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**

This document only covers Part B.

# 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), R2-2009652 (Huawei) and R2-2008849‎ (CATT): 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) and R2-2008849‎ (CATT): Type 2/4 RLF indication may trigger CHO.

R2-2008849‎ (CATT): preemptive configuration‎ of CHO includes the default BAP routing configuration and IP address that is routable ‎via the target IAB-donor-‎DU.

**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** |
| **Kyocera** | We agree with Proposal 100.  |
| **Sony** | Agree with the proposal |
| **Ericsson** | **We are skeptical about this proposal.** **If the target DU/CU does not need to be prepared for the incoming CHO migration, and if the contexts of UEs and IAB nodes can be fetched after reestablishment, then what is the difference compared with a regular reestablishment procedure? Also, how can the target CU accept/reject a CHO preparation blindly without knowing the UEs and descendant IAB nodes that are going to be migrated?****Note also that in Rel.16 CHO, when the UE gets an RLF, and the cell selected for reestablishment is part of the CHO configuration, then the UE does not transmit an RRCReestablishmentRequest, rather it sends an RRCReconfigurationComplete directly as it would do for an handover. Actually, if P100 is accepted for CHO, the consequences will be very strange both from the IAB node side and from the NW. That would imply that the IAB node that experiences RLF will transmit the RRCReconfigurationComplete, even though the CU has not yet admitted the served UEs/descendant nodes. If eventually many UEs will be rejected by the target CU, what was the point for the IAB node to have attached to this CU? What advantage would CHO give over a normal reestablishment procedure?Also from the NW side, it will be very strange for the CU to perform a context fetch from the source after reception of RRCReconfigurationComplete, rather than after RRCReestblishmentRequest as it typically happens. Again, it is not clear what benefit CHO offers over reestablishment.** **Also latency-wise and signaling-wise, it is not clear how the above procedure could be better than a normal reestablishment, given the huge amount of signaling and the complexity needed to fetch and process the contexts of hundreds/thousands of UEs.** **Therefore, if the target can be unprepared (as this proposal assumes), we do not see how the CHO can offer better performances than a regular reestablishement procedure.If the problem is how to make available the context(s) at the target early enough to avoid signaling storm and latency issues (e.g. as hinted in P101 below), we are fine to study it, but that is a separate problem, that neither P100 nor CHO would solve.** |

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** |
| **Kyocera** | We agree with Proposal 101. We’re wondering if it’s related to not only RRC but also F1.  |
| **Sony** | We share the same view on the benefits of pre-emptive preparations, therefore we think RAN2 can make progress on this and then liaison with RAN3 of our progress.  |
| **Ericsson** | **We are OK to discuss this, but we do not understand why this enhancement should be studied only in the context of CHO.****A conventional reestablishment procedure can also benefit from the above enhancement, and it would not have all the shortcomings that CHO has, as mentioned in our reply above, e.g. IAB node sending RRCReconfigurationComplete before the CU performs admission control.** |

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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| **Company** | **Comment** |
| **Kyocera** | We agree with Proposal 102. We think RAN2 should wait for RAN3’s progress.  |
| **Sony** | Agree with the proposal |

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** |
| **Kyocera** | We agree with Proposal 103.  |
| **Sony** | Agree with the proposal |
| **Ericsson** | **In our view, this is already covered in legacy Rel.16 (please see below). Nothing in current RAN2 specification seems to preclude an IAB node to perform a CHO upon RLF, as a normal UE would do.Regarding load/congestion situation, we agree with the Rapporteur.**5.3.10.3 Detection of radio link failureThe UE shall:………2> if connected as an IAB-node, upon BH RLF indication received on BAP entity from the MCG; or2> upon consistent uplink LBT failure indication from MCG MAC while T304 is not running:……6> initiate the connection re-establishment procedure as specified in 5.3.7.5.3.7 RRC connection re-establishment**……..**1> perform cell selection in accordance with the cell selection process as specified in TS 38.304 [20], clause 5.2.6.5.3.7.3 Actions following cell selection while T311 is runningUpon selecting a suitable NR cell, the UE shall:…..1> if *attemptCondReconfig* is configured; and1> if the selected cell is one of the candidate cells for which the *reconfigurationWithSync* is included in the *masterCellGroup* in *VarConditionalReconfig*:2> apply the stored *condRRCReconfig* associated to the selected cell and perform actions as specified in 5.3.5.3; |

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** |
| **Kyocera** | We think “Type-4 event” is Event A4 (Neighbour becomes better than threshold) here, e.g., it’s not Type 4 BH RLF Indication which was introduced in Rel-16. We’re not sure how Event A4 works for the parent’s BH RLF and how CHO is useful for load balancing.  |
| **Sony** | Agree with the proposal and think it should be event A4. According to the topology adaptation target, CHO should be triggered even when the serving cell is good enough in order to maintain multiple viable routes and to reduce the service interruption time. Furthermore, topology adaptation due to load balancing may not necessarily be triggered by radio link degradation. Then A4 type event should be considered for CHO trigger in Rel-17 IAB. |
| **Ericsson** | **A4 event was not considered in Rel.16 for CHO configuration. We do not see the need to introduce it for IAB** |

## 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.

R2-2008849‎ (CATT) proposed:

* When the IAB-node receives Type 2 BH RLF Indication, the IAB-node doesn’t ‎necessarily to perform cell re-selection.‎

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** |
| **Kyocera** | We support Proposal 200. We think Type 1 and Type 2 are actually same, i.e., the IAB-MT initiates BH RLF recovery when it detects BH RLF, and assume Proposal 200 mixes them, i.e., it says Type 2 Indication (“Trying to recover”) is sent when BH RLF is detected (“Type 1”).  |
| **Ericsson** | We are ok with type-2 indication, but we are doubtful about the gain of specifying actions upon reception. Those should be two separate proposals to be discussed separately. |

**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** |
| **Kyocera** | We agree the child node needs to know the parent recovered its BH RLF, if Type 2 Indication is introduced. However, we still think the child node can notice it if Type 2 Indication is transmitted repeatedly (e.g., via SIB1), even without the explicit Type 3 Indication.  |
| **Ericsson** | We are ok with type-3 indication, but we are doubtful about the gain of specifying actions upon reception.Those should be two separate proposals to be discussed separately. |

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** |
| **vivo** | Disagree to trigger CHO upon the reception of type2 indication, since it may result in suboptimal topology as type 4 indication can be used as the triggering condition. Besides, as RLF is a rare case, it is preferred not to define the very complex procedure. It could be enough to define the UL data TX behavior and leave others for implementation.  |
| **Kyocera** | We agree with Proposal 202.  |
| **Ericsson** | **We agree with Vivo.****It is too early to discuss such aspects.** |

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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| **Company** | **Comment** |
| vivo | It’s unclear what the behaviors are upon the reception of Type-2/3 indication, we can discuss this proposal later when those behaviors are specified. |
| **Kyocera** | We support the receiving node’s behavior in Proposal 203, but we think the important thing is for the IAB-MT to know when the parent’s BH has recovered, which doesn’t require the reception of Type 3 indication (also see our comment under Proposal 201).  |
| **Ericsson** | **We agree with Vivo.****It is too early to discuss such aspects** |

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** |
| **Kyocera** | We’re fine with Proposal 204.  |
| **Ericsson** | **To be discussed later if Type2/3 indication is agreed.** |

## 3.3 Local rerouting

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

R2-2009652 (Huawei) and R2-2008849‎ (CATT)‎ claim 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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| **Company** | **Comment** |
| **Kyocera** | We support Proposal 300, but we assume the donor configures multiple routes for a destination at this point. So, we wonder if the modeling should be FFS, e.g., whether the multiple routes have the same BAP Routing ID or these have different Path ID etc.  |
| **Sony** | Agree with the proposal |

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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| **Company** | **Comment** |
| **Kyocera** | We agree with Proposal 301.  |
| **Sony** | Agree with the proposal |
| **Ericsson** | **We are not sure about the gain of indicating routing priorities, over a solution in which the IAB node simply selects the best alternative node on the basis of local measurements, e.g. on the basis of radio conditions, local congestions, etc.****Should not we also discuss the criteria needed to the IAB node to determine whether to perform a local re-routing or not?** |

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** |
| **Kyocera** | We agree with Proposal 302.  |
| **Sony** | Agree with the proposal |
| **Ericsson** | **See our comment to P301.** |

# 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 |