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

E-meeting, November 2 to 13, 2020

Agenda Item: 8.4.3

Source: Qualcomm Incorporated (Email discussion rapporteur)

**Title:** [AT112-e][031][eIAB] Topology Adaptation (QC)

Document for: Discussion

# Introduction

The document handles:

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| * [AT112-e][031][eIAB] Topology Adaptation (QC)   Scope: A) Confirm at least easy agreeable proposals captured in R2-2009292 (short deadline), make modifications to the proposals if needed for final agreement.  B) From R2-2009292 and input contributions below put applicable solution proposals on the table, with a short principal solution description, how the solution is intended to help and possibly comments on complexity, if applicable. In case there are many solutions, initial focus could be on promising and widely proposed/supported solutions. Further discussion and decision making is expected on-line week 2.  Intended outcome: Report  Deadline: Ready Nov 11 (for on-line discussion Nov 11), Intermediate deadlines by Rapporteur. |

As outlined by chairman, this email discussion has two parts.

* Part A): **Deadline: Nov 6**
* Part B): **Deadline: Nov 11**

# Phase A: Confirm at least easily agreeable proposals

## Easily agreeable proposals

**Proposal 0: Consider enhancements to topology adaptation that improve:**

* **Robustness, e.g., to rapid shadowing,**
* **service-interruption,**
* **load balancing among different IAB-nodes, IAB-donor-DUs and IAB-donor-CUs, and**
* **reduction in signaling load.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **For the robustness objective, we prefer to delete “rapid shadowing”.** |
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**Proposal 1’: RAN2 to discuss IAB-specific enhancements of CHO.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **We do not agree with the approach of just focusing on CHO, or any other solutions, without discussing which objectives we want to achieve.**  **We should first discuss the problems that RAN2 wants to tackle, based on the objectives in P0. Jumping directly on solutions, before discussing what those solutions want to achieve and how is not a correct approach, in our opinion.**  **RAN2 has not discussed yet how CHO, or how any other solutions, meet the objectives in Proposal 0. That should be the first step.  We should discuss which are the objectives in P0 that can be achieved by CHO and by other possible solutions mentioned in this email discussion. What are the pros and cons, what are the architectural impacts, what is the complexity, etc.  Once this analysis has been done, and once we have built a common ground of understanding, RAN2 can select the most appropriate solution(s).**  **Therefore, we have the following new proposal:**  **Proposal 1’: RAN2 to assess the pros/cons, complexity, and standard impact of the following solutions:**   * **CHO enhancements** * **DAPS enhancements/Dual IAB protocol stack** * **Reestablishment enhancements,** * **Dual Connectivity enhancements,** * **Etc.**   **Proposal 1b’: RAN2 to discuss how the different solutions address the objectives in P0.** |
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**Proposal 2’: IAB-specific benefits and enhancements of DAPS are FFS.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **Same comment as above. We should first discuss what are the objectives that DAPS promises to achieve.**  **Proposal 1’: RAN2 to assess the pros/cons, complexity, and standard impact of the following solutions:**   * **CHO enhancements** * **DAPS enhancements/Dual IAB protocol stack** * **Reestablishment enhancements,** * **Dual Connectivity enhancements,** * **Etc.**   **Proposal 1b’: RAN2 to discuss how the different solutions address the objectives in P0.** |
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**Proposal 4: For redundancy via inter-donor NR-DC, RAN2 to wait for further progress by RAN3.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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**Proposal 5: Redundancy using routing via descendant nodes is FFS.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
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**Proposal 7: RAN2 to discuss enhancements to RLF indication with the focus on the reduction of service interruption after BH RLF.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **Is this related to the BAP indication also discussed in the other email discussion on fairness?**  **If yes, then we propose the following:**  **P7: RAN2 to discuss enhancements to BAP RLF indication with the focus on the reduction of service interruption after BH RLF.** |
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**Proposal 9: For message bundling, RAN2 to wait for more progress to be made in RAN3 on topology adaptation procedures.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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**Proposal 11’: RAN2 to discuss local rerouting, including the benefits over central route determination, and on how topology-wide objectives can beaddressed.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
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**Proposal 13’: RAN2 to wait on inter-donor-DU rerouting pending RAN3 progress.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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## Less easily agreeable proposals

**Proposal 3’: RAN2 to wait for RAN3 progress on CP redundancy via separate NR access link.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
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**Proposal 6: Support for multiple collocated IAB-MTs at the IAB-node is FFS.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **We assume that this is the Dual IAB Protocol Stack or Multi-MT? As we said above, all solutions should be discussed with their pros/cons and complexity. We therefore propose the following:**  **Proposal 1’: RAN2 to assess the pros/cons, complexity, and standard impact of the following solutions:**   * **CHO enhancements** * **DAPS enhancements/Dual IAB protocol stack** * **Reestablishment enhancements,** * **Dual Connectivity enhancements,** * **Etc.**   **Proposal 1b’: RAN2 to discuss how the different solutions address the objectives in P0.** |
| **LG** | In the POST email discussion, it was identified that the clear majority want not to support this multiple collocated IAB-MTs and it was also discussed in Rel-16. It would be good to have “deprioritized” instead of “FFS” in the proposal. |
| **Huawei** | It should be de-prioritized. |

**Proposal 8: Avoidance of recovery attempts at former descendent nodes for reduced service interruption due to RLF recovery is FFS.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **LG** | Given that the reasonable implementations can avoid this and anyway the baseline solution for this issue would be also implementation, we prefer to change “FFS” to “deprioritized”. |
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**Proposal 10’: RAN2 to discuss a replacement for the UE’s/IAB-MT’s RA procedure at inter-donor topology adaptation when activating the new security context.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **One fundamental assumption of IAB network is that UEs should not be impacted.**  **So maybe the proposal can be reformulated like this:**  **P10: RAN2 to discuss if there is the need for replacing the UE’s/IAB-MT’s RA procedure at inter-donor topology adaptation when activating the new security context.** |
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**Proposal 16: BAP-layer packet duplication is deprioritized.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **LG** | We think the benefit of BAP-layer duplication is meaningful; diversity via opportunistic/selective duplication in the intermediate node along the routing path would be beneficial for lower latency and higher reliability upon local BH problem.  Meanwhile, we note that applicability of PDCP packet duplication is very limited in IAB networks because PDCP packet duplication cannot be performed in the intermediate nodes over routing paths. Furthermore, relying on PDCP packet duplication at the source node is expected to be radio-inefficient.  Given this, it is immature to de-prioritize this at this moment. Instead, it would be good to have technical discussion in the upcoming meeting on the benefit and technical details. So, we propose:  Proposal 16: Support of BAP-layer packet duplication is FFS. |
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**Proposal 17: Procedures for faster topology integration are deprioritized.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Intel** | We suggest to update proposal as follows:  **P17: “Topology establishment enhancement should be studied as part of this WI”**  The topology establishment enhancement is not a “procedure for fast topology integration” and also not limited to the scenario of multiple IAB nodes joining in the IAB network simultaneously.  A well-established topology at initial phase can help to reduce the frequency of topology migration and RLF, thus help to reduce service interruption, especially avoid migration shortly after integration to the network, which is exactly the objective of this WI “Specification of enhancements to reduce service interruption due to IAB-node migration and BH RLF recovery.”, which also align with Proposal 0 of considering service interruption as one of the enhancement areas. |
| **Apple** | We agree here with Intel’s view and believe that an efficient topology establishment would lead to lesser and more efficient topology adaptation needs. As Intel explains, this topic falls into the WID objective. We are ok with Intel’s updated proposal P17. |

**Proposal 18a: RAN2 to discuss lossless delivery of hop-by-hop ARQ after RAN3 has made progress on enhancements to packet loss and reduction of unnecessary transmissions during IAB-node migration.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **We do not understand the intention of this proposal. RLC AM is lossless hop-by-hop by definition.**  **Does this proposal refer to this RAN3 agreement?**  **Discuss mitigation of packet loss and reduction of unnecessary transmissions during IAB-node migration.**  **If yes, then the above RAN3 agreement seems not necessarily related to hop-by-hop lossless ARQ. Rather it can be related to how to manage packets that are already in flight when migration is triggered, e.g. discarding/rerouting.**  **Maybe the proposal should be like this:**  **P18a: RAN2 to discuss lossless delivery/packet discarding after RAN3 has made progress on enhancements to packet loss and reduction of unnecessary transmissions during IAB-node migration.** |
| **LG** | Given that there was no sufficient support for lossless delivery of hop-by-hop ARQ in the POST email discussion and it was already discussed in Rel-16, we think that it is too early to say “RAN2 to discuss ” and the proposal can be changed like followings:  **“For lossless delivery of hop-by-hop ARQ, RAN2 to wait for RAN3 progress on enhancements to packet loss and reduction of unnecessary transmissions during IAB-node migration”** |

**Proposal 18b: RAN2 to discuss further enhancements to the Rel-17 topology adaptation defined by RAN3.**

If you are unhappy with this proposal, please provide a constructive rewording, which moves the discussion forward and promises broad consensus.

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| **Company** | **Comment** |
| **Ericsson** | **We suggest some rewording here, to avoid that RAN3 may come with some solutions which are not suitable from a RAN2 point of view.**  **We suggest this rewording:**  **P18b: RAN2 to discuss further enhancements to the Rel-17 topology adaptation defined by RAN3, and evaluate their impact and complexity from a RAN2 point of view.** |
| **Huawei** | The proposal is intended for the RLF recovery based on the email discussion. We need to clarify this rather than in such high level proposal. We suggest:  **“For RLF recovery, RAN2 to discuss further enhancements to the Rel-17 topology adaptation defined by RAN3.”** |

# 3 Phase B: Applicable solution proposals

The following topics have been selected for further discussion since they received broad support.

## 3.1 CHO

**The following enhancements where proposed in contributions to R2#112-e:**

R2-2009262 (Interdigital): Consider additional triggering conditions such as BH RLF, load, latency

R2-2009387 (ZTE) and R2-2009652 (Huawei): RAN2 needs to discuss the triggering for the migration of UEs and descendent nodes, whose backhaul link is fine.

R2-2009887 (Sony): Consider event A4 for CHO trigger (in addition to A3 and A5)

R2-2010150 (Ericsson):Preparation needs to includeUEs and descendent nodes for admission control

R2-2010233 (Kyocera): Type 2 RLF indication may trigger CHO.

**Additional aspects raised during post-111-e email discussion:**

KDDI: Consider pre-emptive configuration or BH routing to reduce service interruption.

Futurewei: Confirming Ericsson’s point that UEs and descendent IAB-nodes need to be included in preemptive preparation.

Rapporteur’s views:

Preemptive preparation of UEs/descendent nodes

If CHO is considered as an alternative to handover, admission control and resource planning needs to be included in the preparation for the entire subtree. This comes at a high cost especially since BH links are not assumed to fail frequently, and CHO execution is therefore expected to occur rarely.

It is also possible to consider CHO as an alternative to BH RLF recovery, i.e., it is conducted in case the source path deteriorates too fast to perform centrally controlled handover. In the case of RLF recovery, the context of UEs and descendant nodes can be pulled after reestablishment, i.e., without preparation. Since this scenario is more applicable to BH links, it makes sense to not include UEs and descendant nodes into the CHO preparation for IAB-MT.

**Proposal 100: CHO can be applied for the IAB-MT without preparation for UEs and descendant nodes.**

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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Preemptive preparation of BAP routes, UL/DL mappings, BH RLC channels

While preparation for UEs and descendent nodes creates a large resource cost, it would be fairly easy to have the target IAB-donor prepare BAP routes, DL mappings and BH RLC channels beforehand. This would reduce interruption time in case the CHO is executed. Since these configurations are not used until the IAB-node and its subtree is migrated, they do not create a transport resource cost. In the same manner, BAP routes, UL mappings and BH RLC channels can be preemptively configured on the subtree for the new topology.

This enhancement should be aligned with RAN3 efforts on inter-donor reconfiguration for IAB-MT handover, dual-connectivity and BH RLF recovery, which also require these reconfigurations.

**Proposals 101: For CHO of the IAB-MT, preemptive configuration of BAP routes, DL/UL mappings and BH RLC channels to be considered for the target topology and the migrating subtree after RAN3 has made progress on topology adaptation procedures.**

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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Trigger for migration of UEs and descendent nodes following IAB-MT’s CHO execution

After the IAB-MT has decided to execute CHO, the migration of UEs and descendent nodes could follow the same procedures as presently defined by RAN3 for IAB-MT’s RLF recovery and/or handover. RAN2 should therefore wait for RAN3 to make further progress and then assess if further enhancements are necessary.

**Proposals 102: For migration of UEs and descendant nodes following IAB-MT’s CHO execution, RAN2 to wait for further progress by RAN3 on inter-donor topology adaptation procedures.**

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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Additional triggering conditions

It has been proposed to add further CHO trigger conditions such as load/congestion, latency or type-2 RLF indication (if adopted). The rapporteur is skeptical that local decision on topology changes based on load/congestion and latency make a lot of sense. Topology changes typically require significant reconfiguration and should therefore occur rarely. Load-/congestion- or latency-related typically vary on a short time scale and should be mitigated by other means than topology adaptation. If there are longer-term load/congestion or latency problems, which require mitigation via means of topology reconfiguration, the IAB-donor itself can conduct this reconfiguration. The IAB-donor further has global visibility and can make much better decisions than the individual IAB-node.

For BH RLF, the situation is different as it cuts off the IAB-donor from implementing centralized reconfiguration decisions. It certainly makes sense to trigger CHO upon reception of type-4 recovery failure indication. It remains to be discussed of type-2 indication can also trigger CHO. This will be part of the discussion on further enhancements to RLF indications.

**Proposals 103: Rel-16 RLF indication to be considered as CHO trigger.**

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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Additional trigger events

The claim has been made that there is a lot of benefit in including A4 events as CHO triggers. The rapporteur will include this proposal here and expects companies to reply.

**Proposals 104: Type-4 event to be considered for CHO trigger conditions.**

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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## 3.2 RLF indication

**The following enhancements where proposed in contributions to R2#112-e and post-R2#111-e email discussion:**

Most contributions and comments to the post-R2#111-e discussion evolved around the following definition of RLF indications introduced at some point in time during Rel-16:

**Type 1 – “Plain” notification:** Indication that BH link RLF is detected by the child IAB-node.

**Type 2 – “Trying to recover”:** Indication that BH link RLF is detected, and the child IAB-node is attempting to recover from it.

**Type 3 – “BH link recovered”:** Indication that the BH link successfully recovers from RLF.

**Type 4 – “Recovery failure”:** Indication that the BH link RLF recovery failure occurs.

**Type 4x – “Indicating child nodes to perform RLF procedure”:** it is up to implementation on the parent node on when to send this indication.

Based on this definition, all Rel-17 contributions referred to Type 2 and Type 3 indications as potential enhancements to be considered, while Type 4 represents the indication defined in Rel-16.

The main issues to be addressed refer to the conditions of the transmission of Type2/3 indications and the behavior of the receiving node.

R2-2009201 (Intel): RAN2 should ensure that an IAB node does not choose for reestablishment nodes that have failed. The IAB-node may modify SI to bar access to new IAB-node or UEs. The recovery failure indication may include information about ancestors that have failed.

R2-2010233 (Kyocera) proposed:

* The IAB-MT reduces/stops the scheduling request after it receives Type 2 Indication, and it resumes the scheduling request if the parent node no longer experiences BH RLF.
* Discuss other IAB-MT behaviour(s), e.g., local re-routing, while its parent node tries to recover its BH link.
* IAB-DU may send Type 2 BH RLF Indication when it initiates RRC Reestablishment rather than when it initiates one of RLF recovery procedures.
* Discuss whether/how to capture the IAB-DU behaviour.

R2-2010441 (LG) proposed:

* Upon reception of Type3, if multiconnected, apply local re-routing without changing the parent.
* If single-connected, apply early re-establishment or CHO execution to new parent.

Rapporteur’s views:

Support of Type2/3 indications

There is a lot of support for both types of indications. To ensure stable conditions as well as inter-vendor interoperability, the rapporteur insists that proper behavior is defined for the receiving node.

**Proposals 200: RAN2 to support Type-2 indication, which indicates that BH RLF has been detected, together with the behavior on the node receiving the indication.**

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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**Proposals 201: RAN2 to support Type-3 indication, which indicates that the BH link has recovered, together with the behavior on the node receiving the indication.**

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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Behavior of receiving node

The behaviors by the receiving node upon reception of Type 2 indication may include local rerouting, execution of CHO, early RLF reestablishment, discontinuation/reduction of UL scheduling requests, and barring of access for IAB-nodes and UEs. The rapporteur is fine with all of them except early RLF reestablishment. This behavior is already defined for Type 4 indication. Further, having all nodes in the subtree trying to concurrently recover will certainly not converge to a stable solution in short time. For Type-3 indication, the receiving node essentially reverts to the behavior before the reception of the Type-2 indication.

Proposal 202: For Type-2 indication, consider for the behavior of the receiving node to include local rerouting, execution of CHO, discontinuation/reduction of UL scheduling requests, barring of access for IAB-nodes/UEs, and propagation of the indication.

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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Proposal 203: For Type-3 indication, consider for the behavior of the receiving node to revert to the conditions before the reception of Type-2 indication.

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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Inclusion of information into the Type2/3 indication

The rapporteur does not see any benefit of adding information to these indications. Other companies may certainly have a different view. We can keep this aspect FFS.

Proposal 204: Inclusion of further information into the Type-2 or Type-3 indication is FFS.

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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## 3.3 Local rerouting

**The following aspects where proposed in contributions to R2#112-e:**

R2-2009652 (Huawei) claims that local rerouting allows congestion mitigation and load balancing.

R2-2009887 (Sony) claims that local rerouting can improve topology robustness in real-time radio environment, guarantee differentiated packet delivery according to their QoS profile, and simplify the route management framework, therefore reduce the signalling overhead. The IAB-node can select among local candidate routes configured by the CU.

R2-2010490 (Futurewei) proposes centralized configuration of multiple routes with priorities, among which the node can select. In this manner, topology-wide constraints can be guaranteed. Multiple routes with routing priorities were already discussed during Rel-16.

R2-2010671 (Nokia) proposes to introduce a discard timer on BAP layer, which is reset based on RLC ACK. Upon expiry of the timer, the packet can be locally routed.

Rapporteur’s views:

Centralized configuration of multiple routes

This allows the CU to keep control over local rerouting and to also select the subset of routes, where topology-wide constraints can be met.

Proposal 300: The IAB-donor-CU can configure multiple routes with same BAP routing ID, among which the IAB-node can select.

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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Routing priorities

While it is straightforward to a add route priority value to each routing entry, it is necessary to define the IAB-node’s behavior in case it can select among multiple routes with different priorities. The contributions indicate that the IAB-node would primarily select the highest priority route and resort to a lower-priority route if certain conditions are met. Some conditions proposed relate to congestion/load, expiration of an RLC retransmission timer, or reception of an RLF indication.

Proposal 301: The IAB-donor-CU can include a routing priority to each routing entry to constrain the IAB-node’s decision on local route selection.

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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Proposal 302: RAN2 to discuss the IAB-node’s criteria for route selection with route priorities considering, e.g., congestion/load, expiration of RLC retransmission timer and reception of an RLF indication.

*Please provide your company’s view on this proposal. In case you are unhappy, please propose a rewording which moves the discussion forward and promises broad consensus.*

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| **Company** | **Comment** |
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# Conclusion

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# References

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| R2-2008849 | Consideration on Topology adaptation enhancements | CATT |
| R2-2009007 | CHO for UE or IAB-MT on migration | Fujitsu |
| R2-2009201 | Enhancements to establish efficient topologies and backhaul failure recovery | Intel Corporation |
| R2-2009262 | On IAB Topology Adaptation | InterDigital |
| R2-2009292 | Report of email discussion on topology adaptation enhancements RAN2 scope | Qualcomm Incorporated |
| R2-2009330 | Consideration of Inter-CU IAB Migration | vivo |
| R2-2009387 | Considerations on topology adaptation enhancements | ZTE, Sanechips |
| R2-2009508 | Better Cell Selection for eIAB nodes for improved topology adaptation | Apple |
| R2-2009610 | Topology optimization in IAB | NEC |
| R2-2009652 | Consideration of topology adaptation enhancement for R17-IAB | Huawei, HiSilicon |
| R2-2009887 | Topology adaptation enhancements in IAB | Sony |
| R2-2010137 | Consideration on avoiding RLF recovery at former descendent nodes | Sharp |
| R2-2010158 | On WI scope and solutions for topology adaptation and inter-CU migration | Ericsson |
| R2-2010233 | Consideration of topology adaptation enhancements for eIAB | Kyocera |
| R2-2010441 | BAP Packet Duplication and BH RLF Indication Enhancements | LG Electronics France |
| R2-2010490 | RAN2 impacts of Rel.17 IAB topology adaptation enhancements | Futurewei Technologies |
| R2-2010671 | On topology adaptation enhancements | Nokia, Nokia Shanghai Bell |