3GPP TSG-RAN WG2 Meeting #112-e R2-20xxxxx

E-meeting, …, 2020

Agenda Item: …

Source: Qualcomm Incorporated

**Title:** [Post111-e][903][eIAB] Topology adaptation enhancements RAN2 scope

Document for: Discussion

# Introduction

The discussion handles:

* [Post111-e][903][eIAB] Topology adaptation enhancements RAN2 scope (Qualcomm)

Scope: Aim to clarify the scope. Determine which technical issues to address in RAN2 as a part of this WI objective. Identify and clarify driving scenario(s). Determine work split R2 R3 when / if applicable.

Intended Outcome: Report

Deadline: long

The email discussion has two parts.

* Part 1: Identification of enhancement candidates to be handled by RAN2 under the topology adaptation topic. **Deadline: Sept 30, 23:59 PT**.
* Part 2: Clarification, consolidation, down-scoping of candidate features.

As a reminder, the WID includes the following objectives on topology adaptation enhancements [1]:

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| *Topology adaptation enhancements [RAN3-led, RAN2]:*   * *Specification of procedures for inter-donor IAB-node migration to enhance robustness and load-balancing, including enhancements to reduce signalling load.* * *Specification of enhancements to reduce service interruption due to IAB-node migration and BH RLF recovery.* * *Specification of enhancements to topological redundancy, including support of CP/UP separation.* |

The Annex further includes agreements from last RAN3 meeting (R3#109e) on the topology adaptation enhancements topic.

# Phase I: Identification of enhancement candidates

## Purpose/benefit of enhancement

Before discussing specific features for topology adaptation enhancements, we need to converge on what these features are supposed to accomplish, e.g., if they aim to support an additional use case, improve on a specific performance indicator, etc.

In the further discussion (below), we will evaluate if and how well each feature proposed can meet/achieve at least one of these purposes/benefits.

**Q0: Please provide your company’s views on the main purposes/benefits to be expected from topology adaptation enhancements**

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| **Company** | **Comment** |
| Kyocera | We think Rel-17 should provide more robust IAB operations under uncertain BH link quality, such as the frequent shadowing in mmWave and/or the mobile IAB. |
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## Candidates for enhancements

This subsection aims to identify candidates for topology adaptation enhancements. We start with candidates that were discussed during Rel-16, in contributions to R2#111e, and/or in the last RAN3 meeting (R3#109). At the end of this subsection, further candidate enhancements can be proposed.

Each candidate should be evaluated with respect to:

* **Purpose/benefit**. It should be assessed which of the above purposes/benefits (section 2.1) are addressed by the candidate and how effective the enhancement is in that respect.
* **Technical solution**. The solution may be obvious for some enhancements, but it may need more discussion for others. At this stage, the description should establish a rough baseline. Discussion on details, optimization, etc can follow later.
* **Potential shortcomings**.Some features may have great benefits but also significant shortcomings. It is important to understand this trade-off.
* **Specification effort**. This will be a coarse estimate. It should also be identified, which WGs have to be involved.

The discussion rapporteur has allowed himself to provide guidance, i.e., emphasize where clarification is needed for an enhancement, or elaborate on where and how RAN3 has already made progress.

### 2.2.1 CHO

Proposed by R2-2006626, R2-2006967, R2-2007167, R2-2007501, R2-2007863, R2-2008025, R2-2008026, comment by RAN3 chairman

RAN3 chairman added to notes:

**CHO should be supported for IAB-MT.**

Chair: unless excluded, normally current functionality is applicable

**Q1: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We assume CHO can be used for IAB as it is, from Rel-16.  In case of BH RLF in Rel-16, however, cell selection for RRC Reestablishment is triggered, but CHO is only executed when the IAB-MT selects a cell that is in the CHO configuration. In addition, CHO is never triggered if the BH RLF happens at the parent node, since the radio condition of BH link at the concerned IAB-node is still good.  We think more deterministic behaviour for full utilization of CHO is desirable for Rel-17 eIAB and assume it could be solved by a new triggering condition for CHO, e.g., upon reception of BH RLF Indication. |
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### 2.2.2 DAPS

Proposed by R2-2006626, R2-2007501, R2-2007863

Please include aspects such as:

* If DAPS would be used for reduced interruption time of MT handover or to create a prolonged state of topological redundancy between source and parent nodes.
* If and how intra-frequency handover would be supported for FR1 and/or FR2. How resource allocation would be managed during handover between multi-vendor nodes.

**Q2: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We don’t have strong view, but be wondering what DAPS means for IAB, e.g., since there is no PDCP layer in intermediate IAB-nodes on multi-hop relaying path. |
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### 2.2.3 CP redundancy via separate NR access link

Agreed by RAN3.

This enhancement defines the analogue of F1-C routing via LTE/X2 for standalone, i.e., for IAB-nodes that use NR-DC instead of EN-DC.

RAN3 agreed on the following functionality:

**Consider Scenario 1 and 2 for CP/UP separation:**

**Scenario 1: F1-C via M-NG-RAN node (non-donor node) + F1-U via S-NG-RAN node (donor node)**

**Scenario 2: F1-U via M-NG-RAN node (donor node) + F1-C via S-NG-RAN node (non-donor node)**

Please capture the RAN2-related aspects for this enhancement.

**Q3: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We think the CP redundancy in NR-DC is beneficial to be introduced as the same gain considered in EN-DC IAB. We assume it would be specified with the same solution with what Rel-16 did for EN-DC IAB, i.e., F1 container in RRC message. |
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### 2.2.4 Redundancy via inter-donor NR-DC

Agreed by RAN3.

RAN3 agreed on the following functionality:

**Analyze Scenario 1 and Scenario 2 for inter-Donor Topology Redundancy, with the principle that an IAB-DU only have F1 interface with one Donor-CU:**

**Scenario 1: the IAB is multi-connected with 2 Donors.**

**Scenario 2: the IAB’s parent/ancestor node is multi-connected with 2 Donors.**

Please capture the RAN2-related aspects for this enhancement.

**Q4: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We’re wondering what the “multi-connected with 2 Donors” means from RAN2’s perspective, i.e., whether it’s a normal DC (single RRC connection) or an IAB-MT has dual RRC connections. |
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### 2.2.5 Redundancy using routing via descendant nodes

Proposed by R2-2006967, R2-2007023, RAN3 agreement

RAN3 agreed that:

**Routing Enhancement via descendant node can be discussed later or after RAN2 decision.**

This enhancement aims to leverage route redundancy via a dual-connected descendant node, e.g., in case of upstream RLF.

Please include the following aspects:

* Applicability to CP vs. UP
* Conditions to use descendant-node path, e.g., only at upstream RLF or also for other reasons

**Q5: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | In Rel-16, the IAB-node, experiencing upstream BH RLF, first tries RRC Reestablishment to the descendant node (if selected), and then it transmits UP data to the new parent. If Rel-17 still follows this principle, we think it ends up the enhancements of cell selection. The descendant node can be the candidate of cell selection unless its RRC connection (i.e. CP path) goes through the concerned IAB-node (i.e., the one experiencing BH RLF).  We need further clarification of the intended solution, if the intended solution aims to UP data transmissions/re-routing to the descendant node without RRC connection to the IAB-donor (i.e., it’s broken by upstream BH RLF). |
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### 2.2.6 Redundancy via collocation of multiple MTs

Proposed by R2-2006967, RAN3 agreement

RAN3 agreed that:

**Multi-MT Support is FFS in RAN3 pending RAN2**

This enhancement was already discussed during Rel-15 SI. Please provide a brief outline on the technical solution with an emphasis on what could be accomplished via implementation and where specification would be necessary.

**Q6: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We’re wondering what impacts is foreseen from RAN2’s perspective, since TR38.874 states in section 9.7.8 that “*Multi-connectivity of IAB-node (Case 2 above) can be supported by* […] *using several independent MT functions in the IAB-node, where* ***each MT function makes an independent connection*** *to the network (using normal MT setup).*” |
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### 2.2.7 Enhancements to RLF indication

Proposed by R2-2006626, R2-2006948, R2-2006967, R2-2007165, R2-2007773, R2-2007864, R2-2008025, R2-2008026

This enhancement was already addressed in a Rel-16 email discussion. To proceed where this discussion ended, rather than repeating it, please describe:

* Difference of Rel-17 RLF indication over Rel-16 RLF indication (e.g. condition of transmission, information carried, etc).
* How the expected purpose/benefit is achieved via such indication (e.g. what needs to happen upon reception of reception of this indication so that the benefit is achieved).
* Potential shortcomings, if applicable (e.g. uncontrolled behaviour, reestablishment at incorrect node, etc.).

**Q7: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We think…  The additional indication is transmitted when the IAB node experiences BH RLF or be trying BH link recovery (a.k.a., Type 1 or Type 2), and/or when the IAB node successfully recovered BH link (a.k.a., Type 3). We assume Type 1 and Type 2 depicture the same condition.  We prefer Type 1/2 Indication is sent via SIB1 since it allows not only IAB-MTs but also UEs to read/use it, while BAP control PDU is only readable by IAB-MTs.  The child node(s), upon reception of Type 1/2 Indication, stop sending Scheduling Request, and/or it may decide to do the local re-routing (if introduced). As an implementation option, the child node(s) may prepare possibility of its BH recovery, e.g., pre-measurements. The child node(s) should resume the normal operation when the IAB node’s BH link is recovered.  As an optimization, if Type 1/2 Indication is transmitted repeatedly (e.g., via SIB1), Type 3 Indication may not be needed, since the IAB node would stop sending Type 1/2 Indication when its BH link is recovered. |
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### 2.2.8 Avoiding RLF recovery at former descendant node

Proposed by R2-2006626, R2-2006948, R2-2006961, R2-2007773

This issue was already addressed during a Rel-16 email discussion. To proceed where this discussion ended, rather than repeating it, please describe the technical solutions on *how* RLF recovery at former descendant node is avoided.

**Q8: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We think the blacklist and/or the whitelist should be provided to the IAB nodes in order to prevent selecting unsuitable cells. We think the list(s) should be updated dynamically, considering frequent topology changes in Rel-17 eIAB nature. In this sense, we prefer RRC should manage the list(s), not OAM.  We’re wondering if this enhancement may or may not be related to Q1 (i.e., CHO) or Q5 (i.e., Redundancy using routing via descendant nodes). So, RAN2 should consider the relationship of solutions and avoid the potential functional duplication. |
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### 2.2.9 Message bundling (e.g. “group mobility”)

Proposed by R2-2006961, R2-2007313, R2-2007863, RAN3 discussion

RAN3 had a discussion on this topic and the following issues were raised: While bundling of multiple, e.g., UE messages reduces the total number of messages, it does not necessarily reduce the processing load. Further, bundling is restricted by the upper bound of the message size.

Please include in your comments what type of messages you believe the bundling could apply to, and please address RAN3’s concerns.

**Q9: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We don’t have strong view, but be wondering if it’s problematic the handover requests of some UEs/IAB-nodes are accepted but some others are rejected, in case of non-bundling (i.e., the existing) messages. |
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### 2.2.10 Replace/avoid UE/child-MT RACH at inter-donor topology adaptation

Proposed by R2-2006625, R2-2007863

If rapporteur understands the above contributions correctly, this enhancement tries to avoid RACH for UE or descendant-node IAB-MTs during inter-donor migration. Such RACH would generally be considered necessary since the UE and descendant-node IAB-MT change their security association from the source to the target IAB-donor and therefore have to perform an RRC reconfiguration with resync. The proposal is that the RACH procedure of the resync could be avoided since the IAB-DU remains the same. The rapporteur is not certain what signalling would trigger the switch between the security associations, i.e., with what the RACH procedure would be replaced and what benefit this replacement would have.

Please address these issues in your comment.

**Q10: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We think the RACH-less handover was supported in LTE, so it could be assumed there is no significant issue here and the same solution is the baseline. We assume the UE/Child-MT avoids Msg1 and Msg2, so it starts from Msg3 (i.e., RRC Reconfiguration Complete). It’s beneficial to reduce the service interruption due to the handover procedure as considered in LTE. |
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### 2.2.11 Local route selection beyond RLF

Proposed by R2-2007023, R2-2007200, R2-2007295, R2-2007840, R2-2008026, RAN3 agreements

RAN3 has already agreed that:

**Local re-routing scenario other than RLF can be discussed later or after RAN2 decision.**

As discussed in Rel-16, local rerouting tends to be suboptimal if the node has only local scope. Please describe how this issue would be addressed.

**Q11: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We assume the IAB-donor may configure the IAB-node(s) with some alternative routes, and the IAB-nodes may select one of them in case of the local re-routing. It leverages the topology-wide knowledge/optimization by the IAB-donor and the quick response/recovery by the local decision. |
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### 2.2.12 Multiple routes with route priority

Proposed by R2-2006624, R2-200720

This topic was considered during early Rel-16 discussions on routing and never followed up anymore.

**Q12: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We think this topic can be considered together with Q11 (i.e., Local route selection beyond RLF). We assume the route with the smallest number of hops should be prioritized but the route priority is up to IAB-donor configuration |
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### 2.2.13 Inter-donor-DU rerouting

Proposed by R2-2007865, RAN3 agreement

RAN3 has already agreed that:

**Inter-Donor-DU re-routing can be discussed later or after RAN2 decision.**

RAN3 precluded inter-donor-DU rerouting during Rel-16 since this could create packet discard on the wireless network as the source IP address of the rerouted packet would not be compliant with the address pool of the local subnet.

Please address this issue in your comment.

**Q13: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We don’t have strong view on this topic. |
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### 2.2.14 IAB-specific admission control during RLF recovery

Identified in RAN3 discussion

The main idea is to give IAB-MT’s priority over UEs in admission control during RLF recovery. Please describe in more detail how this could be accomplished.

**Q14: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We have no strong view, but tend to think we should wait for more information from RAN3. |
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### 2.2.15 Sending F1AP configuration information via RRC

Identified in RAN3 discussion

The main idea is to avoid F1AP reconfiguration signalling handshakes by including the information in the handover command, for instance.

**Q15: Please provide your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Comment** |
| Kyocera | We’re wondering if RAN2 should wait for RAN3’s progress. |
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### 2.2.16 Other enhancements

**Q16: Please propose other enhancements. Please include your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

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| **Company** | **Enhancement proposed** |
| Kyocera | We think the lossless delivery over hop-by-hop RLC ARQ becomes more important in Rel-17, which was studied as in section 8.2.3 of TR 38.874. We assume the IAB-DU may delay RLC ACK to its child nodes by implementation, but think Stage-2 should capture the outline of how to achieve the end-to-end reliability over multi-hop network. |
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# Phase 2

# Conclusion

# References

1. RP-201293: WID for NR\_IAB\_enh; TSG RAN Meeting #88, Electronic Meeting, June 29 - July 3, 2020

# Annex: RAN3 agreements from R3#109e

## 13.2. Topology Adaptation Enhancements

### 13.2.1. Inter-Donor IAB Node Migration

**Inter-donor migration due to load balancing and RLF recovery may use the same signaling, where additional procedures and signaling, specific for each of the use cases, are possible.**

**The following cases for inter-donor migration are studied:**

**a) IAB-MT is migrated between IAB-donors.**

**b) IAB-MT is simultaneously connected to two IAB-donors**

**c) IAB-DU is simultaneously connected to 2 donor-CUs (common understanding is that we won’t break F1 interface principles)**

**d) IAB-MT performs RLF recovery at new IAB-donor.**

**How to achieve b)?**

I) IAB-MT simultaneously connected to 2 donors;

**-> How to achieve I)?**

II) IAB node simultaneously connected to 2 donor-CUs.

**-> How to achieve II)?**

**When evaluating the solutions for inter-donor migration, the following aspects should be considered:**

**- the ability to avoid service interruption,**

**- the ability to avoid signaling storm caused by the migration,**

**- the incurred processing load caused by the migration (clarification: simultaneous migration of all affected devices causes more processing load than gradual migration),**

**- the complexity of the solution,**

**- the specification impact**

**The migration mechanism should allow to migrate to another donor all or some devices (the IAB nodes and/or UEs directly or indirectly served by the top-level IAB node).**

**We assume that all parent-child relations are retained at the new donor**

**(common understanding that this also includes UEs)**

**UEs and IAB-MTs should not be forced into connection re-establishment in order to migrate to a new donor**

**(common understanding that the network shall not force disconnection)**

The inter-donor migration solutions where IAB nodes maintain simultaneous connections to both donors are enabled.

**The following information should be made available to the new donor:**

**1. Contexts of all involved UEs,**

**2. Contexts of all involved MTs,**

**3. Contexts of all involved DUs,**

**4. Backhaul and topology-related information,**

**5. IP address information**

**Current signaling is taken as baseline for inter-donor migration of UEs and IAB-MTs**

**(common understanding is that we shall consider reducing the associated signaling load)**

**The approach where IAB-MT migration uses separate procedure from the ones used for migration of the collocated IAB-DU and the served UEs and MTs is adopted as baseline.**

**As baseline, IAB-MT migration should use a separate procedure w.r.t. the migration of the co-located IAB-DU, the served UEs and the served MTs**

### 13.2.2. Reduction of Service Interruption

**Topological redundancy should be considered as one mean among others for service interruption reduction.**

**CHO should be supported for IAB-MT.**

Chair: unless excluded, normally current functionality is applicable

**We shall consider how to reconfigure descendant nodes in order to reduce service interruption during migration**

**Discuss mitigation of packet loss and reduction of unnecessary transmissions during IAB-node migration.**

### 13.2.3. Topology Redundancy

**Consider Scenario 1 and 2 for CP/UP separation:**

**Scenario 1: F1-C via M-NG-RAN node (non-donor node) + F1-U via S-NG-RAN node (donor node)**

**Scenario 2: F1-U via M-NG-RAN node (donor node) + F1-C via S-NG-RAN node (non-donor node)**

**Analyze Scenario 1 and Scenario 2 for inter-Donor Topology Redundancy, with the principle that an IAB-DU only have F1 interface with one Donor-CU:**

**Scenario 1: the IAB is multi-connected with 2 Donors.**

**Scenario 2: the IAB’s parent/ancestor node is multi-connected with 2 Donors.**

**Routing Enhancement via descendant node can be discussed later or after RAN2 decision.**

**local re-routing scenario other than RLF can be discussed later or after RAN2 decision.**

**inter-Donor-DU re-routing can be discussed later or after RAN2 decision.**

**Deprioritize Multi-Route Support with data split in IAB.**

**Multi-MT Support is FFS in RAN3 pending RAN2**