**3GPP TSG-RAN WG2 Meeting #116-bis Electronic R2-22xxx**

**Online Meeting, 17th - 25th JAN, 2022**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **38.340** | **CR** | **xxxx** | **rev** | **-** | **Current version:** | **16.5.0** |  |
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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 |  |

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| ***Title:*** | Running CR of TS 38.340 for eIAB | | | | | | | | | |
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| ***Source to WG:*** | Huawei, HiSilicon | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_IAB\_enh-Core | | | | |  | ***Date:*** | | | 2022-01-26 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-17 |
|  | *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-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | Introduce eIAB to TS 38.340 by capturing the following RAN2 and RAN3 agreements:  - after RAN2#115-e meeting:   |  | | --- | | * RAN2 to support type-2/3 RLF indication (FFS specified behavior(s) TS impact, FFS details). * Type-2 RLF indication may be used to trigger local rerouting. * Local rerouting can be triggered by indication of hop-by-hop flow control. * A configured threshold of available buffer size based on flow control feedback is used to determine the congestion, for the purpose of local re-routing. * For inter-donor-DU re-routing, support the “previous routing ID to new routing ID” BAP header rewriting. * Support inter-CU re-routing, i.e. IAB-node re-routes the data to its original donor-CU via the alternative BAP path over the topology in target CU. * As baseline, support the 1:1 and N:1 mapping from “previous routing ID” to “new routing ID” for BAP header rewriting at the boundary node, in inter-CU routing. * As baseline, support the 1:1 and N:1 mapping from “ingress BH link + ingress BH RLC ID” to “egress BH link + egress BH RLC ID” for bearer mapping at the boundary node, in inter-CU routing. |   - after RAN3#113-e meeting:   |  | | --- | | * RAN3 prefers that the boundary node processes access traffic in the same manner as the non-boundary access IAB-node. * RAN3 prefers that the boundary node performs BAP header rewriting only for traffic routed on BAP layer from a BH link in one topology to a BH link in the adjacent topology, for both UL and DL traffic. * FFS: In addition to BAP header rewriting, performs routing and bearer mapping in the same manner as the non-boundary intermediate IAB-node. * RAN3 assumes that the boundary node has only one BAP address in each topology. * RAN3 assumes that for each topology, the boundary node’s BAP address for that topology is only used to identify packets that have to be passed to upper layers. * For DL traffic, the configurations of BAP routing entry and BAP-routing-ID mapping at the boundary node need to indicate the ingress topology they refer to. For UL traffic, they need to indicate the egress topology they refer to. The indications may be implicit. |   - after RAN2#116-e meeting:   |  | | --- | | * For triggering condition of type-2 indication by a single-connected node, initiation of RRC re-establishment is a sufficient condition to trigger type-2 indication. * Type 2 indication by dual-connected node is triggered when the node initiates RRC re-establishment resulting from BH RLF on both CGs or BH RLF on MCG with no fast MCG recovery. * FFS if Type 2 indication by dual-connected node can be triggered when the node detects BH RLF on any BH and it cannot perform re-routing for affected traffic (if agreed see R2-2111539 for more details) * Upon reception of type-2 indication, the node should perform local re-routing if possible. * A node can transmit type-3 indication if re-establishment is successful. * A node can transmit type-3 indication only if it previously sent type-2 indication, i.e., type-3 indication cannot be triggered without triggering type-2 indication previously. * To agree that the following terms are used: * Type-2: “BH RLF detection indication”, * Type-3: “BH RLF recovery indication” , and * Type-4: FFS whether “BH RLF recovery failure indication” or existing name “BH RLF indication” * Go with B, including the following: * If BAP address matches, deliver to upper layer; * Else: * - If routing ID matches rewriting table, perform the header rewriting; * - perform routing and mapping to BH RLC CH. * For downstream, the boundary node is able to identify/differentiate the traffic routed from inter-topology vs. the traffic routed from intra-topology, based on the ingress link. * For downstream at the boundary node, for any received data from inter-topology identified by the ingress link: * The data is delivered to upper layer, if the BAP address in the header is same as the boundary node BAP address configured in the topology of the ingress link (of this packet); otherwise, the data is determined as to be header rewritten (assumes support only of topology where decedent nodes belong to same topology). * (This requires that traffic not terminated at the boundary node should not use the BAP address in header same as the boundary node BAP address configured in the topology of the ingress link.) * Perform the header rewriting based on the configured rewriting table, and then perform routing and mapping to BH RLC CH. * For upstream at the boundary node, for any received data from lower layer: * We may keep the ingress BAP text of R16 (that is intended for donor DU but general in Stage-3), i.e. if the BAP address in header match the boundary node BAP address configured in the topology of the ingress link, deliver to upper layer. * The data is determined as to be header rewritten and perform the header rewriting accordingly, if routing ID in header matches any “previous routing ID” in the rewriting table; and then perform routing and mapping to BH RLC CH. * For upstream, The pre-condition/criteria of “BAP header rewriting for re-routing” is that there is no available next hop found based on BAP routing ID and based on BAP address in the routing table (e.g. due to BH RLF, congestion or type2 indication, etc.), as in R16. * Will have rewriting mapping configuration(s) Old routing ID to New routing ID that limits the possible rewriting (for all cases of re-writing), details FFS |   - after RAN2#116-bis-e meeting:   |  | | --- | | * For a dual-connected node, e.g., configured with CP-UP split/NR-DC/EN-DC, type-2 indication is triggered when all the CG(s) providing F1-over-BAP fail. * FFS if successful CHO executed during re-establishment should be captured as an explicit triggering condition of type-3 indication or if genetic condition “upon recovery” from BH RLF is sufficient. * For each topology, the BAP address is configured to the boundary node by the CU of that topology via RRC (may need to check different scenarios). * In the Routing configuration: A BH link and the corresponding next-hop BAP address belong to the topology of the CU that provided the configuration of that BH link and next-hop BAP address. * The header rewriting configuration is provided via F1AP. * FFS if The header rewriting configuration to include an indicator, which identifies either the egress topology, or the ingress topology, or the traffic direction (RAN2 to select one of these three options). * For the two scenario of inter-topology routing and intra-to-inter-topology re-routing, there is only one header rewriting for a packet, where the header rewriting entry includes the BAP routing ID of the packet’s ingress topology and the BAP routing ID of the packet’s egress topology. * Referring to previous agreement “Will have rewriting mapping configuration(s) Old routing ID to New routing ID that limits the possible rewriting (for all cases of re-writing)”: It is FFS whether for upstream there would be a configuration optimization such that the “New Routing ID” is the same for all entries (a.k.a. default routing ID) * [049] For inter-topology routing, the header rewriting configuration to include information that allows the boundary node to determine either the egress topology, or the ingress topology, or the traffic direction of a header-rewriting entry (selection of one of these expected). RAN3 to handle the St3-related aspects. * [049] The BH RLC CH mapping configuration of the boundary node includes information for the boundary node to differentiate mappings based on ingress topology and egress topology. * [049] The UL mapping configuration to include information for the boundary node to determine the egress topology of each UL mapping entry. * [049] In configurations, the topology is referred to as “F1-terminating CU’s topology” vs. “non-F1-terminating CU’s topology”. The terms “F1-terminating CU” and “non-F1-terminating CU” to be defined in St2 spec. * [049] Determination/execution of header rewriting is handled by the BAP TX entity. * [049] The routing configuration to include information that allows the boundary node to determine the topology each routing entry applies to. RAN3 to decide on St3-related aspects. | | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | 1. Add followings NOTEs to allow IAB to trigger local rerouting in case of receiving type 2 RLF indication or flow control feedback, in 5.2.1.3.   NOTE x: An egress link is not considered to be available [for a BAP routing ID], upon receiving BH RLF detection indication on the link. An egress link is considered to be available again [for a BAP routing ID], upon receiving BH RLF recovery indication on the link.  NOTE y: An egress link may be not considered to be available for a [BAP routing ID and/or BH RLC channel], if it is determined as congested based on the received flow control feedback, as defined in sub-clause 5.3.1.   1. Introduce Control PDU for BH RLF detection indication in 6.2.3.x and 6.3.7, for type 2 RLF indication, and its transmission and reception in 5.4; 2. Introduce Control PDU for BH RLF recovery indication in 6.2.3.y and 6.3.7, for type 3 RLF indication, and its transmission and reception in 5.4; 3. Introduce congestion determination in 5.3.1, based on the configured threshold. 4. Introduce the inter-donor-DU re-routing, after the BAP header rewriting, in 5.2.1.3. 5. Introduce the “BAP header rewriting operation” in 5.2.x, which may be commonly used by inter-donor-DU re-routing, inter-CU (re)-routing.   **Impact analysis**  Impacted functionality:  Local re-routing, BAP control PDU, BAP header rewriting | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | eIAB is not correctly specified in TS 38.340. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 5.2.1.3, 5.2.x, 5.3.1, 5.4, 6.2.3.x, 6.2.3.y, 6.3.7 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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:*** | | The change is marked by “Post-R2#115”, which is endorsed as R2-2108930 during [Post115-e][076][eIAB].  The change is marked by “Post-R2#116”, which is endorsed as R2-2111637 during [Post116-e][074][eIAB].  The change is marked by “Post-R2#116BIS”, which is endorsed as R2-21xxxx during [Post116bis-e][078][eIAB]. | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

Start of Change

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 38.300: "NG Radio Access Network; Overall description".

[3] 3GPP TS 38.331: "NR Radio Resource Control (RRC); Protocol Specification".

[4] 3GPP TS 38.322: "NR Radio Link Control (RLC) protocol specification".

[5] 3GPP TS 38.473: "NG-RAN F1 application protocol (F1AP) protocol specification".

[6] 3GPP TS 38.401: "NG-RAN; Architecture description".

3 Definitions of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] 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].

**BH RLC channel:** an RLC channel between two nodes, which is used to transport backhaul packets, as defined in TS 38.300 [2]**.**

**Boundary IAB-node**: an IAB-node with one RRC interface terminating at a different IAB-donor-CU than the F1 interface, as defined in TS 38.401 [6].

**Egress BH RLC channel:** a BH RLC channel on which a packet is transmitted by a node.

**Egress link**: a radio link on which a packet is transmitted by a node.

**F1-terminating donor**: The IAB-donor of one IAB-node, which manages the F1 interface with this IAB-node.**IAB-donor**: as defined in TS 38.300 [2].

**IAB-donor-DU**: as defined in TS 38.401 [6].

**IAB-node**: as defined in TS 38.300 [2].

**Ingress BH RLC channel:** a BH RLC channel on which a packet is received by a node.

**Ingress link**: a radio link on which a packet is received by a node.

**Non-F1-terminating donor**: The IAB-donor for one IAB-node, which does not have F1 interface with this IAB-node.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] 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].

BH Backhaul

DSCP Differentiated Services Code Point

IAB Integrated Access and Backhaul

MT Mobile Termination

TEID Tunnel Endpoint Identifier

4 General

4.1 Introduction

The present document describes the functionalities of BAP.

4.2 Architecture

4.2.1 BAP structure

Figure 4.2.1-1 represents one possible structure for the BAP sublayer; it should not restrict implementation. The figure is based on the radio interface protocol architecture defined in TS 38.300 [2].

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**Figure 4.2.1-1: BAP layer, structure view**

The BAP sublayer is configured by upper layers TS 38.331 [3] and TS 38.473 [5].

4.2.2 BAP entities

On the IAB-node, the BAP sublayer contains one BAP entity at the MT function and a separate collocated BAP entity at the DU function. On the IAB-donor-DU, the BAP sublayer contains only one BAP entity. Each BAP entity has a transmitting part and a receiving part.

NOTE: The modelling of BAP entities does not restrict internal implementation of IAB-nodes, i.e. the exact modelling of BAP sublayer may vary for different IAB-node implementations.

The transmitting part of the BAP entity has a corresponding receiving part of a BAP entity at the IAB-node or IAB-donor-DU across the BH link.

Figure 4.2.2-1 shows one example of the functional view of the BAP sublayer. This functional view should not restrict implementation. The figure is based on the radio interface protocol architecture defined in TS 38.300 [2].

In the example of Figure 4.2.2-1, the receiving part on the BAP entity delivers BAP PDUs to the transmitting part on the collocated BAP entity. Alternatively, the receiving part may deliver BAP SDUs to the collocated transmitting part. When passing BAP SDUs, the receiving part removes the BAP header and the transmitting part adds the BAP header with the same BAP header content as carried on the BAP PDU header prior to removal. Passing BAP SDUs in this manner is therefore functionally equivalent to passing BAP PDUs, in implementation. The following specification therefore refers to the passing of BAP Data Packets.

Besides, BAP entity generates, delivers/receives BAP Control PDU(s) as described in clause 6.1.2. BAP Control PDU can only be exchanged between peer BAP entities across the BH link.



**Figure 4.2.2-1. Example of functional view of BAP sublayer**

Editor's Note: FFS how to capture the BAP header rewriting in the figure.

4.3 Services

4.3.1 Services provided to upper layers

The following services are provided by the BAP sublayer to upper layers:

- data transfer.

4.3.2 Services expected from lower layers

A BAP sublayer expects the following services from lower layers per RLC entity (for a detailed description see TS 38.322 [4]):

- acknowledged data transfer service;

- unacknowledged data transfer service.

4.4 Functions

The BAP sublayer supports the following functions:

- Data transfer;

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

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

- Routing of packets to next hop;

- BAP header rewriting;

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

- Flow control feedback and polling signalling;

- BH RLF related indications;

4.5 Configurations

The configuration of the BAP entity includes:

- The IAB-node's BAP address via RRC.

- The IAB-donor-DU's BAP address via F1AP.

- Mapping from next hop BAP address to downstream egress link via F1AP.

- Mapping from next hop BAP address to upstream egress link via RRC.

- Mapping from upper layer traffic to BAP routing ID in BAP header via F1AP and RRC.

- The BAP routing entries via F1AP.

- Mapping to egress BH RLC channels via F1AP and RRC.

- Flow control feedback type(s) to be provided, if any, via RRC.

BH RLC channels are configured via RRC on the IAB-MT, and via F1AP on the IAB-DU/IAB-donor-DU.

For F1AP configurations, the following mapping, which are derived from the original F1AP signaling, are used in procedure:

- Uplink Traffic to Routing ID Mapping Configuration.

- Downlink Traffic to Routing ID Mapping Configuration.

- BH Routing Configuration.

- BH RLC Channel Mapping Configuration.

- Uplink Traffic to BH RLC Channel Mapping Configuration.

- Downlink Traffic to BH RLC Channel Mapping Configuration.

Editor's Note: Further new configuration is to be added (e.g. Header Rewriting Configuration)

5 Procedures

5.1 BAP entity handling

5.1.1 BAP entity establishment

When upper layers request establishment of a BAP entity, the node shall:

- establish a BAP entity;

- follow the procedures in clause 5.

5.1.2 BAP entity release

When upper layers request release of a BAP entity, the node shall:

- release the BAP entity and the related BAP configurations.

5.2 Data transfer

5.2.1 Transmitting operation

5.2.1.1 General

The transmitting part of the BAP entity on the IAB-MT can receive BAP SDUs from upper layers and BAP Data Packets from the receiving part of the BAP entity on the IAB-DU of the same IAB-node, and construct BAP Data PDUs as needed (see clause 4.2.2). The transmitting part of the BAP entity on the IAB-DU can receive BAP Data Packets from the receiving part of the BAP entity on the IAB-MT of the same IAB-node, and construct BAP Data PDUs as needed (see clause 4.2.2). The transmitting part of the BAP entity on the IAB-donor-DU can receive BAP SDUs from upper layers, and construct BAP Data PDUs as needed (see clause 4.2.2).

Upon receiving a BAP SDU from upper layers, the transmitting part of the BAP entity shall:

- select a BAP address and a BAP path identity for this BAP SDU in accordance with clause 5.2.1.2;

- construct a BAP Data PDU by adding a BAP header to the BAP SDU, where the DESTINATION field is set to the selected BAP address and the PATH field is set to the selected BAP path identity, in accordance with clause 6.2.2;

When the BAP entity has a BAP Data PDU to transmit, the transmitting part of the BAP entity shall:

- for the IAB-MT of boundary IAB-node, if there is an entry with Type as [*CU1ToCU2Routing]* in the Header Rewriting Configuration whose BAP address of Previous Routing ID matches the DESTINATION field, and whose BAP path identity of Previous Routing ID matches the PATH field (as specified in sub-clause 5.2.X):

- perform the BAP header rewriting operation, using the entries with Type as [*CU1ToCU2Routing]*, in accordance with clause 5.2.x;

- consider this BAP Data PDU as one non-F1-terminating donor topology data;

- for the IAB-DU of boundary IAB-node, if the ingress link of this BAP Data PDU belongs to non-F1-terminating donor’s topology of the boundary IAB-node:

- perform the BAP header rewriting operation, using the entries with Type as [*CU2ToCU1Routing*], in accordance with clause 5.2.x;

- perform routing to determine the egress link in accordance with clause 5.2.1.3;

- determine the egress BH RLC channel in accordance with clause 5.2.1.4;

- submit this BAP Data PDU to the selected egress BH RLC channel of the selected egress link.

NOTE 1: Data buffering on the transmitting part of the BAP entity, e.g., until RLC-AM entity has received an acknowledgement, is up to implementation. In case of BH RLF, the transmitting part of the BAP entity may reroute the BAP Data PDUs, which has not been acknowledged by lower layer before the BH RLF, to an alternative path in accordance with clause 5.2.1.3.

NOTE 2: A BH link belongs to the topology of the IAB-donor that provides the configuration of that BH link, as specified in TS 38.331 [3].

5.2.1.2 BAP routing ID selection

5.2.1.2.1 BAP routing ID selection at IAB-node

At an IAB-node, for a BAP SDU received from upper layers and to be transmitted in upstream direction, the BAP entity performs mapping to a BAP address and BAP path identity based on:

- Uplink Traffic to Routing ID Mapping Configuration, which is derived from F1AP on the IAB-node in TS 38.473 [5],

- *defaultUL-BAP-RoutingID*, which is configured by RRC on the IAB-node in TS 38.331[3].

Each entry of the Uplink Traffic to Routing ID Mapping Configurationcontains:

- a traffic type specifier, which is indicated by *UL UP TNL Information* IE for F1-U packets and *Non-UP Traffic Type* IE for non-F1-U packets in TS 38.473 [5], and

- a BAP routing ID, which includes a BAP address and a BAP path identity, indicated by *BAP Routing ID* IE in *BH Information* IE in TS 38.473 [5].

At the IAB-node, for a BAP SDU received from upper layers and to be transmitted in upstream direction, the BAP entity shall:

- if the Uplink Traffic to Routing ID Mapping Configuration has not been (re)configured by F1AP after the last (re)configuration of *defaultUL-BAP-RoutingID* by RRC:

- select the BAP address and the BAP path identity as configured by *defaultUL-BAP-RoutingID* in TS 38.331 [3] for non-F1-U packets;

- else:

- for the BAP SDU encapsulating an F1-U packet:

- select an entry from the Uplink Traffic to Routing ID Mapping Configuration with its traffic type specifier corresponds to the destination IP address and TEID of this BAP SDU;

- for the BAP SDU encapsulating a non-F1-U packet:

- select an entry from the Uplink Traffic to Routing ID Mapping Configuration with its traffic type specifier corresponds to the traffic type of this BAP SDU;

- select the BAP address and the BAP path identity from the BAP routing ID in the entry selected above;

NOTE: Uplink Traffic to Routing ID Mapping Configuration may contain multiple entries for F1-C traffic. It is up to IAB node's implementation to decide which entry is selected.

5.2.1.2.2 BAP routing ID selection at IAB-donor-DU

For a BAP SDU received from upper layer at the IAB-donor-DU, the BAP entity performs mapping to a BAP address and a BAP Path identity based on:

- Downlink Traffic to Routing ID Mapping Configuration, which is derived from *IP-to-layer-2 traffic mapping Information List* IE configured on the IAB-donor-DU in TS 38.473 [5].

Each entry of the Downlink Traffic to Routing ID Mapping Configuration contains:

- a destination IP address, which is indicated by *Destination IAB TNL Address* IE in *IP header information* IE, including an IPv4 address or IPv6 address or an IPv6 address prefix,

- an IPv6 flow label, if configured, which is indicated by *IPv6 Flow Label* IE in *IP header information* IE,

- a DSCP, if configured, which is indicated by *DSCP* IE in *DS Information List* IE in *IP header information* IE, and

- a BAP routing ID, which is indicated by *BAP Routing ID* IE in *BH Information* IE in TS 38.473 [5].

At the IAB-donor-DU, for a BAP SDU received from upper layers and to be transmitted in downstream direction, the BAP entity shall:

- for the BAP SDU encapsulating an IPv6 packet:

- select an entry from the Downlink Traffic to Routing ID Mapping Configuration which fulfils the following conditions:

- the Destination IP address of this BAP SDU matches the destination IP address in this entry; and

- the IPv6 Flow Label of this BAP SDU matches IPv6 flow label in this entry if configured; and

- the DSCP of this BAP SDU matches DSCP in this entry if configured;

- for the BAP SDU encapsulating an IPv4 packet:

- select an entry from the Downlink Traffic to Routing ID Mapping Configuration which fulfils the following conditions:

- the Destination IP address of this BAP SDU matches the destination IP address in this entry; and

- the DSCP of this BAP SDU matchesDSCP in this entry if configured;

- select the BAP address and the BAP path identity from the BAP routing ID in the entry selected above;

5.2.1.3 Routing

The BAP entity performs routing based on:

- the BH Routing Configuration derived from an F1AP message as specified in TS 38.473 [5].

Each entry of the BH Routing Configuration contains:

- a BAP Routing ID consisting of a BAP address and a BAP path identity, which is indicated by *BAP Routing ID* IE, and

- a Next Hop BAP Address which is indicated by *Next-Hop BAP Address* IE.

The entry indicated by [*non-F1-terminating donor topology*] IE applies to the BAP Data PDU considered as non-F1-terminating donor topology data, and the entry without [*non-F1-terminating donor topology*] IE only applies to the BAP Data PDU not considered as non-F1-terminating donor topology data.

Editor's Note: RAN3 to decide on F1AP singling details. The above can be updated based on RAN3 signalling.

For a BAP Data PDU to be transmitted, BAP entity shall:

- if the BAP Data PDU corresponds to a BAP SDU received from the upper layer, and

- if the BH Routing Configuration has not been (re)configured by F1AP after the last (re)configuration of *defaultUL-BH-RLC-Channel* by RRC:

- select the egress link on which the egress BH RLC channel corresponding to *defaultUL-BH-RLC-Channel* is configured as specified in TS 38.331 [3] for non-F1-U packets;

- else if there is an entry in the BH Routing Configuration whose BAP address matches the DESTINATION field, whose BAP path identity is the same as the PATH field, and whose egress link corresponding to the Next Hop BAP Address is available:

- select the egress link corresponding to the Next Hop BAP Address of the entry;

NOTE 1: An egress link is not considered to be available if the link is in BH RLF.

NOTE 2: For each combination of a BAP address and a BAP path identity, there should be at most one entry in the BH Routing Configuration. There could be multiple entries of the same BAP address in the BH Routing Configuration.

NOTE 3: An egress link may be not considered to be available for a BAP routing ID, if it is determined as congested based on the received flow control feedback, as defined in sub-clause 5.3.1.

- else if there is at least one entry in the BH Routing Configuration whose BAP address matches the DESTINATION field, and whose egress link corresponding to the Next Hop BAP Address is available:

- select an entry from the BH Routing Configuration whose BAP address is the same as the DESTINATION field, and whose egress link corresponding to the Next Hop BAP Address is available;

- select the egress link corresponding to the Next Hop BAP Address of the entry selected above;

- else at least one egress link is available:

[- if the BAP Data PDU is considered as non-F1-terminating donor topology data in accordance with clause 5.2.1.1, and

- if the Header Rewriting Configuration includes the entries with Type as [*CU2ToCU1Routing]*:

- perform the BAP header rewriting operation, using the entries with Type as *CU2ToCU1Routing*, in accordance with clause 5.2.x;

- consider this BAP Data PDU not as one non-F1-terminating donor topology data;

- if the BAP Data PDU is not considered as non-F1-terminating donor topology data in accordance with clause 5.2.1.1, and

- if the Header Rewriting Configuration includes the entries with Type as *Rerouting*:

- perform the BAP header rewriting operation, using the entries with Type as *Rerouting*, in accordance with clause 5.2.x;]

- if there is an entry in the BH Routing Configuration whose BAP address matches the DESTINATION field, whose BAP path identity is the same as the PATH field, and whose egress link corresponding to the Next Hop BAP Address is available:

- select the egress link corresponding to the Next Hop BAP Address of the entry;

Editor's Note: The above procedure in bracket [ ] needs to be updated after RAN2 conclude the details considering below options for the scenario of inter-to-intra-topology re-routing:

Option 1: No header rewriting is applied, and the upstream packet’s BAP routing ID in the ingress topology contains the BAP address of the IAB-donor-DU in the same topology.

Option 2: Header rewriting is applied based on a header-rewriting entry, which contains the packet’s ingress BAP routing ID and the BAP routing ID of the packet’s egress topology after inter-to-intra re-routing.

Option 3: Header rewriting is applied based on a header-rewriting entry, which contains the BAP routing ID of the packet’s intended egress topology after inter-topology routing and the BAP routing ID of the packet’s egress topology after inter-to-intra re-routing.

Option 4: The boundary node is configured with a default BAP routing ID for each topology via RRC, and such default BAP routing ID can be used as the egress routing ID when applying inter-topology rerouting.

Editor's Note: FFS if BAP routing ID granularity is supported for local rerouting triggered by type2 indication.

Editor's Note: FFS on granularity for local rerouting triggered by flow control feedback.

5.2.1.4 Mapping to BH RLC Channel

5.2.1.4.1 Mapping to BH RLC Channel for BAP Data Packets from collocated BAP entity at IAB-node

For a BAP Data Packet received from the collocated BAP entity, the transmitting part of the BAP entity performs mapping to an egress BH RLC channel based on:

- BH RLC Channel Mapping Configuration, which is derived from *BAP layer BH RLC channel mapping Information List* IE, and optionally together with the *Configured BAP address* IE and the *BH RLC Channel to be Setup/Modified List* IE, as configured on the IAB-node in TS 38.473 [5],

Each entry of the BH RLC Channel Mapping Configuration contains:

- an ingress link ID, which is indicated by *Prior-Hop BAP Address* IE, or by the *Configured BAP address* IE in UE-associated F1AP message for upstream,

- an egress link ID, which is indicated by *Next-Hop BAP Address* IE, or by the *Configured BAP address* IE in UE-associated F1AP message for downstream,

- an ingress BH RLC channel ID, which is indicated by *Ingress BH RLC CH ID* IE, or by the *BH RLC CH ID* IE in UE-associated F1AP message for upstream, and,

- an egress BH RLC channel ID, which is indicated by *Egress BH RLC CH ID* IE, or by the *BH RLC CH ID* IE in UE-associated F1AP message for downstream.

For a BAP Data PDU received from an ingress BH RLC channel of an ingress link and for which the egress link has been selected as specified in clause 5.2.1.3:

- if there is an entry in the BH RLC Channel Mapping Configuration, whose ingress BH RLC channel ID matches the BAP Data PDU's ingress BH RLC channel, whose ingress link ID matches the BAP Data PDU's ingress link, and whose egress link ID corresponds to the selected egress link;

- select the egress BH RLC channel corresponding to egress BH RLC channel ID of this entry;

- else:

- select any egress BH RLC channel on the selected egress link;

Editor's Note: Wait for RAN3 signalling design on below agreement:

* The BH RLC CH mapping configuration of the boundary node includes information for the boundary node to differentiate mappings based on ingress topology and egress topology.
* The UL mapping configuration to include information for the boundary node to determine the egress topology of each UL mapping entry.

5.2.1.4.2 Mapping to BH RLC Channel for BAP SDUs from upper layers at IAB-node

For a BAP SDU received from upper layers at the IAB-node, the BAP entity performs mapping to an egress BH RLC channel based on:

- Uplink Traffic to BH RLC Channel Mapping Configuration, which is derived from F1AP message, configured on the IAB-node in TS 38.473 [5],

- *defaultUL-BH-RLC-Channel*, which is configured by RRC on the IAB-node in TS 38.331[3].

Each entry of the Uplink Traffic to BH RLC Channel Mapping Configuration contains:

- a traffic type specifier, which is indicated by *UL UP TNL Information* IE for F1-U packets or *Non-UP Traffic Type* IE for non-F1-U packets in TS 38.473 [5],

- an egress link ID, which is indicated by *Next-Hop BAP address* IE in *BH Information* IE in TS 38.473 [5], and

- an egress BH RLC channel ID, which is indicated by *BH RLC CH ID* IE in *BH Information* IE in TS 38.473 [5].

For a BAP SDU received from upper layers at the IAB-node and to be transmitted in upstream direction, whose egress link has been selected as specified in clause 5.2.1.3, the BAP entity shall:

- if the Uplink Traffic to BH RLC Channel Mapping Configurationhas not been (re)configured by F1AP after the last (re)configuration of *defaultUL-BH-RLC-Channel* by RRC:

- select the egress BH RLC channel corresponding to *defaultUL-BH-RLC-Channel* configured in TS 38.331 [3] for non-F1-U packets;

- else:

- for the BAP SDU encapsulating an F1-U packet:

- if there is an entry in the Uplink Traffic to BH RLC Channel Mapping Configuration with its traffic type specifier corresponds to the destination IP address and TEID of this BAP SDU and its egress link ID corresponding to the selected egress link;

- select the egress BH RLC channel corresponding to the egress BH RLC channel ID of this entry;

- else:

- select any egress BH RLC channel on the selected egress link;

- for the BAP SDU encapsulating a non-F1-U packet:

- if there is an entry from the Uplink Traffic to BH RLC Channel Mapping Configuration with its traffic type specifier corresponds to the traffic type of this BAP SDU and its egress link ID corresponding to the selected egress link;

- select the egress BH RLC channel corresponding to the egress BH RLC channel ID of this entry;

- else:

- select any egress BH RLC channel on the selected egress link;

NOTE: Uplink Traffic to BH RLC Channel Mapping Configuration may contain multiple entries for F1-C traffic. It is up to IAB node's implementation to decide which entry is selected, but the selected entry has to match the BAP routing ID selected in 5.2.1.2.1, i.e. BAP routing ID and BH RLC channel must be derived from the same *BH Information* IE.

5.2.1.4.3 Mapping to BH RLC Channel at IAB-donor-DU

For a BAP SDU received from upper layers at the IAB-donor-DU, the BAP entity performs mapping to an egress BH RLC channel based on:

- Downlink Traffic to BH RLC Channel Mapping Configuration, which is derived from *IP-to-layer-2 traffic mapping Information List* IE , and optionally together with the *Configured BAP address IE and* the *BH RLC Channel to be Setup/Modified List* IE, as configured on the IAB-donor-DU in TS 38.473 [5].

Each entry of the Downlink Traffic to BH RLC Channel Mapping Configuration contains:

- a destination IP address, which is indicated by *Destination IAB TNL Address* IE in *IP header information* IE including an IPv4 address or IPv6 address or an IPv6 address prefix,

- an IPv6 flow label, if configured, which is indicated by *IPv6 Flow Label* IE in *IP header information* IE,

- a DSCP, if configured, which is indicated by *DSCP* IE in *DS Information List* IE in *IP header information* IE,

- an egress link ID, which is indicated by *Next-Hop BAP Address* IE in *BH Information* IE, or by the *Configured BAP address* IE in UE-associated F1AP message, and

- an egress BH RLC channel ID, which is indicated by *Egress BH RLC CH ID* IE in *BH Information* IE, or by the *BH RLC CH ID* IE in UE-associated F1AP message.

At the IAB-donor-DU, for a BAP SDU received from upper layers and to be transmitted in downstream direction, whose egress link has been selected as specified in clause 5.2.1.3, the BAP entity shall:

- for the BAP SDU encapsulating an IPv6 packet:

- if there is an entry in the Downlink Traffic to BH RLC Channel Mapping Configuration with its egress link ID corresponding to the selected egress link, and the entry fulfils the following conditions:

- the Destination IP address of this BAP SDU matches the destination IP address in this entry; and

- the IPv6 Flow Label of this BAP SDU matches IPv6 flow label in this entry if configured; and

- the DSCP of this BAP SDU matches DSCP in this entry if configured:

- select the egress BH RLC channel corresponding to egress BH RLC channel ID of this entry;

- else:

- select any egress BH RLC channel on the selected egress link;

- for the BAP SDU encapsulating an IPv4 packet:

- if there is an entry in the Downlink Traffic to BH RLC Channel Mapping Configuration with its egress link ID corresponding to the selected egress link, and the entry fulfils the following conditions:

- the Destination IP address of this BAP SDU matches the destination IP address in this entry; and

- the DSCP of this BAP SDU matches DSCP in this entry if configured:

- select the egress BH RLC channel corresponding to egress BH RLC channel ID of this entry;

- else:

- select any egress BH RLC channel on the selected egress link;

5.2.2 Receiving operation

Upon receiving a BAP Data PDU from lower layer (i.e. ingress BH RLC channel), the receiving part of the BAP entity shall:

- if DESTINATION field of this BAP Data PDU matches the BAP address, which is configured for this node by the IAB-donor providing this ingress BH RLC channel configuration [(i.e. the one of ingress topology)] :

- remove the BAP header of this BAP Data PDU and deliver the BAP SDU to upper layers;

- else:

- deliver the BAP Data Packet to the transmitting part of the collocated BAP entity.

5.2.x BAP header rewriting operation

Editor's Note: This section can be used to capture how to perform BAP header rewriting, which can be used for the inter-CU routing, inter-CU re-routing and inter-donor-DU re-routing cases. The need/place/details of this section are to be confirmed/revised after RAN2 make clear agreements for all the cases for header rewriting.

The BAP entity performs BAP header rewriting based on:

- the Header Rewriting Configuration derived from an F1AP message as specified in TS 38.473 [5].

Each entry of the Header Rewriting Configuration contains:

- a Previous Routing ID consisting of a BAP address and a BAP path identity of the BAP Data PDU, which is indicated by *FFS* IE, and

- a New Routing ID consisting of a BAP address and a BAP path identity of the BAP Data PDU, which is indicated by *FFS* IE, and

- a Type, including *[CU2ToCU1Routing], [CU1ToCU2Routing]* and *[Rerouting]*, which is optionally indicated by *FFS* IE.

Editor's Note: The details of Header Rewriting Configuration can be revised with any potential new RAN2/RAN3 agreement.

For a BAP Data PDU to be considered for BAP header rewriting, the BAP entity shall:

- if there is an entry in the Header Rewriting Configuration whose BAP address of Previous Routing ID matches the DESTINATION field, whose BAP path identity of Previous Routing ID matches the PATH field:

- replace the BAP header of this BAP Data PDU, where the DESTINATION field is reset to the leftmost 10 bits of New Routing ID of the entry (i.e. BAP address), and the PATH field is reset to the rightmost 10 bits of New Routing ID of the entry (i.e. BAP path identity).

Editor's Note: For inter-topology routing, the header rewriting configuration to include information that allows the boundary node to determine either the egress topology, or the ingress topology, or the traffic direction of a header-rewriting entry (selection of one of these expected). RAN3 to handle the St3-related aspects. FFS on whether the header rewriting entry to include a “rerouting” indicator.

5.3 Flow control

5.3.1 Flow control feedback

5.3.1.x Transmitting operation

For a link, the BAP entity at the IAB-MT shall:

- when a flow control feedback is triggered due to the buffer load exceeding a certain level, or

- when a BAP Control PDU for flow control polling is received at the receiving part, the transmitting part of this BAP entity shall:

- construct a BAP Control PDU for flow control feedback per BH RLC channel, if configured by RRC, in accordance with clause 6.2.3;

- construct a BAP Control PDU for flow control feedback per BAP routing ID, if configured by RRC, in accordance with clause 6.2.3;

- if the egress BH RLC channel for the BAP Control PDU is configured as specified in TS 38.473 [5]:

- submit the BAP Control PDU(s) to the configured egress BH RLC channel of the egress link, indicated by *Egress BH RLC CH ID* IE in *BH Information* IE associated with *Non-UP Traffic Type* IE set to *BAP control PDU* in TS 38.473 [5];

- else:

- submit the BAP Control PDU(s) to any egress BH RLC channel of the egress link.

NOTE: The BH RLC channel(s) and BAP routing ID(s) to be included in the flow control feedback is up to IAB node implementation, once triggered.

5.3.1.y Receiving operation

For a link, the BAP entity at the IAB-DU or IAB-donor-DU may:

- if the available buffer size as indicated by the received BAP Control PDU for flow control feedback per BAP routing ID is less than the [*congestedThreshold-r17*], if configured:

- consider the BH link as congested for this BAP routing ID (for rerouting purpose defined in accordance with clause 5.2.1.3).

Editor's Note: FFS if the per BH RLC channel level link congestion should also be determined for local rerouting.

5.3.2 Flow control polling

When a flow control polling is to be transmitted over an egress link, the transmitting part of the BAP entity at the IAB-DU or IAB-donor-DU:

- construct a BAP Control PDU for flow control polling in accordance with clause 6.2.3:

- if the egress BH RLC channel for the BAP Control PDU is configured as specified in TS 38.473 [5]:

- submit this BAP Control PDU to the configured egress BH RLC channel of the egress link, indicated by *BH RLC CH ID* IE which is associated with *BAP Control PDU Channel* IE that is set to true in TS 38.473[5];

- else:

- submit this BAP Control PDU to any egress BH RLC channel of the egress link.

5.4 BH RLF related indications

5.4.1 Transmitting operation

When a BH RLF recovery failure is detected at the IAB-MT, for each egress link associated with the IAB-DU, the transmitting part of the collocated BAP entity at the IAB-DU may:

- construct a BAP Control PDU for BH RLF indication in accordance with clause 6.2.3.3;

When BH RLF(s) occur at the IAB-MT on all the link(s) providing F1 interface over BAP, for each egress link associated with the IAB-DU, the transmitting part of the collocated BAP entity at the IAB-DU may:

- construct a BAP Control PDU for BH RLF detection indication in accordance with clause 6.2.3.x;

When BH RLF recovery is successful at the IAB-MT, for each egress link associated with the IAB-DU on which there was a BAP Control PDU for BH RLF detection indication transmitted, the transmitting part of the collocated BAP entity at the IAB-DU may:

- construct a BAP Control PDU for BH RLF recovery indication in accordance with clause 6.2.3.y;

For any constructed BAP Control PDU, the BAP entity shall:- if the egress BH RLC channel for the BAP control PDU is configured as specified in TS 38.473 [5]:

- submit this BAP Control PDU to the configured egress BH RLC channel of the egress link, indicated by *BH RLC CH ID* IE which is associated with *BAP Control PDU Channel* that is set to true in TS 38.473 [5];

- else:

- submit this BAP Control PDU to any egress BH RLC channel of the egress link.

Editor's Note: FFS if generic condition “upon recovery” from BH RLF is sufficient for type3 indication.

Editor’s NOTE: Type-4: FFS whether “BH RLF recovery failure indication” or existing name “BH RLF indication”

5.4.2 Receiving operation

Upon receiving a BAP Control PDU for BH RLF indication from lower layer (i.e. ingress BH RLC channel), the receiving part of the BAP entity shall:

- indicate to upper layers that the BH RLF indication has been received for the ingress link where this BAP Control PDU is received.

Upon receiving a BAP Control PDU for BH RLF detection indication from lower layer (i.e. ingress BH RLC channel), the receiving part of the BAP entity shall:

- consider the BH link, from which this BAP Control PDU is received not be available (for rerouting purpose defined in accordance with clause 5.2.1.3). [FFS for routing ID level].

Upon receiving a BAP Control PDU for BH RLF recovery indication from lower layer (i.e. ingress BH RLC channel), the receiving part of the BAP entity shall:

- consider the BH link, from which this BAP Control PDU is received, to be available again (for rerouting purpose defined in accordance with clause 5.2.1.3). [FFS for routing ID level].

Editor's Note: The exact information indicated to upper layer upon receiving Type2 and Type3 indications is still FFS.

Editor’s NOTE: FFS whether “BH RLF recovery failure indication” or existing name “BH RLF indication”

5.5 Handling of unknown, unforeseen, and erroneous protocol data

When a BAP Data PDU that contains a BAP address which is not included in the configured BH Routing Configuration and is not the BAP address of this node is received; or when a BAP Control PDU that contains reserved or invalid values is received the BAP entity shall:

- discard the received BAP PDU.

6 Protocol data units, formats, and parameters

6.1 Protocol data units

6.1.1 Data PDU

The BAP Data PDU is used to convey one of the following in addition to the PDU header:

- upper layer data.

6.1.2 Control PDU

The BAP Control PDU is used to convey one of the following in addition to the PDU header:

- flow control feedback per BH RLC channel;

- flow control feedback per BAP routing ID;

- flow control polling;

- BH RLF related indications;

6.2 Formats

6.2.1 General

A BAP PDU is a bit string that is byte aligned (i.e. multiple of 8 bits) in length. The formats of BAP PDUs are described in clause 6.2.2, 6.2.3 and their parameters are described in clause 6.3.

6.2.2 Data PDU

Figure 6.2.2-1 shows the format of the BAP Data PDU.

****

**Figure 6.2.2-1: BAP Data PDU format**

6.2.3 Control PDU

6.2.3.1 Control PDU for flow control feedback

Figure 6.2.3.1-1 and 6.2.3.1-2 show the formats of the BAP Control PDU for flow control feedback.

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**Figure 6.2.3.1-1: BAP Control PDU format for flow control feedback per BH RLC channel**

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**Figure 6.2.3.1-2: BAP Control PDU format for flow control feedback per BAP routing ID**

6.2.3.2 Control PDU for flow control polling

Figure 6.2.3.2-1 shows the formats of the BAP Control PDU for flow control polling.

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**Figure 6.2.3.2-1: BAP Control PDU format for flow control feedback polling**

6.2.3.3 Control PDU for BH RLF indication

Figure 6.2.3.3-1 shows the format of the BAP Control PDU for BH RLF indication.

****

**Figure 6.2.3.3-1: BAP Control PDU format for BH RLF indication**

6.2.3.x Control PDU for BH RLF detection indication

Figure 6.2.3.x-1 shows the format of the BAP Control PDU for BH RLF detection indication.

**Figure 6.2.3.x-1: BAP Control PDU format for BH RLF detection indication**

Editor's Note: The granularity and content of this control PDU is still FFS.

6.2.3.y Control PDU for BH RLF recovery indication

Figure 6.2.3.y-1 shows the format of the BAP Control PDU for BH RLF recovery indication.

**Figure 6.2.3.y-1: BAP Control PDU format for BH RLF recovery indication**

Editor's Note: The granularity and content of this control PDU is still FFS.

6.3 Parameters

6.3.1 General

If not otherwise mentioned in the definition of each field, the bits in the parameters shall be interpreted as follows: the left most bit string is the first and most significant and the right most bit is the last and least significant bit.

Unless otherwise mentioned, integers are encoded in standard binary encoding for unsigned integers. In all cases the bits appear ordered from MSB to LSB when read in the PDU.

6.3.2 DESTINATION

Length: 10 bits.

This field carries the BAP address of the destination IAB-node or IAB-donor-DU.

6.3.3 PATH

Length: 10 bits.

This field carries the BAP path identity.

6.3.4 Data

Length: Variable

This field carries the BAP SDU (i.e. IP packet).

6.3.5 R

Length: 1 bit

Reserved. In this version of the specification reserved bits shall be set to 0. Reserved bits shall be ignored by the receiver.

6.3.6 D/C

Length: 1 bit

This field indicates whether the corresponding BAP PDU is a BAP Data PDU or a BAP Control PDU.

**Table 6.3.6-1: D/C field**

|  |  |
| --- | --- |
| **Bit** | **Description** |
| 0 | BAP Control PDU |
| 1 | BAP Data PDU |

6.3.7 PDU type

Length: 4 bits

This field indicates the type of control information included in the corresponding BAP Control PDU.

**Table 6.3.7-1: PDU type**

|  |  |
| --- | --- |
| **Bit** | **Description** |
| 0000 | Flow control feedback per BH RLC channel |
| 0001 | Flow control feedback per BAP routing ID |
| 0010 | Flow control feedback polling |
| 0011 | BH RLF indication |
| 0100 | BH RLF detection indication |
| 0101 | BH RLF recovery indication |
| 0110-1111 | Reserved |

6.3.8 BH RLC channel ID

Length: 16 bits.

This field indicates the identity of the BH RLC channel whose flow control information is provided in the flow control feedback.

6.3.9 BAP Routing ID

Length: 20 bits.

This field indicates BAP routing identity, for which the flow control information is provided in the flow control feedback. It contains the BAP address in the leftmost 10 bits and the BAP path identity in the rightmost 10 bits.

6.3.10 Available Buffer Size

Length: 24 bits.

This field indicates the maximum traffic volume the transmitter should send. The unit is kilobyte.

End of Change