**3GPP TSG-RAN WG2 Meeting #109e-bis R2-20xxxxx**

**E-meeting, April 20-30, 2020**

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| *CR-Form-v11.4* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **38.300** | **CR** | **0153** | **rev** | **-** | **Current version:** | **16.1.0** |  |
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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 |  | Radio Access Network | **X** | Core Network | **X** |

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| ***Title:*** | CR to 38.300 on Integrated Access and Backhaul for NR | | | | | | | | | |
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| ***Source to WG:*** | Qualcomm (Rapporteur) | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_IAB-Core | | | | |  | ***Date:*** | | | 2020-04-20 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***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 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-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:*** | | Add the support for IAB | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Change to notation of IAB terminology and some editorial changes. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 3, 4, 6 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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 ... | | |
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| ***Other comments:*** | |  | | | | | | | | |

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First Modified Subclause

## 3.2 Definitions

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

**CAG Cell**:a cell broadcasting at least one Closed Access Group identity.

**CAG Member Cell**:for a UE, a cell broadcasting the identity of the selected PLMN, registered PLMN or equivalent PLMN, and for that PLMN, a CAG identifier belonging to the Allowed CAG list of the UE for that PLMN.

**CAG-only cell**: a cell that is only available for normal service for CAG UEs.

**Cell-Defining SSB**: an SSB with an RMSI associated.

**Child node**: IAB- DU’s and IAB-donor-DU’s next hop neighbour node; the child node is also an IAB-node.

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

**CORESET#0**: the control resource set for at least SIB1 scheduling, can be configured either via MIB or via dedicated RRC signalling.

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

**Downstream**: Direction toward child node or UE in IAB-topology.

**gNB**: node providing NR user plane and control plane protocol terminations towards the UE, and connected via the NG interface to the 5GC.

**IAB-donor**:gNB that provides network access to UEs via a network of backhaul and access links.

**IAB-DU**: gNB-DU functionality supported by the IAB-node to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in TS 38.401 [4], on the IAB-donor.

**IAB-MT**: IAB-node function that terminates the Uu interface to the parent node using the procedures and behaviours specified for UEs unless stated otherwise. IAB-MT function used in 38series of 3GPP Specifications corresponds to IAB-UE function defined in TS 23.501 [3].

**IAB-node**: RAN node that supports NR access links to UEs and NR backhaul links to parent nodes and child nodes. The IAB-node does not support backhauling via LTE.

**Intra-system Handover**:Handover that does not involve a CN change (EPC or 5GC).

**Inter-system Handover**:Handover that involves a CN change (EPC or 5GC).

**MSG1**: preamble transmission of the random access procedure for 4-step random access (RA) type.

**MSG3**: first scheduled transmission of the random access procedure.

**MSGA**:preamble and payload transmissions of the random access procedure for 2-step RA type.

**MSGB**:response to MSGA in the 2-step random access procedure. MSGB may consist of response(s) for contention resolution, fallback indication(s), and backoff indication.

**Multi-hop backhauling**: Using a chain of NR backhaul links between an IAB-node and an IAB-donor.

**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.

**NG-C**: control plane interface between NG-RAN and 5GC.

**NG-U**: user plane interface between NG-RAN and 5GC.

**NG-RAN node**: either a gNB or an ng-eNB.

**NR backhaul link**: NR link used for backhauling between an IAB-node and an IAB-donor, and between IAB-nodes in case of a multi-hop backhauling.

**NR sidelink communication**: AS functionality enabling at least V2X communication as defined in TS 23.287 [40], between two or more nearby UEs, using NR technology but not traversing any network node.

**Numerology**: corresponds to one subcarrier spacing in the frequency domain. By scaling a reference subcarrier spacing by an integer *N*, different numerologies can be defined.

**Parent node**: IAB- MT’s next hop neighbour node; the parent node can be IAB-node or IAB-donor-DU

**SNPN Access Mode**: mode of operation whereby a UE only accesses SNPNs.

**SNPN-only cell**: a cell that is only available for normal service for SNPN subscribers.

**Upstream**: Direction toward parent node in IAB-topology.

**V2X sidelink communication**: AS functionality enabling V2X communication as defined in TS 23.285 [41], between nearby UEs, using E-UTRA technology but not traversing any network node.

**Xn**: network interface between NG-RAN nodes.

*Next Modified Subclause*

## 4.7 Integrated Access and Backhaul

### 4.7.1 Architecture

Integrated access and backhaul (IAB) enables wireless relaying in NG-RAN. The relaying node, referred to as *IAB-node*, supports access and backhauling via NR. The terminating node of NR backhauling on network side is referred to as the *IAB-donor*, which represents a gNB with additional functionality to support IAB. Backhauling can occur via a single or via multiple hops. The IAB architecture is shown in Figure 4.7.1-1.

The IAB-node supports gNB-DU functionality, as defined in TS 38.401 [4], to terminate the NR access interface to UEs and next-hop IAB-nodes, and to terminate the F1 protocol to the gNB-CU functionality, as defined in TS 38.401 [4], on the IAB-donor. The gNB-functionality on the IAB-node is also referred to as *IAB-DU*.

In addition to the gNB-DU functionality, the IAB-node also supports a subset of the UE functionality referred to as *IAB-MT*, which includes, e.g., physical layer, layer-2, RRC and NAS functionality to connect to the gNB-DU of another IAB-node or the IAB-donor, to connect to the gNB-CU on the IAB-donor, and to the core network.

The IAB-node can access the network using either SA-mode or EN-DC. In EN-DC, the IAB-node also connects via E-UTRA to a MeNB, and the IAB-donor terminates X2-C as SgNB (TS 37.340 [21]).



Figure 4.7.1-1: IAB architecture; a) IAB-node using SA mode with NGC; b) IAB-node using EN-DC

All IAB-nodes that are connected to an IAB-donor via one or multiple hops form a directed acyclic graph (DAG) topology with the IAB-donor at its root (Fig. 4.7.1-2). In this DAG topology, the neighbour node on the IAB-DU’s interface is referred to as *child* node and the neighbour node on the IAB-MT’s interface is referred to as *parent* node. The direction toward the child node is further referred to as *downstream* while the direction toward the parent node is referred to as *upstream*. The IAB-donor performs centralized resource-, topology- and route management for the IAB topology.



Figure 4.7.1-2: Parent- and child-node relationship for IAB-node

### 4.7.2 Protocol Stacks

Fig. 4.7.2-1 shows the protocol stack for F1-U and Fig. 4.7.2-2 shows the protocol stack for F1-C between IAB-DU and IAB-donor-CU. In these figures, F1-U and F1-C are carried over two backhaul hops.

F1-U and F1-C use an IP transport layer between IAB-DU and IAB-donor-CU as defined in TS 38.470 [32]. F1-U and F1-C need to be security-protected as described in TS 33.501 [5] (the security layer is not shown in the Figures 4.7.2-1/2).

On the wireless backhaul, the IP layer is carried over the backhaul adaptation protocol (BAP) sublayer, which enables routing over multiple hops. The IP layer is also used for some *non*-F1 traffic, such as signalling traffic for the establishment and management of SCTP associations and the F1-supporting security layer.

On each backhaul link, the BAP PDUs are carried by BH RLC channels. Multiple BH RLC channels can be configured on each BH link to allow traffic prioritization and QoS enforcement. The BH-RLC-channel mapping for BAP PDUs is performed by the BAP entities on each IAB-node and the IAB-donor-DU.

Protocol stacks for an IAB-donor with split gNB architecture are specified in TS 38.401 [4].



Fig. 4.7.2-1: Protocol stack for the support of F1-U protocol



Fig. 4.7.2-2: Protocol stack for the support of F1-C protocol

The IAB-MT further establishes SRBs (carrying RRC and NAS) and potentially also DRBs (e.g. carrying OAM traffic) with the IAB-donor. These SRBs and DRBs are transported between the IAB-MT and its parent node over Uu access channel(s). The protocol stacks for the SRB is shown in Fig. 4.7.2-3.



Figure 4.7.2-3: Protocol stack for the support of IAB-MT’s RRC and NAS connections

### 4.7.3 User-plane Aspects

#### 4.7.3.1 Backhaul transport

The IAB-DU’s IP traffic is routed over the wireless backhaul via the BAP sublayer. The BAP sublayer is specified in TS 38.340 [31]. In downstream direction, upper layer packets are encapsulated by the BAP sublayer at the IAB-donor, and de-encapsulated at the destination IAB-node. In upstream direction, upper layer packets are encapsulated at the IAB-node, and de-encapsulated at the IAB-donor. IAB-specific transport between IAB-donor-CU and IAB-donor-DU is specified in TS 38.401 [4].

On the BAP sublayer, packets are routed based on the BAP routing ID, which is carried in the BAP header. The BAP header is added to the packet when it arrives from upper layers, and it is stripped off when it has reached its destination node. The selection of the packet’s BAP routing ID is configured by the IAB-donor. The BAP routing ID consists of BAP address and BAP path ID, where the BAP address indicates the destination node of the packet on the BAP sublayer, and the BAP path ID indicates the routing path the packet should follow to this destination. For the purpose of routing, each IAB-node is further configured with a designated BAP address.

On each hop of the packet’s path, the IAB-node inspects the packets BAP address in the routing header to determine if the packet has reached its destination, i.e., matches the IAB-node’s BAP address. In case the packet has *not* reached the destination, the IAB-node determines the next hop backhaul link, referred to as *egress* link, based on the BAP routing ID carried in the packet header and a routing configuration it received from the IAB-donor.

The IAB-node also selects the BH RLC channel on the designated egress link. For packets arriving from upper layers the selection of the BH RLC channel is configured by the CU, and it is based on upper layer traffic specifiers. Since each BH RLC channel is configured with QoS information or priority level, BH-RLC-channel selection facilitates traffic-specific prioritization and QoS enforcement on the BH. For F1-U traffic, it is possible to map each GTP-U tunnel to a dedicated BH RLC channel or to aggregate multiple GTP-U tunnels into one common BH RLC channel. For non-user-plane traffic, it is possible to map UE-associated F1AP messages, non-UE-associated F1AP messages and non-F1 traffic onto the same or separate BH RLC channels.

When packets are routed from one BH link to another, the BH RLC channel on the egress BH link is determined based on the mapping configuration between ingress BH RLC channels and egress BH RLC channels provided by the IAB-donor.

#### 4.7.3.2 Flow and Congestion Control

Flow and congestion control can be supported in both upstream and downstream directions in order to avoid congestion-related packet drops on IAB-nodes and IAB-donor-DU:

- In upstream direction, UL scheduling on MAC layer can support flow control on each hop;

- In downstream direction, the NR user plane protocol (TS 38.425 [33]) supports flow and congestion control between the IAB-node and the IAB-donor for UE bearers that terminate at this IAB-node. Further, flow control is supported on BAP sublayer, where the IAB-node can send feedback information on the available buffer size for an ingress BH RLC channel or BAP-sublayer destination to its parent node. The feedback can be sent proactively, e.g., when the buffer load exceeds a certain threshold, or based on polling by the parent node.

#### 4.7.3.3 Uplink Scheduling Latency

Editor’s Note: Brief description of problem needs to be added

The IAB-node can reduce UL scheduling latency through pre-emptive signalling of BSR to its parent node. The IAB-node can send the pre-emptive BSR based on UL grants it has provided to child nodes and/or UEs, or based on BSRs it has received from child nodes or UEs (Figure 4.7.3-3). The pre-emptive BSR conveys the data expected rather than the data buffered.



Figure 4.7.3-3: Scheduling of BSR in IAB:

a) regular BSR based on buffered data,  
b) pre-emptive BSR based on UL grant,  
c) pre-emptive BSR based on reception of regular BSR

### 4.7.4 Signalling procedures

#### 4.7.4.1 IAB-node Integration

The IAB-node integration procedure is captured in TS 38.401 [4].

#### 4.7.4.2 IAB-node Migration

The IAB-node can migrate to a different parent node underneath the same IAB-donor-CU. The IAB-node continues providing access and backhaul service when migrating to a different parent node.

The IAB-node migration procedure is captured in TS 38.401 [4].

#### 4.7.4.3 Topological Redundancy

The IAB-node may have redundant routes to the IAB-donor-CU.

For IAB-nodes operating in SA-mode, NR DC is used to enable route redundancy in the BH by allowing the IAB-MT to have concurrent BH links with two parent nodes. The parent nodes have to be connected to the same IAB-donor-CU, which controls the establishment and release of redundant routes via these two parent nodes. The parent nodes gNB-DU functionality together with the IAB-donor-CU obtain the roles of the IAB-MT’s master node and secondary node. The NR DC framework (e.g. MCG/SCG-related procedures) is used to configure the dual radio links with the parent nodes (TS 37.340 [21]).

The procedure for establishment of topological redundancy for IAB-nodes operating in SA is captured in TS 38.401 [4].

IAB-nodes operating in ENDC can exchange F1-C traffic with the IAB-donor via the MeNB. The F1-C message are carried over LTE RRC using SRB2 between IAB-node and MeNB and via X2AP between MeNB and IAB-donor.

The procedure for establishment of redundant transport of F1-C for IAB-nodes using ENDC is captured in TS 38.401 [4].

#### 4.7.4.4 Backhaul RLF Recovery

When the IAB-node using SA-mode declares RLF on the backhaul link, it can migrate to another parent node. The BH RLF recovery procedure to a parent node underneath the same IAB-donor-CU is captured in TS 38.401 [4]. BH RLF declaration for IAB is handled in Section 9.2.7.

*Next Modified Subclause*

## 6.1 Overview

The layer 2 of NR is split into the following sublayers: Medium Access Control (MAC), Radio Link Control (RLC), Packet Data Convergence Protocol (PDCP) and Service Data Adaptation Protocol (SDAP). The two figures below depict the Layer 2 architecture for downlink and uplink, where:

- The physical layer offers to the MAC sublayer transport channels;

- The MAC sublayer offers to the RLC sublayer logical channels;

- The RLC sublayer offers to the PDCP sublayer RLC channels;

- The PDCP sublayer offers to the SDAP sublayer radio bearers;

- The SDAP sublayer offers to 5GC QoS flows;

- *Comp.* refers to header compression and *segm.* to segmentation;

- Control channels (BCCH, PCCH are not depicted for clarity).

NOTE: The gNB may not be able to guarantee that a L2 buffer overflow will never occur. If such overflow occurs, the UE may discard packets in the L2 buffer.



Figure 6.1-1: Downlink Layer 2 Structure



Figure 6.1-2: Uplink Layer 2 Structure

Radio bearers are categorized into two groups: data radio bearers (DRB) for user plane data and signalling radio bearers (SRB) for control plane data.

For IAB, the layer 2 of NR also includes: Backhaul Adaptation Protocol (BAP).

- The BAP sublayer supports routing across the IAB topology and mapping to BH RLC channels for enforcement of traffic prioritization and QoS.

Figures 6.1-3 below depicts the Layer-2 architecture for downlink on the IAB-donor. Figure 6.1-4 and 6.1-5 depict the Layer-2 architecture for downlink and uplink on the IAB-node, where the BAP sublayer offers routing functionality and mapping to backhaul RLC channels.



Figure 6-1.3: DL L2-structure at IAB-donor



Figure 6.1-4: DL L2-structure at IAB-node



Figure 6.1-5: UL L2-structure at IAB-node

*Next Modified Subclause*

## 6.11 Backhaul Adaptation Protocol Sublayer

### 6.11.1 Services and Functions

The main service and functions of the BAP sublayer include:

- Transfer of data;

- Routing of packets to next hop;

- Determination of BAP destination and BAP path for packets from upper layers;

- Determination of egress BH RLC channels for packets routed to next hop;

- Differentiating traffic to be delivered to upper layers from traffic to be delivered to egress link;

- Flow control feedback signalling;

- BH RLF notification.

### 6.11.2 Traffic Mapping from Upper Layers to Layer-2

In upstream direction, the IAB-donor-CU configures the IAB-node with mappings between upstream F1- and non-F1-traffic originated at the IAB-node, and the appropriate BAP routing ID and BH RLC channel. A specific mapping is configured:

- for each F1-U GTP-U tunnel;

- for non-UE associated F1AP messages;

- for UE-associated F1AP messages;

- for non-F1 traffic.

Multiple mappings can contain the same BH RLC channel and/or BAP routing ID.

These configurations are received via F1AP. During IAB-node integration, before F1AP is established, a default BH RLC channel and a default BAP routing ID are configured via RRC, which are used for all upper layer traffic.

In downstream direction, traffic mapping occurs internal to the IAB-donor. Transport for IAB-donors that use split-gNB architecture is handled in TS 38.401 [4].

### 6.11.3 Routing and BH-RLC-channel mapping on BAP sublayer



Figure 6.11.3-1: Routing and BH RLC channel selection on BAP sublayer

Routing on BAP sublayer uses the BAP routing ID, which is configured by the IAB-donor. The BAP routing ID consists of BAP address and BAP path ID. The BAP address is used for the following purposes:

1. Determination if a packet has reached the destination node, i.e. IAB-node or IAB-donor-DU, on BAP sublayer. This is the case if the BAP address in the packet’s BAP header matches the BAP address configured via RRC on the IAB-node, or via F1AP on the IAB-donor-DU.

2. Determination of the next-hop node for packets that have not reached their destination. This applies to packets arriving from a prior hop on BAP sub-layer or that have been received from IP layer.

For packets arriving from a prior hop, the determination of the next-hop node is based on a routing configuration provided by the IAB-donor-CU via F1AP signalling. This configuration contains the mapping between the BAP routing ID carried in the packet’s BAP header and the next-hop node’s BAP address.

Table 6.11.3-1: Routing configuration

|  |  |
| --- | --- |
| BAP routing ID | Next-hop BAP address |
| Derived from BAP packet’s BAP header | To be used to forward packet |

The IAB-node resolves the next-hop BAP address to a physical backhaul link. For this purpose, the IAB-donor-CU provides the IAB-node with its child-node’s BAP address via F1AP and its parent-node’s BAP address via RRC.

The IAB-node can receive multiple routing configurations with the same destination BAP address but different BAP path IDs. These routing configurations may resolve to the same or different egress BH links. In case the BH link has RLF, the IAB-node may select another BH link based on routing entries with the same destination BAP address, i.e., by disregarding the BAP path ID. In this manner, a packet can be delivered via an alternative path in case the indicated path is not available.

When routing a packet from an ingress to an egress BH link, the IAB-node derives the egress BH RLC-channel on the egress BH link through an F1AP-configured mapping from the BH RLC channel used on the ingress BH link. The RLC channel IDs used for ingress and egress BH RLC channels are generated by the IAB-donor-CU. Since the RLC channel ID only has link-local scope, the mapping configurations also include the BAP addresses of prior and next hop:

Table 6.11.3-2: BH RLC channel mapping configuration

|  |  |  |  |
| --- | --- | --- | --- |
| Next-hop BAP address | Prior-hop BAP address | Ingress RLC channel ID | Egress RLC channel ID |
| Derived from routing configuration | Derived from packet’s ingress link | Derived from packet’s ingress BH RLC channel | To be used on egress link to forward packet |

The IAB-node resolves the BH RLC channel IDs from logical channel IDs based on the configuration by the IAB-donor-CU. For BH RLC channels in downstream direction, the BH RLC channel ID is included in the F1AP configuration of the BH RLC channel. For RLC channels in upstream direction, the BH RLC channel ID is included in the RRC configuration of the corresponding logical channel.

*Next Modified Subclause*

### 9.2.7 Radio Link Failure

In RRC\_CONNECTED, the UE performs Radio Link Monitoring (RLM) in the active BWP based on reference signals (SSB/CSI-RS) and signal quality thresholds configured by the network. SSB-based RLM is based on the SSB associated to the initial DL BWP and can only be configured for the initial DL BWP and for DL BWPs containing the SSB associated to the initial DL BWP. For other DL BWPs, RLM can only be performed based on CSI-RS. In case of DAPS handover, the UE continues the RLM at the source cell until the successful completion of the random access procedure to the target cell.

The UE declares Radio Link Failure (RLF) when one of the following criteria are met:

- Expiry of a radio problem timer started after indication of radio problems from the physical layer (if radio problems are recovered before the timer is expired, the UE stops the timer); or

- Expiry of a timer started upon triggering a measurement report for a measurement identity for which the timer has been configured while another radio problem timer is running; or

- Random access procedure failure; or

- RLC failure; or

- Detection of consistent uplink LBT failures for operation with shared spectrum channel access as described in 5.6.1.

In case of regular handover, after RLF is declared, the UE:

- stays in RRC\_CONNECTED;

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

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

In case of DAPS handover, if RLF is declared in 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;

In case of DAPS handover, when handover failure is declared at the target cell after source cell RLF was declared, the UE:

- stays in RRC\_CONNECTED;

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

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

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

- stays in RRC\_CONNECTED;

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

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

When RLF occurs at the IAB BH link, the same mechanisms and procedures are applied as for the access link. This includes BH RLF detection, RLF recovery using RRC reestablishment procedure and execution of conditional handover.

In case the RRC reestablishment procedure fails, the IAB-node may transmit an RLF notification message to its child nodes. The child node considers the BH link, on which it has received the RLF notification as failed (i.e. as if it has detected RLF on that BH link). The RLF notification message is transmitted on BAP layer.

End of Modifications