**3GPP TSG-RAN WG2 Meeting #105bis R2-19xxxxx**

**Reno, NV, USA, May 13th – 17th**

**Agenda item:** 11.1.2

**Source:** Qualcomm Incorporated

**Title:** Email discussion 106#29: IAB running CR 38300

**Document for:** Discussion

# 1 Introduction

This document captures email discussion:

[106#29][IAB] Stage-2 Running CR (Qualcomm)

Intended outcome: agreed draft CR capturing agreements from R2#106

Deadline: Thursday 2019-06-06]

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# 2 Running CR 38.300:

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| *CR-Form-v11.4* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | **38.300** | **CR** | **0153** | **rev** | **002** | **Current version:** | **15.4.0** |  |
|  | | | | | | | | |
| *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:*** | | | 2018-02 |
|  |  | | | |  | |  | | |  |
| ***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)* | |
|  |  | | | | | | | | | |
| ***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:*** | |  | | | | | | | | |

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

IAB Integrated Access and Backhaul

>>>> Skip

MT Mobile TerminationNEXT CHANGE

## 3.2 Definitions

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**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.

**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

**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 enables wireless relaying for NR access by using NR for backhauling. The relaying node is referred to as the *IAB-node*. The terminating node of NR backhauling on network side is referred to as the *IAB-donor gNB*, which represents a gNB with additional functionality to support IAB.

Backhauling can occur via a single or via multiple hops.

The IAB-node supports gNB-DU functionality 1) to terminate NR access interface to UEs and IAB-nodes, and 2) to support F1 protocol to the gNB-CU on the IAB-donor. The neighbour node on the DU’s NR access interface is also referred to as *child* node.

NOTE: The architecture and the F1 interface for a functional split are defined in TS 38.401.

The IAB-node also supports the NR Uu radio interface, referred to as MT functionality, 1) to connect to the DU of another IAB-node or the IAB-donor, and 2) to connect to the gNB-CU on the IAB-donor via RRC. The neighbour node on the MT’s NR Uu radio interface is also referred to as *parent* node.

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. In this DAG topology, *upstream* refers to the direction of the parent node while *downstream* refers to the direction of the child node.

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**

### 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. 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**

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### 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: End-to-end flow control is FFS.

- In downstream direction, the NR UP protocol (TS 38.425 [xx]) supports end-to-end flow control.

Editor’s Note: Hop-by-hop flow control is FFS.

#### 4.x.3.2 Uplink scheduling latency

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

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.

>>>> Skip

### 4.x.4 Signalling procedures

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

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

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#### 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.

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

>>>> Skip

#### 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-node MT to have concurrent BH RLC channels with two parent nodes. In Rel-16, 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 NR DC framework (e.g. MCG/SCG-related procedures) is used to configure the dual radio links with the parent nodes. Since backhaul RLC channels do not carry the PDCP layer split-bearer functionality is not supported for backhauling.

For IAB-nodes operating in EN-DC mode, the BH does not support route redundancy for backhauling since the BAP layer is only supported on the NR link

Editor’s Note: It is FFS whether to support IAB control connectivity between IAB-node and IAB-donor via the MN when the SN link breaks.

NEXT CHANGE

# 6 Layer 2

## 6.1 Overview

>>>>>Skip

## 6.x Backhaul Adaptation Protocol Sublayer

### 6.x.1 Services and Functions

The main service and functions of the BAP sublayer for the user plane include:

- Routing,

This includes delivery of packets to a destination node by selecting a next backhaul link among given multiple backhaul links at an IAB node and an IAB donor node

- Bearer mapping,

Editor’s Note: Detail description of bearer mapping needs to be added.

END OF CHANGES

# Appendix

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 #106s:

**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.