes SRBs for target cell. UE releases the source cell SRBs configuration upon receiving source cell release indication from target cell after successful DAPS handover execution. When DAPS handover to target cell fails and if source cell link is available then UE will revert back to source cell configuration and activates source cell SRBs for control plane signalling.

During DAPS handover, UE maintains only PCell connection with both source and target cells and any configured SCells are released by network. When DAPS handover is configured, PDCP duplication is not allowed.

Editor's Note: FFS how to capture DAPS data forwarding based on RAN3 discussion.

#### 10.1.2.1a Conditional Handover

##### 10.1.2.1a.1 General

A Conditional Handover (CHO) is defined as a handover that is executed by the UE when one or more handover execution conditions are met. The UE starts evaluating the execution condition(s) for CHO candidate cells upon receiving the CHO configuration, and executes the HO command once the execution condition(s) are met for a CHO candidate cell. UE stops evaluating the execution condition(s) for other candidate cells once the execution condition(s) are met.

The following principles apply to CHO:

- The CHO configuration contains the configuration of CHO candidate cell(s) generated by each CHO candidate cell and execution condition(s) generated by the source cell.

- An execution condition may consist of one or two trigger condition(s) (A3/A5). Only single RS type is supported and at most two different trigger quantities (e.g. RSRP and RSRQ, RSRP and SINR, etc.) can be configured simultaneously for the evaluation of CHO execution condition of a single candidate cell.

- UE maintains connection with source eNB until UE determines a CHO execution condition is met for CHO candidate cell.

- Before any CHO execution condition is satisfied, upon reception of HO command (without CHO configuration), the UE executes the HO procedure as described in clause 10.1.2.1, regardless of any previously received CHO configuration.

- After source eNB sends CHO command to UE, the network is allowed to change source eNB configuration and network can add, modify or release a configured CHO configuration using RRC message (i.e. until UE starts executing CHO.

- While executing CHO, i.e. from the time when the UE starts synchronization with target cell, UE does not monitor source cell.

NOTE: CHO is not supported for S1 based handover in this release of the specification.

##### 10.1.2.1a.2 C-plane handling

The figure below depicts the CHO scenario where neither MME nor Serving Gateway changes:



Figure 10.1.2.1a-1: Intra-MME/Serving Gateway Conditional Handover

1. The source eNB configures the UE with measurement configuration, which may be used by UE to trigger Measurement Reports for potential CHO candidate cell(s).

2. A MEASUREMENT REPORT is triggered and sent to the source eNB.

3. The source eNB makes decision on the usage of CHO to handoff the UE based on MEASUREMENT REPORT information.

4. The source eNB sends a CHO Request message to the eNB(s) of candidate cell(s).

5. Same as step 5 in Figure 10.1.2.1.1-1 of clause 10.1.2.1.1.

6. The eNB(s) of candidate cell(s) sends CHO response including configuration of CHO candidate cell(s) to the source eNB.

7. The source eNB sends a *RRCConnectionReconfiguration* message to the UE, containing configuration of CHO candidate cell(s) and CHO execution condition(s). The source eNB decides on the condition for the execution of CHO and adds the condition(s) to the RRC message sent to UE.

NOTE: the source eNB may reconfigure the UE’s source configuration after providing CHO configuration for candidate target cell(s).

8. UE sends an *RRCConnectionReconfigurationComplete* message to the source eNB.

9. UE maintains connection with source eNB after receiving CHO configuration, and starts evaluating the CHO execution condition(s) for the CHO candidate cell(s). If at least one CHO candidate cell satisfies the corresponding CHO execution condition, the UE detaches from the source eNB, applies the stored corresponding configuration for that candidate cell and synchronises to that candidate cell.

10-11. The UE accesses to the target eNB and completes the handover procedure by sending *RRCConnectionReconfigurationComplete* message to target eNB. The UE releases stored CHO configurations after successful completion of RRC handover procedure.

12. Steps 12-18 as in Figure 10.1.2.1.1-1.

Editor's note: FFS how to perform data forwarding, RAN3 scope.

##### 10.1.2.1a.3 U-plane handling

Editor's note: FFS based on RAN3 decisions

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| --- |
| Start of next changes |

### 10.1.6 Radio Link Failure

Two phases govern the behaviour associated to radio link failure as shown on Figure 10.1.6-1:

- First phase:

- started upon radio problem detection;

- leads to radio link failure detection;

- no UE-based mobility;

- based on timer or other (e.g. counting) criteria (T1).

- Second Phase:

- started upon radio link failure detection or handover failure;

- leads to RRC\_IDLE;

- UE-based mobility;

- Timer based (T2).



Figure 10.1.6-1: Radio Link Failure

Table 10.1.6-1 below describes how mobility is handled with respect to radio link failure:

Table 10.1.6-1: Mobility and Radio Link Failure

|  |  |  |  |
| --- | --- | --- | --- |
| Cases | First Phase | Second Phase | T2 expired |
| UE returns to the same cell | Continue as if no radio problems occurred | Activity is resumed by means of explicit signalling between UE and eNB | Go via RRC\_IDLE |
| UE selects a different cell from the same eNB | N/A | Activity is resumed by means of explicit signalling between UE and eNB | Go via RRC\_IDLE |
| UE selects a cell of a prepared eNB (NOTE) | N/A | Activity is resumed by means of explicit signalling between UE and eNB | Go via RRC\_IDLE |
| UE selects a cell of a different eNB that is not prepared (NOTE) | N/A | Go via RRC\_IDLE | Go via RRC\_IDLE |
| NOTE: a prepared eNB is an eNB which has admitted the UE during an earlier executed HO preparation phase, or obtains the UE context during the Second Phase. |

For a NB-IoT UE that only uses Control Plane CIoT EPS/5GS optimisations, as defined in TS 24.301 [20] and does not support RRC Connection re-establishment for the control plane as defined in TS 36.331 [16], at the end of the first phase, the UE enters RRC\_IDLE (there is no second phase).In the Second Phase, in order to resume activity and avoid going via RRC\_IDLE when the UE returns to the same cell or when the UE selects a different cell from the same eNB, or when the UE selects a cell from a different eNB, the following procedure applies:

- The UE stays in RRC\_CONNECTED;

- The UE accesses the cell through the random access procedure;

- Except for a NB-IoT UE using only Control Plane CIoT EPS/5GS optimisations, the UE identifier used in the random access procedure for contention resolution (i.e. C‑RNTI of the UE in the cell where the RLF occurred + physical layer identity of that cell + short MAC-I based on the keys of that cell) is used by the selected eNB to authenticate the UE and check whether it has a context stored for that UE:

- If the eNB finds a context that matches the identity of the UE, or obtains this context from the previously serving eNB, it indicates to the UE that its connection can be resumed;

- If the context is not found, RRC connection is released and UE initiates procedure to establish new RRC connection. In this case UE is required to go via RRC\_IDLE.

- For a NB-IoT UE using only Control Plane CIoT EPS/5GS optimisations, the UE identifier used in the random access procedure for contention resolution (i.e. S-TMSI (for EPS) or truncated 5G-S-TMSI (for 5GS) of the UE at the time where the RLF occurred + UL NAS MAC + UL NAS COUNT) is used by the selected (ng-)eNB to request the MME/AMF to authenticate the UE's re-establishment request and provide the UE context:

- If the authentication of the UE is successful and a context is provided, it indicates to the UE that its connection can be resumed;

- If no context is provided, the RRC connection is released and UE initiates procedure to establish new RRC connection. In this case UE is required to go via RRC\_IDLE.

The radio link failure procedure applies also for RNs, with the exception that the RN is limited to select a cell from its DeNB cell list. Upon detecting radio link failure, the RN discards any current RN subframe configuration (for communication with its DeNB), enabling the RN to perform normal contention-based RACH as part of the re-establishment. Upon successful re-establishment, an RN subframe configuration can be configured again using the RN reconfiguration procedure.

For DC, PCell supports above phases. In addition, the first phase of the radio link failure procedure is supported for PSCell. However, upon detecting RLF on the PSCell, the re-establishment procedure is not triggered at the end of the first phase. Instead, UE shall inform the radio link failure of PSCell to the MeNB.

NOTE: If the recovery attempt in the second phase fails, the details of the RN behaviour in RRC\_IDLE to recover an RRC connection are up to the RN implementation.

In case of DAPS handover, the UE continues the RLM of the source cell until the successful completion of the random access procedure to the target cell. If RLF is declared in the source cell, the UE:

- stays in RRC\_CONNECTED;

- stops any data transmission or reception via the source link and releases the source link, but maintains the source RRC configuration;- if handover failure is declared at the target cell after source cell RLF was declared,

- initiates RRC re-establishment and then selects a suitable cell ;

- enters RRC\_IDLE if a suitable cell was not found within a certain time after handover failure was declared.

In case of CHO, after handover failure is declared in the source cell, the UE:

- stays in RRC\_CONNECTED;

- initiates RRC re-establishment and then selects a suitable cell and if the selected cell is a CHO candidate and if network configured the UE to try CHO at the selected CHO candidate cell after RLF, then the UE attempts CHO execution, otherwise re-establishment is performed;

- enters RRC\_IDLE if a suitable cell was not found within a certain time after RLF was declared.

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| End of changes |