**3GPP TSG-RAN WG2 Meeting #107bis R2-19xxxxx**

**Chongqing, China, October 14th – 18th, 2019**

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| *CR-Form-v11.4* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.300** | **CR** | **0153** | **rev** | **005** | **Current version:** | **15.7.0** |  |
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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 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Qualcomm | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_IAB Core | | | | |  | ***Date:*** | | | 2019-06 |
|  |  | | | |  | |  | | |  |
| ***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:*** | | Introduce clauses where IAB-related stage-2 aspects will be added | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 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 ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |

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| ***This CR's revision history:*** | Rev0: CR skeleton.  Rev1: Abbreviations & definitions; clause 4: IAB architecture, protocol stacks, a few aspects on user-plane aspects and signaling procedures; clause 6: BAP sublayer, principal functions.  Rev2: clause 4: update to signaling procedures on topological redundancy  Rev3: Update on MT’s own traffic, flow control and low-latency scheduling and topologyical redundancy.  Rev4: Minor change of Rev3.  Rev5: Capture discussion on recovery from BH RLF failure (clause 4). Further, L2 structures were included and BAP layer services and functions updated (clause 6). The IAB-node MT was renamed to IAB-MT. |

FIRST CHANGE

# 3 Abbreviations and Definitions

## 3.1 Abbreviations

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

>>>> Skip

BH Backhaul

>>>> Skip

DAG Directed Acyclic Graph

>>>> Skip

IAB Integrated Access and Backhaul

>>>> Skip

MT Mobile TerminationNEXT CHANGE

## 3.2 Definitions

>>>> Skip

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

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

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

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

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

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

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

**gNB-CU**: See 3GPP TS 38.401

**gNB-DU**: See 3GPP TS 38.401

**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-DU**: IAB-node DU

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

NEXT CHANGE

# 4 Overall Architecture and Functional Split

## 4.1 Overall Architecture

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## 4.x Integrated Access and Backhaul

### 4.x.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.x.1-1.

The IAB-node supports gNB-DU functionality, as defined in TS 38.401, 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, on the IAB-donor. The IAB-node DU 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, and to connect to the gNB-CU on the IAB-donor.

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.



**Figure 4.x.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.x.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*.



**Figure 4.x.1-2: Parent- and child-node relationship for IAB-node**

### 4.x.2 Protocol stacks

Fig. 4.x.2-1 shows the protocol stack for F1-U and Fig. 4.x.2-2 shows the protocol stack for F1-C between IAB-DU and IAB-donor gNB-CU. In these figures, F1-U and F1-C are carried over two backhaul hops.

Note: F1 needs to be security-protected as described in TS 33.501.

Editor’s note: These protocol stacks do not include F1 security layer, e.g., as mandated by TS 33.501. They may have to be revisited based on discussions by SA3.



Fig. 4.x.2-1: Protocol stack for the support of F1-U protocol



**Fig. 4.x.2-2: Protocol stack for the support of F1-C protocol**

The IAB MT 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) reusing legacy Uu. The protocol stacks for the SRBis shown in Fig. 4.x.2-3.



Figure 4.x.2-3: Protocol stack for the support of IAB-MT’s RRC and NAS connections

>>>> Skip

### 4.x.3 User plane aspects

#### 4.x.3.1 Flow control

Flow control is 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 supports hop-by-hop flow control.

Editor’s Note: In upstream direction, end-to-end flow control is is not supported in IAB network.

- In downstream direction, the NR UP protocol (TS 38.425 [xx]) supports flow control between the IAB-node and the IAB-donor for UE bearers that access this IAB-node. Further, hop-by-hop flow control is supported, where the congested IAB-node sends one-hop feedback flow control info to its parent node. This flow control feedback includes information on IAB-node buffer load and flow control granularity The one-hop flow control feedback functionality is supported by the BAP layer.

Editor’s Note: For hop-by-hop flow control in downstream direction, per-BH-RLC-channel flow control feedback is considered as baseline.

#### 4.x.3.2 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.

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### 4.x.4 Signalling procedures

#### 4.x.4.1 IAB-node integration

The IAB-node integration procedure is captured in TS 38.401[zz], clause 8.x.

>>>> Skip

#### 4.x.4.2 IAB-node migration

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

The IAB-node migration procedures are captured in TS 38.401[zz], clause 8.x.

Editor’s Note: For IAB-node migration, Uu handover and connection reestablishment procedures are baseline.

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#### 4.x.4.3 Topological redundancy

The IAB-node may have redundant routes with 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 RLC channels with two parent nodes. The parent nodes have to be connected to the same IAB-donor CU-CP, which controls the establishment and release of redundant routes via these two parent nodes. The parent nodes together with the IAB-donor CU obtain the roles of the IAB-MT’s MN and SN. 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 [zz]).

NEXT CHANGE

# 6 Layer 2

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 include: Backhaul Adaptation Protocol (BAP). 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 layer offers routing functionality and mapping to backhaul RLC channels.



Figure 6-1.3: DL L2-structure for user plane at IAB-donor



Figure 6.1-4: DL L2-structure for user plane at IAB-node



Figure 6.1-5: UL L2-structure for user plane at IAB-node

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## 6.x Backhaul Adaptation Protocol Sublayer

### 6.x.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 path for packets from upper layers;

- Determination of egress 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;

NEXT CHANGE

# 9 Mobility and State Transitions

## 9.1 Overview

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## 9.2 Intra-NR

### 9.2.1 Mobility in RRC\_IDLE

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### 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.

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

- Expiry of a 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

- Random access procedure failure; or

- RLC failure.

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.

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 and RLF recovery using RRC reestablishment procedure.

In case the RRC reestablishment procedure to recover the BH link fails, the IAB-node transmits 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.

Editor’s Note: The procedures for backhaul RLF recovery will be captured in TS 38.401[zz], clause 8.x.

END OF CHANGES

# Appendix 1: RAN2 agreements

#### The following agreements were reached in RAN2 #105:

**Adaptation layer functionality**

- RAN2 confirms that routing and bearer mapping (e.g. mapping of BH RLC channels) are adaptation layer functions

- RAN2 assumes that the TX part of the adaptation layer performs routing and “bearer mapping”, and the RX part of the adaptation layer performs “bearer de-mapping”.

- RAN2 assumes that SDUs are forwarded from the RX part of the adaptation layer to the TX part of the adaptation layer (for the next hop) for packets that are relayed by the IAB node.

- It is FFS how to model adaptation layer protocol entities, e.g. whether separate for DU and MT or not, and how these are configured, i.e. via F1-AP or RRC.

**L2 configuration**

- RAN2 assumes that IAB-donor CU is controlling the setup and modification of all backhaul channels in the IAB network below the IAB-donor.

- RAN2 assumes that a separate BH RLC channel should be setup for each UE DRB with one-to-one bearer mapping.

- RAN2 assumes that for a UE DRB with many-to-one bearer mapping, a BH RLC channel associated with IAB node existing BH RLC channel might be reused as BH RLC channel to forward traffic of this UE DRB (e.g. if the BH RLC channel supports the required UE DRB QoS).

- RAN2 assumes that IAB-donor CU configures the adaptation layer.

- RAN2 assumes that routing is a function of the adaptation layer.

- The details of the routing functionality, e.g. what is configured vs. what is decided locally, is FFS.

**BH radio-link failure**

- RAN2 assumes that there is a RLF-notification at BH RLF, at least to downstream node(s).

- Alternate routes and/or Dual Connectivity could be utilised at recovery at a failure of a BH link.

- Current UE RLF detection and recovery is reused as baseline

- It is FFS, whether other indications are needed, e.g. when link has recovered, or when recovery is in progress.

#### The following agreements were reached in RAN2 #105bis:

**Agreements from email discussion 105#45: IAB Miscellaneous:**

* The name of the “adapt’ is “Backhaul Adaptation Protocol” “BAP”
* 1-1 agreed with comments

Note: Proposal 1-1 on figure for IAB architecture has been captured as Figure 4.x.1-1 in running CR to 38.300 above.

* 1-2 agreed as baseline (can polish the wordings)

Note: Proposal 1-2 on the IAB architecture has been captured in sub-clause 4.x.1 in running CR to 38.300 above.

* 2 agreed with removal F1-U and F1-C from the figures

Note: Proposal 2 has been captured in sub-clause 4.x.2 in running CR to 38.300 above.

* 4 is agreed

Note: Proposal 4 states on backhaul configuration:

The backhaul RLC channel and the adaptation layer are configured by the IAB-donor CU using F1-AP and/or RRC.

* 6 is agreed

Note: Proposal 6 states on flow control:

Flow control is 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 is considered baseline for hop-by-hop flow control. End-to-end flow control is FFS.

• In downstream direction, the NR UP protocol is considered baseline for end-to-end flow control. Hop-by-hop flow control is FFS.

* One method by which the IAB-node can reduce UL scheduling latency is through signalling of SR and/or BSR to its parent node, e.g., based on UL grants provided to child nodes and/or UEs, or based on SRs and/or BSRs from a child nodes or UEs.
* The IAB system should provide lossless end-to-end packet delivery. Enhancements to existing mechanisms, if needed, are FFS.
* 9 is agreed, with the understanding that intra-donor cases have priority.

Note: Proposal 9 states on IAB-node migration:

• The IAB-node can migrate to a different parent node underneath the same or at a different IAB-donor CU.

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

• The IAB-donor CU controls IAB-node migration as baseline.

• Uu handover and connection reestablishment procedures are baseline for migration of IAB-node MT.

• During IAB-node migration, continuity of ongoing sessions should be provided, and packet loss should be minimized.

* 10, 11 are agreed

Note: Proposal 10 states on topological redundancy:

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

• NR DC is used to enable route redundancy for IAB-nodes operating in SA-mode.

• In this case, the IAB-donor CU controls the establishment and release of redundant routes.

Note: Proposal 11 on definitions has been captured in sub-clauses 3.1 and 3.2 in the running CR to 38.300 above.

**Agreement on multi-connectivity:**

* R2 assumes that the NR DC framework (e.g. MCG SCG related procedures) is used to configure dual radio links used as IAB bh links with two parent nodes.

**Agreements on bearer mapping:**

* Confirm that the intention is to support 1-to-1 and 1-to-N bearer mapping, for UE bearers, at least for UP.
* For user plane, The UL mapping in the IAB access node to BH RLC channels should be based on the knowledge about UE bearers (identified with GTP TEID)
* For control plane (F1-C messages) The UL mapping in the IAB access node to BH RLC channels should be based on F1-C message type. FFS if per UE.
* FFS if the mapping should also consider DSCP/Flow labels (e.g. as an intermediate step).
* Observation: The UL/DL mapping in intermediate IAB node(s) to egress BH RLC channel will take into account ingress BH RLC channel.
* FFS: The UL/DL mapping in intermediate IAB node(s) to egress BH RLC channel could also take into account some ID(s) (from Adaptation Layer).
* The above two Bullets are applicable for all types of traffic (e.g. UP, CP, OAM).

**Agreements on BAP routing:**

* Routing delivers a packet to a destination node by selecting a next backhaul link among given multiple backhaul links at an IAB node and an IAB donor node as a baseline.
* “Destination IAB node/IAB donor-DU address” and “Specific path identifier” (carried in the BAP) are considered as candidate for route identifier for routing at an adaptation layer. Additional required information for routing is FFS.
* “Destination IAB node/IAB donor-DU address” and/or “Specific path identifier” is unique within an IAB donor-CU.
* FFS what ID is used to identify the egress link (next hop link) in routing table. C-RNTI alone will not be used for this purpose.
* Load balancing by routing by Donor CU shall be possible
* Local selection of path/route is done at link failure, other cases FFS

#### The following agreements were reached in RAN2 #106:

**Agreements on Stage-2 and general:**

* R2 has not found problems with the CU/DU addressing limitation of 20 bits per IAB-node connected to the Donor DU.

**Agreements NSA and multi-connectivity:**

* In NR-DC framework for IAB nodes, PDCP is not supported for BH RLC channels, so any PDCP related functions like “split bearer” is not supported, For routing etc BAP is used.
* In Rel-16, the d’ option [proposed in R2-1908028] is supported

Note: In option d, IAB-node MR conducts NR DC with two parent nodes at different IAB-donors. In option d’, IAB-node MR conducts NR DC to two parents nodes underneath the same IAB-donor.

* For IAB node using EN-DC, from BAP and backhaul RLC channels point of view, this is a single link deployment (BAP route only by NR link).
* It is FFS whether to support the option 2, e.g. to keep Control Connection with a Donor which is an SN at link break.

**BAP functionality:**

* The below lists the functions of BAP (initial, might not be complete)

F1: Retrieve packets from ingress RLC layer

F2: Deliver packets to egress RLC layer

F3: Retrieve packets from upper layer

F4: Deliver packets to upper layer

F5: Differentiate traffic to be delivered to upper layers from traffic to be delivered to egress RLC layer

F6: Perform bearer mapping and routing for packets delivered to egress RLC layer

F7: Selection/addition of BAP identifiers for packets received from upper layer

**BAP routing:**

* The BAP routing id (carried in the BAP header) consists of BAP address and BAP path ID. Encoding of the path ID in the header is FFS.
* Each BAP address defines a unique destination (unique for IAB network of one Donor, either an IAB access node, or the IAB donor)
* Each BAP address can have one or multiple entries in the routing table to enable local route selection. Multiple entries are for load balancing, re-routing at RLF. For load balancing still FFS what is decided locally and/or decided by the Donor.
* Each BAP routing id has only one entry in the routing table.
* The routing table can hold other information, e.g. priority level for entries with same BAP address, to support local selection. Configuration of this information is optional.

#### The following agreements were reached in RAN2 #107:

F1AP transport in EN-DC

* We identify the impact, attempt to converge on a solution for F1 over LTE in the EN-DC case, decision next meeting.

MT traffic

* MTs SRBs (carrying RRC and NAS) and MTs DRBs if any (e.g. carrying OAM traffic) are transported to/from the MT on Uu access channel(s), i.e. reusing legacy Uu.

**Multi-Connectivity General**

* Also the d’ can be supported by DC, by assigning the roles of MN and SN to the IAB nodes serving the outer leaf access IAB node.

BAP modelling configuration and Control

* Confirm that the earlier agreed functions F1-F7 are applicable
* BAP has a DU part configured by F1-AP and a MT part configured by RRC
* BAP specification should focus on describing the interaction on Uu (mindset)
* A BAP DU part and MT part each has one transmitter and one receiver (detail naming TBD)
* The BAP address of the IAB node is used to differentiate traffic to be delivered to upper layers from traffic to be delivered to egress RLC layer (FFS for the Donor node).
* For routing and bearer mapping of a packet retrieved from RLC layer, the IAB-node needs to be configurable with the following mappings:

BAP routing ID in BAP header 🡪 Egress link (routing table)

Ingress RLC channel🡪 Egress RLC channel (bearer mapping)

* For the selection/addition of a BAP routing ID as well as routing and bearer mapping for a packet retrieved from upper layers, the IAB-node and IAB donor needs to be configurable with the following mappings:

(FFS) Upper layer information 🡪 BAP Routing ID to be added in BAP header

BAP routing ID in BAP header 🡪 Egress link

Upper layer information (FFS) 🡪 Egress RLC channel

Bearer Mapping

* The UL/DL mapping in intermediate IAB node(s) to egress BH RLC channel is determined by the ingress BH RLC channel.
* Egress BH RLC channel determined by other means in intermediate IAB node, e.g. BAP header QoS or BAP header bearer information is not applied when the above agreement is applied.
* R2 assumes to support prioritization and separate BH RLC channel between non UE-associated signaling and UE-associated signaling, impact FFS.
* We support per SRB bearer type mapping to BH RLC channel (both UL and DL), if feasible from R3 perspective, i.e. this would require separate SCTP stream per SRB bearer type
* LS on CP bearer mapping for IAB to RAN3 approved in R2-1911538

Routing

* For upstream, Cell group ID is used to identify next hop/egress link. For downstream FFS

Flow Control

* The UL end-to-end flow control is not supported in IAB network
* The DL hop-by-hop flow control is supported in IAB network.
* One hop DL flow control feedback is considered for DL hop-by-hop flow control, i.e. congested IAB node feedback flow control info to its parent IAB node.
* DL One-hop flow control feedback should include the IAB node buffer load (details FFS) and flow control granularity info. FFS other information.
* Per BH RLC channel based flow control feedback can be considered as baseline. FFS on the necessity of other flow control granularity
* BAP layer supports the DL hop-by-hop flow control and flow control feedback function
* It is FFS how to trigger the the DL hop-by-hop flow control in IAB network
* LS on flow control in IAB to RAN3 approved in R2-1911539

**Lossless behaviour**

* Most companies think B1 can be implementation without standards specification. No need to specify anything in R16 for Lossless behaviour.
* A note in the BAP specification, indicating this, can be captured. Detailed text FFS (it should be simple).
* Discussion continuation postponed to next meeting (doc to be resubmitted as is)

Low latency Scheduling

* Will have “preemptive” BSR.
* R2 assumes that any new triggering rules are only introduced for pre-emptive BSR, i.e. SR triggering is then governed by NR Rel-15 baseline (pre-emptive BSR = regular BSR from SR triggering point of view).
* R2 assumes that Both types of triggers for pre-emptive BSR that were discussed (1. based on UL grants provided to child nodes and/or UEs, and 2. based on BSRs from child nodes or UEs) can be supported for IAB Rel-16 operation. FFS what details need to be specified.

#### The following agreements were reached in RAN2 #107bis:

F1AP transport in EN-DC

* Working assumption: R2 assumes to use solution 1a (or possibly 1b) (agreement in R2).
* R2 understanding is that the protocol stacks in R2-1914179 are the ones applicable to solution 1a and solution 1b.
* Whether to use LTE SRB1 or SRB2 for solution 1a/1b is open but it is not foreseen the specification of a new SRB for this.

Terminology

* From R2 specifications point of view, IAB MT (or other term if changed) is equivalent to UE, unless otherwise stated.

BAP functionality

* BAP address of forwarded packet is the same as in the incoming PDU
* R2 assumes that BAP path ID of forwarded packet is the same as in the incoming PDU (need to agree routing behaviour at rerouting, e.g. at RLF)
* Running CR for TS 38.340 (BAP): Endorsed in [R2-1913254](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\RAN2\\Docs\\R2-1913254.zip" \o "D:Documents3GPPtsg_ranWG2RAN2DocsR2-1913254.zip)

BAP header

* Routing ID is 13bits
* There is a C/D bit
* Length of the BAP address and BAP path ID sub-fields of the BAP routing ID to be fixed/predefined
* For the DL, BAP address is 10bits and BAP path ID is 3bits
* For the UL, BAP address is FFS bits and BAP path ID is FFS bits
* R2 expects that there will be no restrictions in the TS to restrict configuration of routing ID and its components. The network has to ensure that e.g. there is no path confusion.

Low-latency scheduling

* RAN2 will not specify any normative solution to the perceived issue of possible resource wastage due to introduction of pre-emptive BSR.
* Confirmation that this is the expected enhanced behavior: Following the reception by the second (parent) node of a BSR from a first (child) node, resources may be requested from the third node (parent of second node) before actual data arrives from the first node

LCID extension for IAB

* Whether the extended LCID is used is indicated in the MAC header
* A reserved LCID value (in the legacy field) is used to indicate the extended LCID extension.
* We assume 16-bit LCID for the extension for IAB, and add 2 bytes to the MAC header (no additional reserved bits or values)
* For Rel-16 we don’t expect to extend LCG (or make any other changes for fine-grained QoS for UL scheduling)

RLF handling

* R2 confirm that when the IAB-node is not configured with DC, it applies for BH RLF handling the same mechanisms and procedures as UE’s RLF handling currently specified in TS 38.331 (including e.g. detection and recovery). FFS on need of additional enhancements.
* When NR DC is configured for the IAB-node, 2.1 RLF is detected separately for the MCG-link and for the SCG-link, and 2.2 existing UE procedures are used for MCG-link and SCG-link failure handling.
* The following is agreed as working assumption: BH RLF recovery for DC case reuses UE’s MCG and SCG failure recovery procedures specified in Rel-16.
* For an IAB-node not configured with DC, it initiates RRC reestablishment when it receives downstream notification “Recovery Failure”
* For DC case, the IAB-node considers the radio link is failed and uses RRC existing or Rel-16 Mechanism (e.g. MCG or SCG failure report, RRC reestablishment) if “Recovery Failure” notification is received from parent nodes on MCG-link or/and SCG-link.
* R2 assumes that RLF notification “recovery failure” would be triggered when RRC reestablishment has failed. FFS whether this need to be specified
* BAP layer is used to transmit BH RLF notification(s).
* R2 assumes that Upstream BH RLF notification to Donor CU via current F1-AP signalling is supported.

BAP configuration

* For BAP routing Next Hop ID, The BAP address of the next hop node to be used as the next hop identifier for the downstream
* For BAP routing Next Hop ID, The BAP address of the next hop node also to be used as the next hop identifier for the upstream
* Confirm that BAP address for a IAB node (e.g. to differentiate the data delivered to higher layer in BAP) is configured via RRC
* To configure the association between child IAB-node and Next Hop ID, RAN2 assumes that the CU includes the BAP address of the child IAB-node in a F1AP configuration (e.g. F1AP UE CONTEXT SETUP/MODIFICTION REQUEST message) for the child IAB-node MT. Details up to R3.
* To configure the association between parent IAB-node and Next Hop ID (i.e. BAP address of next hop), the CU includes the BAP address of the parent IAB-node together with the cell group ID of the parent node in the RRCReconfiguration message (details FFS).
* Observation: Upstream and downstream bearer mapping tables can use either the BH RLC CH ID or the LCID (they are mapped 1-to-1 always) for BAP ingress and egress RLCchannelIDs.
* The BH RLC CH ID is used for ingress / egress RLCchannelID in the BAP bearer mapping configuration.

# Appendix 2: RAN3 agreements (informative)

#### The following agreements were reached in RAN3 #103:

**Running CRs**

* Running CR to 38.401: endorsed as BL in R3-191143
* Running CR to 38.413: endorsed as BL in R3-191018
* Running CR to 36.423: endorsed as BL in R3-191144
* Running CR to 36.413: endorsed as BL in R3-191078

**IAB-node integration: MT Attach**

* The donor needs to know that this is not a normal UE
* SA:

AMF includes “IAB Authorized” IE in the INITIAL CONTEXT SETUP REQUEST/CONTEXT MODIFICATION REQUEST messages

* NSA for IAB node:

MME includes “IAB Authorized” IE in the INITIAL CONTEXT SETUP REQUEST/CONTEXT MODIFICATION REQUEST messages

* The eNB should include “IAB Authorized” IE in SgNB ADDITION REQUEST/MODIFICATION REQUEST messages

**IAB-node integration: Network interface setup (includes F1 setup and backhaul bearer setup)**

* Routing/forwarding for F1-C and for F1-U should be the same

#### The following agreements were reached in RAN3 #103bis:

**Running CRs**

* Update to running CR to 38.401: endorsed as BL in R3-192162
* Update to running CR to 36.413: endorsed as BL in R3-191173
* Update to running CR to 36.423: endorsed as BL in R3-191175
* Update to running CR to 36.470: endorsed as BL in R3-192161
* Update to running CR to 36.473: endorsed as BL in R3-192056

**IAB-node integration**

* IAB node indication to CN – to be signaled in INITIAL UE MESSAGE (details FFS)
* No need for explicit indication over F1AP from donor CU to parent DU

**BH RLC ch mgmt**

* An F1AP procedure is used to configure BH RLC channels (detailed info up to RAN2); FFS whether it’s a new procedure or an existing one

**OAM aspects**

* IAB node indication is transferred over Xn/X2 HO signaling (i.e. the HO of the IAB node itself)

**Adaptation, QoS, Bearer Setup**

* TP to running CR to 38.401 on BH Channel Setup and Modification Procedure: Agreed in R3-192165

**IP Address Management**

* DU IP address needs to be different from MT IP address
* DU IP address needs to be routable
* IAB-DU IP address may be assigned by donor DU or by donor CU; if assigned by donor DU, DHCP is used (donor DU may act as DHCP server or as DHCP proxy)

**IAB Node Release Procedure**

* The existing NAS Deregistration procedure shall be reused for the IAB node release procedure.
* The existing NGAP UE Context Release procedure can be reused for releasing the MT context in the RAN.
* For the disorderly release case, it should be left to network implementation how to cope with the issue of hanging contexts.
* TP to running CR to 38.401 on IAB release procedure: Agreed in R3-192175

**User Plane**

* For 1:1 mapping, the use of GTP tunnel ID to identify a DRB between donor CU and donor DU is confirmed
* WA: adopt IPv6 flow labels for 1:1 mapping; FFS whether to also use DSCP
* LS on confirmation on bearers supported with IPv6 Flow Label to RAN2 in [R3-192087](file:///C:\Projects\mmW\mesh\3GPP\RAN-2\RAN2%20Aug19\email%20discussion\107%2309%20running%20CR%2038300\Inbox\R3-192087.zip)

#### The following agreements were reached in RAN3 #104:

**Running CRs**

* Update to running CR to 38.401: endorsed as BL in R3-192621
* Update to running CR to 36.413: endorsed as BL in R3-192619
* Update to running CR to 38.413: endorsed as BL in R3-192622
* Update to running CR to 36.423: endorsed as BL in R3-192620
* Update to running CR to 36.470: endorsed as BL in R3-192411
* Update to running CR to 36.473: endorsed as BL in R3-192412

**IAB-node integration**

* TP to running CR to 38.401 on IAB node integration procedure: Agreed in R3-193176

**Parent node selection**

* OAM options are not precluded
* WA: Parent node selection is performed via legacy handover/redirection mechanisms (i.e. opt4); enhancements to existing mechanisms enabling opt4, if necessary, are not precluded

**OAM aspects**

* Specify in St2 optA, and that optB is allowed

**Adaptation, QoS, Bearer Setup**

* F1AP signaling is used to configure DL forwarding; FFS whether UE-associated or non-UE-associated
* After DU has been set up, F1AP is used to configure BAP layer of the DU of an IAB node (regardless of whether IAB includes one or two BAP entities)

**Backhaul RLC channel Issues, F1AP impacts**

* TP to running CR to 38.473 on BH RLC channel configuration: Agreed in R3-193180
* Different BH RLC channels may be used for the different SCTP streams on which F1AP is transported

**User Plane**

* Adopt IPv6 flow labels for 1:1 mapping (in conjunction with the IAB node IP address); the use of additional information to differentiate bearers is not precluded
* WA: For N:1 mapping, both DSCP-based and IPv6 flow-label based mapping may be used in donor DU for DL
* WA: They may coexist in the same network

#### The following agreements were reached in RAN3 #105:

**Running CRs**

* Update to running CR to 38.401: endorsed as BL in R3-193351
* Update to running CR to 36.413: endorsed as BL in R3-193349
* Update to running CR to 38.413: endorsed as BL in R3-193352
* Update to running CR to 36.423: endorsed as BL in R3-194688
* Update to running CR to 36.470: endorsed as BL in R3-193347
* Update to running CR to 36.473: endorsed as BL in R3-193348

**IAB-node integration: Parent node selection and IAB indication**

* We specify Opt3; opt4 does not require any specific normative text and it is not precluded
* We assume to send IAB indication toward CN in INITIAL UE MESSAGE message to an MME/AMF; SA2 to confirm that this indication is needed from the NG-RAN node to know that the MT is part of an IAB node
* LS to RAN2 and SA2 on IAB-indication and parent-node selection. Agreed in R3-194787
* TP to running CR to 38.413 on IAB-node indication: Agreed in R3-194329
* TP to running CR to 36.413 on IAB-node indication: Agreed in R3-194330

**OAM aspects**

* TP to running CR to 38.401 on IAB OAM: Agreed in R3-194691

**Backhaul RLC channel Issues, F1AP impacts**

* UL: We need to configure mapping between F1-U,F1-C, and non-F1 traffic, and BH RLC channel+BAP routing identifier ID; this may apply to OAM traffic, up to implementation
* TP to running CR to 38.473 on BH RLC channel management: Agreed in R3-194692
* Running CR to 38.300 on BH RLC channel mapping in IAB nodes: Endorsed as BL in R3-194693

**User Plane**

* On the DL, the IAB-donor DU is configurable with information that allows deriving the BAP routing ID from IP header information for F1-U, F1-C and non-F1 traffic.
* On the DL, the IAB-donor DU is configurable with mappings that allow to derive BH RLC channel from IP header information for F1-U, F1-C and non-F1 traffic.
* On the DL, the IAB-donor is configurable with information that allows deriving the BAP address from the destination IP address.
* The IAB-donor DU is configurable with a mapping between IPv6 Flow Label, DS information and Destination IP address to the BH RLC channel, where any of these three IP header fields are optional in the mapping.
* The configuration of the DL F1-U GTP-U tunnel information on the CU-UP is extended to optionally include IPv6 Flow Label and/or DS information.
* It is FFS to what extent the configuration of the DL X2-U and Xn-U GTP-U tunnel information on the MN is extended to optionally include IPv6 Flow Label and/or DS information.

#### The following agreements were reached in RAN3 #105bis:

**Running CRs**

* Update to running CR to 38.401: endorsed as BL in R3-194967
* Update to running CR to 36.413: endorsed as BL in R3-194966
* Update to running CR to 38.413: endorsed as BL in R3-194968
* Update to running CR to 38.423: endorsed as BL in R3-194942
* Update to running CR to 38.470: endorsed as BL in R3-194932
* Update to running CR to 38.473: endorsed as BL in R3-196198
* Update to running CR to 38.300: endorsed as BL in R3-194943

**IAB integration**

* TP to running CR to 38.401 on IAB-node integration: Agreed in R3-196199
* TP to running CR to 38.401 on IAB-node integration: Agreed in R3-196200
* TP to running CR to 38.401 on topology discovery: Agreed in R3-196278
* TP to running CR to 38.401 on RLC BH CH establishment: Agreed in R3-195527
* TP to running CR to 36.413 on IAB capability: Agreed in R3-196201
* TP to running CR to 38.413 on IAB capability: Agreed in R3-196202
* TP to running CR to 38.423 on Xn handover: Agreed in R3-196203
* TP to running CR to 36.423 on X2 handover: Agreed in R3-196204

**BAP - UL mapping**

* UL mapping is to configure mapping between GTP-U FTEID (IP address + TEID) and egress backhaul RRC channel
* WA: we support one-step UL mapping (for F1-U and F1-C)

**BAP – Intra-donor configuration**

* Configuration of downlink bearer mapping and routing should be performed by F1-AP
* Path id is derived from IP header and mapping provided by CU
* In the DL, for BAP path id derivation on the donor DU: IP address, IPv6 flow level and/or DS/DSCP can be used; all of these fields are optional in F1AP message to configure routing
* TP to running CR to 38.463 on F1-U traffic mapping: Agreed in R3-196206

**IP address management**

1. IAB node can obtain an IP address via OAM
2. The donor CU or donor DU can use OAM or DHCP to allocate IAB node IP address
3. IAB node can request one or more IP addresses from donor CU via RRC
4. CU can obtain IAB node IP address from donor DU via F1AP (other methods are not precluded)
5. CU can send IP address to IAB node via RRC

* TP to running CR to 38.401 on IP address allocation: Agreed in R3-196285
* LS to RAN2 on IP address allocation: Agreed in R3-196284

**Topology adaptation**

* TP to running CR to 38.401 on intra-CU topology adaptation: Agreed in R3-196171

# Appendix 3: RAN3 running CR to 38.300 (informative)

This section contains changes based on RAN3 running CR to 38.300 (R3-194693).

-------------------------------------------Change 1-------------------------------------------

### 4.x.y Mapping of Uplink Traffic to Backhaul RLC Channels

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 Backhaul RLC channel. A separate mapping is configured:

- for each F1-U GTP-U tunnel,

- for non-UE associated F1AP messages,

- for UE-associated F1AP messages of each UE.

Editor’s Note: The mapping for non-F1 traffic is FFS.

Multiple mappings can contain the same Backhaul RLC channel.

-------------------------------------------End of changes ------------------------------------------