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.*
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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.  |
| LG | Main purposes/benefits of topology adaptation enhancements should be:* Reducing recovery time and Minimizing service interruption time incurred by BH RLF.
* Increasing reliability thorough path diversity
 |
| Huawei | This is for topology update due to some IAB node located in the cell edges of two donors. BTW, the purposes is clear from the WID itself, including service interruption reduction, robustness, topology redundancy, etc. So, any enhancement aligned with the WID scope can be discussed below in this email for R17. |
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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.  |
| LG | CHO is a useful way to reduce recovery time upon occurrence of BH problems. However, it should be noted that it is completely unknown when the conditional mobility actually occur and hence preparation should be done for many UEs. |
| Huawei | Agree to support CHO for R17 IAB-MT;**Purpose/benefit**: migration robustness**Technical solution**: reuse R16 CHO for UE**Potential shortcomings**: some minor standard efforts**Specification effort**: To discuss the behaviour of child MT/UE upon CHO for parent node. |
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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.  |
| LG | Not prefer to include DAPS for IAB.DAPS has been specified for 0ms user plane data interruption, and the PDCP has an important role as an anchor point in DAPS. However, there is a BAP entity and no PDCP entity for forwarded user plane data in the intermediate IAB nodes. If it is determined to support DAPS in IAB node, the current DAPS mechanism would not be a baseline and huge RAN2 and RAN3 (maybe RAN1 as well) work are expected.  |
| Huawei | Agree to support DAPS for R17 IAB-MT;**Purpose/benefit**: supporting the DAPS of migrating IAB-MT can reduce the service interruption of this IAB node. Also it provides the simultaneous connections with both source and target donor. At least, we can support the inter-frequency HO with DAPS. We can further discuss the intra-frequency case after R1 finalize the support of intra-frequency DC for IAB. **Technical solution**: reuse R16 DAPS for UE**Potential shortcomings**: N/A**Specification effort**: Minor, if we only support the DAPS of migrating IAB-MT. |
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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.  |
| LG | Not prefer to discuss this issue in this email discussion and want to wait more RAN3 progress.It’s too early to figure out clearly what the RAN3 identified issue and we also think it is not urgent from RAN2 point of view and the RAN2 discussion/conclusion may be different depending on RAN3 decision/progress. Thus, we would like to discuss other RAN2 originated issues first, which are based on the contributions submitted in the last RAN2 meeting and it would be better to wait RAN3 progress on it and then RAN2 can start to discuss this issue based on more concrete RAN3 conclusion/progress. |
| Huawei | Not support the scenario 1 and 2**Purpose/benefit**: We supported the EN-DC case in R16. If we want to support the F1-C on FR1 but F1-U on FR2, we can also reuse the NR-DC in R16, with F1-C on one FR1 BH path while F1-U on another FR2 BH path. We need to clarify if any purpose/benefit is not supported in R16.For the new deployment case, where F1-C is on the non-backhaul NR link of FR1, we are not sure if this is explicitly under WID scope. “support of CP/UP separation” is in the scope, which is already supported by R16. But “CP redundancy via separate NR access link” may require the update of WID.**Technical solution**: reuse R16 F1-C over LTE (only if the scenario is agreed by R2)**Potential shortcomings**: less benefits but require new discussion.**Specification effort**: This may also open more discussion on how IAB-MT integrates in the NR-DC with non-backhaul MN. |
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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.  |
| LG | Not prefer to discuss this issue in this email discussion and want to wait more RAN3 progress.It’s too early to figure out clearly what the RAN3 identified issue and we also think it is not urgent from RAN2 point of view and the RAN2 discussion/conclusion may be different depending on RAN3 decision/progress. Thus, we would like to discuss other RAN2 originated issues first, which are based on the contributions submitted in the last RAN2 meeting and it would be better to wait RAN3 progress on it and then RAN2 can start to discuss this issue based on more concrete RAN3 conclusion/progress.  |
| Huawei | We prefer to first identify the R2 impacts before we agree on any of those scenarios. We also prefer to discuss this later after we have some progress on the basic inter-CU migration procedure. Note that this was not agreed by R3 yet (it is only to **analyse**). **Purpose/benefit**: 1) For the case of inter-CU migration, the service interruption reduction can be achieved. We need to finalize how the inter-CU migration procedure works before we agree on the support of the above two scenarios. It seems we already have sufficient interruption reduction with the agreed R3 cases “IAB-MT is simultaneously connected to two IAB-donors + IAB-DU is simultaneously connected to 2 donor-CUs”;2) For the case of F1-U redundancy when there is no migration, this could bring the topology redundancy for the IAB node in the middle of two donors. Not sure if this is the common deployment.**Technical solution**: To be discussed**Potential shortcomings**: not clear on the benefits but require more standard impact and efforts.**Specification effort**: How the BAP path/BH RLC under the target donor and the corresponding IAB nodes are controlled/configured by source donor requires significant discussion and spec impacts. |
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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).  |
| LG | This requires complex operation unnecessarily. For example, the IAB node should know the descendant IAB node has a route to the intended destination IAB node in advance because if there is no path to the intended IAB node in the descendant node, the IAB node cannot use this descendant IAB node as redundancy. Furthermore, in Rel-17, two different IAB donors may be used to transmit CP/UP data. In this condition, if the descendant IAB node has a path to only one IAB donor, the IAB node should select packets which can be forwarded to the descendant IAB node. Another point is that when the routing configuration or channel condition is changed in the descendant IAB node, this information should be indicated to the parent IAB node to avoid unnecessary data forwarding from the parent IAB node. Given this aspects, we doubt whether there is much gain to overcome this complex and how frequently use this redundancy route. |
| Huawei | Agree to support this for both CP and UP. The condition to use this can be same as the R17 condition for local re-routing.**Purpose/benefit**: This is for service interruption reduction in case at least RLF, and for robustness, topology redundancy. This is to support the missing upstream topology redundancy in R16, where parent IAB node has no DC but child IAB node has DC.**Technical solution**: allow IAB node forwards the upstream data to its child node in case at least for RLF. No need to change the topology between parent and child node. The backup BAP path via descendant node is configured by CU as ususal.**Potential shortcomings**: N/A.**Specification effort**: Minor or barely not spec impact. Some clarification in 38340 may be needed. |
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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).*” |
| LG | Not prefer to support multi-MT.We think that this needs complex inter-operation between one IAB-DU and multiple IAB-MT and between multiple IAB-MTs. For example, given that IAB-MT is considered as sort of UE, if multiple IAB-MTs are supported, it should be clarified whether each IAB-MT has RRC connection or one RRC connection manages all multi-MTs in one IAB node. BAP specification may be impacted to handle the case of two IAB-MTs and one BAP SDU is given to be forwarded since each IAB-MT has one BAP entity which handles routing ID determination and selection of next hop IAB node. In addition, inter-operability between IAB nodes would be also complex. |
| Huawei | Not to support this.**Purpose/benefit**: The benefit seems for UL redundancy with more than 2 links. With single MT, we can support the 2 link redundancy. With two MTs, we can support the 4 link redundancy. However, the performance gain is small when we compare 4 links to 2 links. Since we do not support the BAP layer duplication, the rest 3 backup links can only be used if the primary link is under RLF. Base on R16 design, only 1 backup link is sufficient, because there is no benefit to select among 3 or more than 3 backlinks if anyway we only support the BAP data via single path at a give time.Anyway, multiple MT is not under the WID scope.**Technical solution**: In R16, we agree to use the multiple MT redundancy by implementation, by combining the two pair of DU&MT or two IAB nodes in one box. We see no big difference in R17.**Potential shortcomings**: whether this works requires R1 analyses.**Specification effort**: Significant R1 impact. How the BAP at MT side works is to be discussed (e.g. shared or dedicated BAP for the multiple MTs). |
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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.  |
| LG | We suggest to introduce BH RLF indications that are triggered upon BH RLF and upon successful recovery of BH RLF. These additional indications would reduce service interruption significantly and benefit sustaining preferred/planned topology.  |
| Huawei | Agree to introduce two new RLF indication: type1/2: “BH recovering indication” and type3 as “BH recovered indication”;**Purpose/benefit**: The purpose is for the scope of reducing service interruption in case RLF. “BH link recovering indication” is to warn its child to prepare for the possible RRC re-establishment and allow child node’s local re-routing. “BH link recovered indication” is to notify the child node to go back to the normal operations.**Technical solution**: The child node behaviour upon reception of this indication needs more discussion. We don’t need to work on the detailed solution by this email discussion.**Potential shortcomings**: N/A.**Specification effort**: New BAP control PDUs. |
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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.  |
| LG | We do not see the need of this; Cell selection during RLF recovery is already up to implementations, and hence the reasonable implementations would avoid this, i.e. no standardization work is necessary. WE observe that our arguments are further justified by the fact that that IAB topology should be well pre-planned, i.e. topological knowledge is well known a-priori to those IAB nodes.  |
| Huawei | No need of this.By implementation in R16, if one IAB node select its descendant node after RLF, there is no available path to the donor CU. Then, the RRC re-establishment procedure will fail anyway, due to no response from CU. As the consequence, IAB node will then select another cell.In addition, in the realistic IAB deployment, parent IAB-MT is usually not able to select child IAB-DU due to the beam forming. |
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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.  |
| LG | We do not think group mobility is essential for enhancing IAB network performance. Group mobility would aim to solve the problem of signalling storm upon the change of topology, but we are not convinced if the problem is really severe or jeopardize the IAB network’s stability.  |
| Huawei | For group mobility, we agree to support this, i.e. migrating node and all/parts its child nodes/UEs migrate together as a group;For the bundling singling, the XnAP message and F1AP message, which are related to the IAB nodes within the migrating group, during the migration procedure can be bundled. Please note that R3 agreed: 1) all parent-child relations are retained at the new donor; 2) topology-related information should be made available to the new donor. This means the migrating IAB node and some its descendant nodes/UEs will migrate to the target CU **together as a topology/group**, and target should be aware of this topology. So, we anyway need the group mobility, but leave the group singling to be discussed by R3 mainly.**Purpose/benefit**: The group mobility itself is essential for the migration procedure. As to the group signalling, the purpose is to reduce the latency and overhead of multiple separate signalling.**Technical solution**: Design new XnAP and F1AP message as the grouped signalling.**Potential shortcomings**: N/A.**Specification effort**: New XnAP/F1AP procedure and message. |
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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.  |
| LG | It is too pre-mature to discuss this point at this stage. We can discuss it after making more progress about mobility enhancement. |
| Huawei | Agree to support the RACH less at decedent IAB MT/UE. Please note that the HO command (e.g. *RRCReconfiguration* including *reconfigurationWithSync* but no RACH resource) will still be sent to child MT/UE. Child IAB-MT still perform the RRC reconfiguration with resync, which will trigger the security change operation, but without MAC layer RACH.**Purpose/benefit**: The purpose is to reduce the latency caused by lots of RA procedure at almost the same time.**Technical solution**: Child MT/UE has the valid TA to its cell of parent node, since the parent-child relations are retained at the new donor. UL grant can also be allocated by parent DU as usual. Therefore, the MAC layer RA procedure can be saved during the inter-CU migration.**Potential shortcomings**: N/A.**Specification effort**: Minor updates to the reconfiguration with resync procedure. |
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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.  |
| LG | Even if one of main enhancement in IAB Rel-17 is to provide topological and path redundancy, just supporting path/topological redundancy is not enough and RAN2 should also study and develop the proper way to use this redundancy. We think that allowing local route selection beyond BH RLF would be the correct way not only to use topological and path redundancy efficiently but also to provide load balancing and resolve a DL congestion problem as well. Specifically, when the IAB node 1 receives a flow control feedback from the IAB node 3 to indicate a DL congestion problem toward the IAB node 4, even if the IAB node 1 has another route toward the IAB node 4, the IAB node 1 cannot forward the packet to the IAB node 2 because there is an entry matched to both BAP address and BAP path ID of the packet and no BH RLF on the link to the IAB node 3 occurs. In this condition, if the IAB node 1 holds all packets related to the flow control feedback until the congestion problem in the IAB node 3 is resolved, this may cause another congestion problem in the IAB node 1. But, if local re-routing is allowed before BH RLF occurs, the IAB node 1 not only reduce congestion problem in the IAB node 3 but also provide proper load balancing over the IAB network. For this, most of work would be RAN2. |
| Huawei | Agree to support the local re-routing for congestion mitigation or load balancing. The principle should be that IAB node will use the CU configured path based on the routing ID as in R16, unless some triggers (e.g. the RLF in R16 and other new conditions defined in R17) allow the IAB node to select the backup path (which is also configured by CU).**Purpose/benefit**: The purpose is to avoid UP data interruption or congestion caused by the cases other than RLF. For example, in case the primary BH link is congested but not under RLF yet, IAB node can switch the traffic to the backup BH link without any interruption to the traffic transmission.**Technical solution**: discuss the new cases other than RLF to trigger the local re-routing. For the re-routing itself, R16 BAP spec can be reused.**Potential shortcomings**: N/A.**Specification effort**: Minor updates to the routing performed at BAP layer. See no impact on the configuration. |
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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  |
| LG | We think that this enhancement is minor optimization and needed only when local rerouting is allowed other than BH RLF. If local rerouting is performed only after BH RLF as in Rel-16 IAB, gains of this enhancement is very limited and may be not meaningful. Thus, it is better to discuss the local rerouting or route selection issue first and then we can come back to discuss this issue after RAN2 determines something on local rerouting issue. It is also expected that if we do on this issue, most of work may be charged in RAN2. |
| Huawei | Before we agree anything, we need ensure this does not conflict with the R16 BAP routing architecture (based on routing ID configured by CU rather than based on the routing entry priority).We need to clarify if this is only used in case of local re-routing.Need more clarification on the proposal before we provide views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate. |
|  |  |

### 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.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Kyocera | We don’t have strong view on this topic.  |
| LG | The inter-Donor-DU re-routing is to retransmit the buffered BAP PDUs to the new donor-DU after intra-donor topology or inter-donor topology update, but this requires to change the carried BAP routing ID which is not allowed for re-routing even after BH RLF in Rel-16 IAB. In addition, in inter-donor topology update case, even though the packets containing PDCP PDUs is successfully retransmitted to the new donor-CU, these PDCP PDUs may be discarded because the applied security configuration is different the at the new donor-CU. This means that radio resource is wasted. We think that simple approach is to rely on upper layer retransmission mechanism, e.g., TCP or application level retransmission.  |
| Huawei | Agree to support the inter-donor-DU rerouting.We intend to solve this for the case of intra-/inter-CU migration.For the packed discard issue at new donor-DU, as mentioned by rapporteur, one example is that new donor-DU does not apply the “IP address filer” during the period of migration.**Purpose/benefit**: The purpose is for data lossless, which is more like to fix the R16 leftover/bugs. In R17, once we have the intra-/inter-CU migration, the destination donor-DU (i.e. destination BAP address) may change. The UE’s traffic may be lost once the data has been added with the BAP header, which is not allowed to be modified, even in case the destination donor-DU has changed.**Technical solution**: In R17, the BAP routing ID in the BAP header should be allowed to be modified, so that the BAP data during the migration period can be routed to the new donor-DU.**Potential shortcomings**: N/A.**Specification effort**: To specific how to route the on-the-air data to the target donor DU and how to avoid the data being discarded at target donor DU due to the source IP address filer. |

### 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.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Kyocera | We have no strong view, but tend to think we should wait for more information from RAN3.  |
| LG | Not prefer to discuss this issue in this email discussion and want to wait more RAN3 progress.It’s too early to figure out clearly what the RAN3 identified issue and we also think it is not urgent from RAN2 point of view and the RAN2 discussion/conclusion may be different depending on RAN3 decision/progress. Thus, we would like to discuss other RAN2 originated issues first, which are based on the contributions submitted in the last RAN2 meeting and it would be better to wait RAN3 progress on it and then RAN2 can start to discuss this issue based on more concrete RAN3 conclusion/progress. |
| Huawei | No strong view, but not clear on the purpose.In R16, we agreed there is no need of early IAB indication than Msg5. We need to clarify why there is no need to prioritize the IAB during RRC connection setup but there is the need in RRC re-establishment case. |

### 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.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Kyocera | We’re wondering if RAN2 should wait for RAN3’s progress.  |
| LG | Not prefer to discuss this issue in this email discussion and want to wait more RAN3 progress.It’s too early to figure out clearly what the RAN3 identified issue and we also think it is not urgent from RAN2 point of view and the RAN2 discussion/conclusion may be different depending on RAN3 decision/progress. Thus, we would like to discuss other RAN2 originated issues first, which are based on the contributions submitted in the last RAN2 meeting and it would be better to wait RAN3 progress on it and then RAN2 can start to discuss this issue based on more concrete RAN3 conclusion/progress. |
| Huawei | We need to first clarify the proposal on what is the “F1AP reconfiguration signalling handshakes” and how can it be saved by included in RRC. |

### 2.2.16 Conditional packet duplication

Proposed by R2-2008025,

Conditional packet duplication is expected to increase robustness of the IAB networks. It would be also useful to decrease latency. To maximally utilize path diversity, it should be possible for conditional packet duplication to occur at the intermediate nodes over the routing path, not limited to the originating/source node. For this reason, packet duplication functionality should be located at BAP.

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

|  |  |
| --- | --- |
| **Company** | **Comment** |
| LG | We think that it is worthwhile to discuss packet duplication at BAP entity to overcome packet loss and increase reliability after BH RLF.One important issue is that conditional packet duplication should be triggered in a strictly controlled manner to avoid packet flooding in the IAB networks. This requires investigation on the triggering condition of duplication, selection of target packet flows allowed for duplication. |
|  |  |
|  |  |

### 2.2.17 Other enhancements

**Q17: Please propose other enhancements. Please include your views on purpose/benefit, technical solution, potential shortcomings and specification effort for this enhancement candidate.**

|  |  |
| --- | --- |
| **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.  |
| Huawei | R2 impact for **inter-CU RLF recovery** (not enhancement but the basic procedure)RAN2 needs to discuss the behaviours of the descendent IAB-nodes/UEs of the IAB-node recovering to a new IAB-donor-CU, in the following two aspects: 1) How can descendent IAB-nodes and UEs be aware of the CU change? 2) Whether descendent IAB-nodes and UEs should migrate/re-establish to the new IAB-donor-CU together with the recovering IAB-node? |
|  |  |

# 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**