3GPP TSG-RAN WG2 #113bis-e R2-21xxxxx

Electronic meeting, April 12th – 20th 2021

Agenda Item: 8.4.3

Source: CATT (Email discussion rapporteur)

Title: [Post113-e][057][ IAB17] CHO and DAPS for IAB (CATT)

Document for: Discussion

# Introduction

This document captures the outcome of the following email discussion [1]

* [Post113-e][057][IAB17] CHO and DAPS for IAB (CATT)

 Scope: Collect comments on the (potential) usage of CHO and DAPS, starting from agreements and previous input and discussions. Identify options / potential ways forward, easy agreements and discussion points. Detail level: Should focus on the next steps agreements.

 Intended outcome: Report

 Deadline: Long

This email discussion is divided in two phases:

* **Phase I** with the deadline on Tuesday March 23 1100 UTC (3am PST) for companies to provide their views.
* **Phase II** with deadline on Friday March 26 1100 UTC (3am PST) for companies to provide their views on the summary and suggested proposals.

As a reminder, the following agreements have been reached in previous meetings:

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| * **RAN2 Agreements**

**RAN2#112e*** CHO and potential IAB-specific enhancements of CHO is on the table.
* DAPS and potential IAB-specific enhancements of DAPS is not precluded for now (but as there is no PDCP it is not clear how to support DAPS).

**RAN3#113e*** Will indicate regarding P3 that R2 doesn’t understand what is asked by “DAPS-like”, Ask R3 to clarify what they want to achieve.
* RAN2 to discuss CHO and start with intra-donor CHO until RAN3 has made progress on inter-donor IAB-node migration.
* R2 confirm the intention Rel-16 CHO is / can be used for IAB-MT (FFS whether any modification is needed).
* R2 assumes that Rel-16 specification is the baseline for the configuration of default route, IP address(es) and target path for intra-donor CHO.
* **RAN3 Agreements**

**RAN3#111e****Discuss how to support simultaneous connectivity with 2 donors, to reduce service interruption; potential solutions may include dual-protocol-stack solutions (“DAPS-like”); FFS whether the same solution also applies to descendant nodes****The simultaneous connectivity dual-protocol-stack solutions (“DAPS-like”) of an IAB node should allow at least DL simultaneous transmission of BH traffic carried on BH RLC channels, on the paths to both donors.****Rel-16 CHO can be considered as baseline for the discussion of CHO for IAB; further analysis is expected****Rel-16 CHO is supported for INTRA-donor migration of IAB-MT****FFS whether the descendant nodes and UEs receive RRC reconfiguration messages before migrating IAB node connects to target path****RAN3 further studies “DAPS-like” solution after RAN2 has conclusions** |

Rapporteur encourages the participating delegates to provide your contact information in this table.

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# Discussion

## CHO

Rel-16 CHO is used for handover and RLF recovery for the purpose of service robustness. During Rel-17 eIAB discussion, both RAN2 and RAN3 agreed to take Rel-16 CHO as baseline for IAB-MT. At the first step, we can discuss if the use cases of Rel-16 CHO, i.e., handover and RLF recovery can be applicable to IAB-MT.

**Q1: Do you agree that the use cases for IAB-MT CHO should be handover and RLF recovery? If no,** **please provide the use case you suggested.**

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| **Company** | **Yes/No** | **Comments (if any)** |
| Kyocera | Yes | We think Rel-16 CHO was introduced for handover robustness improvements, so it’s still applicable to IAB.  |
| LG | Yes |  |
| Huawei | Generally fine | Not sure about the intention of this question. Which use case is excluded? If the intention to reuse the motivation from R16 CHO, it should be fine, as we already agreed to “R2 confirm the intention Rel-16 CHO is / can be used for IAB-MT”.“Handover” should be “migration”. |
| CATT | Yes | This question is to clarify the details of use cases to make progress since we agreed “R2 confirm the intention Rel-16 CHO is / can be used for IAB-MT (FFS whether any modification is needed)”.We have no strong preference for “handover” or “migration”. We think “migration” has no explicit definition and clear procedure, but we are OK for the terminology if all companies are fine with it. |
| Ericsson | Same as Rel.16 | Our understanding is that as CHO is already supported for IAB-MT since Rel-16; we do not as such need to further go into details as for what reasons it is supported. It is up to NW implementation for what it is used; or how much resource is reserved in advance. We do not see the need to have further specification impact. Legacy functionality and implementation should cover. During Release 16 capabilities discussions, RAN2 concluded that for IAB, RAN2 would not do a list of capabilities which are possible to combine with IAB. Further, it would not take any actions to fix any combination which did not work. Thus, the possibility to combine IAB and CHO is there since Release 16.When it comes to use cases, we refer to the WID scope and the WID discussions at the plenaries. Mobile IAB was explicitly ruled out and, therefore, enhancements addressing mobility e.g. handover, are not to be considered. |
| vivo | Yes | Rel-16 CHO should be the baseline.  |
| Fujitsu | Yes |  |
| Qualcomm | Yes | The use cases should be more specific. “Handover”, for instance, is a procedure, not a use case. We propose:* Reduction of IAB-MT handover failure, e.g., in case the source link deteriorates rapidly.
* Reduction of interruption time due to RLF recovery.
 |
| Sharp | Yes |  |
| Convida | Yes | “Handover” should be “migration”. |
| Apple | Yes | However, we prefer to also evaluate the solutions based on other metrics which are - service interruption delay, congestion handling and robustness. We also prefer to use the term “migration” in this case until about the point when true “handovers” with mobile IAB nodes come into play.  |
| Futurewei | Yes | Prefer “migration” to “handover” |
| NEC | Yes  | We can re-use the Rel\_16 CHO use cases for IAB. |
| ZTE | Yes | If applying CHO, IAB-donor-CU performs early preparation of candidate cells on the candidate IAB-DUs and sends the CHO configuration to migrating IAB-MT in advance. If the link quality towards the parent node degrades, the migrating IAB-MT can access to the target cell by itself. In this way, it can reduce the HO failure rate and improve handover robustness. In the RLF scenario, if using CHO, the IAB-MT can choose to sync with an available candidate parent IAB-DU based on CHO configuration, which may reduce the interruption time compared to traditional RLF recovery procedure via RRC Reestablishment.  |
| Intel | Yes with comment | In general, we agree IAB-MT CHO can be used to enhance topology adaptation for IAB network. We would like to mention that Rel-16 CHO is used for RLF recovery only if the selected cell after RLF declaration is one of the CHO candidate cells. RLF declaration is not the execution condition of Rel-16 CHO.Besides, considering Rel-17 eIAB only supports fixed IAB nodes, hence A3/A5 event and RLF may not happen frequently. We need to consider a long-live CHO may exist for IAB-MT and enhance accordingly.  |

In last meeting, RAN2 agreed to discuss CHO and start with intra-donor CHO until RAN3 has made progress on inter-donor IAB-node migration. Since inter-donor CHO has been postponed, we don’t discuss it in this email discussion. For intra-donor CHO, we find two potential cases: 1) intra-CU and intra-donor-DU CHO; and 2) intra-CU and inter-donor-DU CHO.

The possible differences between the two cases are:

* BAP address of migration IAB-node: In case 1, the BAP address of migration IAB-node can be unchanged during migration. In case 2, the destination DU can allocate another BAP address to the migration IAB-node. It may impact routing procedure.
* Migration IAB-node DU cell: In case 1, migration IAB-node DU cell for descendant IAB-nodes/UEs can be unchanged. In case 2, IAB-node DU cell could be reconfigured considering the resource pools in different donor-DUs. It may impact the mobility of descendant IAB-nodes/UEs, for example, whether the descendant IAB-nodes/UEs perform handover.

**Q2: Do you agree that we can discuss intra-CU/intra-DU CHO and intra-CU/inter-DU CHO separately? If yes, please identify potential issues you considered. If most companies answer no, we can consider common solution for the two cases.**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Kyocera | Maybe No | We prefer a common solution for intra-/inter-DU CHO, even though we understand there’re some differences as the rapporteur pointed out. But we agree that it can avoid unnecessary confusion due to mixing the discussions for intra-/inter-DU CHOs We agree with the first analysis from the rapporteur, i.e., for BAP address. On the other hand, we’re wondering why the second analysis is the case, since the IAB-node is still connected with the same CU, i.e., the same donor.  |
| LG | No | Common aspect should be investigated first. Different aspects depending on intra/inter-DU cases can be discussed later, based on the discussion results of the common aspects.  |
| Huawei | No | There should be easy way to design common approach for intra-CU cases. Please note that R16 IAB already support the intra-CU migration regardless intra or inter donor-DU.Not fully agree that BAP address and resource pools of migration IAB-DU will change in the intra-CU inter-donor-DU case. |
| CATT |  | So a common solution for intra-/inter-DU CHO is preferred. |
| Ericsson | No | Separating the issues may lead to two different solutions. Ideally, RAN2 should find one solution that addresses the targeted agreed use cases/scenarios. Only where a certain solution or part of it is not application to one use case, then specific deviations could be discussed and introduced. |
| vivo | No | We prefer to have a unified solution for both cases.  |
| Fujitsu | No  | Common solution is preferred. |
| Qualcomm | No | We didn’t make any distinction between these two cases for intra-donor migration in Rel-16. Why should we do it for CHO?We should start with Rel-16 intra-donor migration as baseline and discuss if anything would have to change when IAB-MT HO is replaced with CHO.We don’t understand why BAP address would have to change.We believe that existing Rel-16 migration procedure could be used AS IS for CHO.  |
| Sharp | No | We prefer a common solution, as pointed out by companies. |
| Convida | No  | Common solution is preferred. |
| Apple | No | We prefer to also have a unified solution for both the cases.  |
| Futurewei | No | We prefer a common solution |
| NEC | No | Common solution is preferred. |
| ZTE | No | We prefer a common solution for these two scenarios. We think the BAP address does not change during the inter-donor DU migration. The resource pool may or may not change in both intra-donor DU and inter-donor DU scenario. |
| Intel | No | There’s not much difference between two cases, except the first difference pointed out by rapporteur. For the second difference, we don’t think the descendant IAB nodes/UEs should perform handover during migration in both cases. It will introduce more service interruption, which is controversial to introduce CHO for IAB network.  |

In last meetings, several open issues of CHO have been discussed in companies’ contributions. We list them as below.

**Open Issue 1: CHO execution condition**

CHO execution condition has been discussed in R2-2100226, R2-2101315, R2-2100359, R2-2100802, R2-2100903. The mentioned conditions are listed below.

* Condition 1: condEventA3;
* Condition 2: condEventA5;
* Condition 3: type-4 RLF indication;
* Condition 4: type-2 RLF indication;
* Condition 5: Event A4.

We think condition 1, 2, and 3 are supported in Rel-16 specification and the 3 conditions can be applied to IAB-MT CHO without specification revision. Other conditions need more discussion and verification.

**Q3: Do you agree that condEventA3, condEventA5 and type-4 RLF indication can be applied to IAB-MT CHO?**

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| **Company** | **Yes/No** | **Comments (if any)** |
| Kyocera | Yes, but… | Regarding Type 4 BH RLF indication, in Rel-16 we understand CHO is “executed” when the IAB-MT selects the CHO, as result of cell selection before RRC Reestablishment. However, I think Type 4 BH RLF indication is not the “trigger” of CHO. Also, the cell selection is up to IAB-MT implementation. So, we think Type 4 BH RLF Indication should “trigger” CHO in Rel-17.  |
| LG | Yes | Same as legacy (R16) |
| Huawei | Yes for A3, A5No for type4 indication  | We agree to reuse R16 basic solution. But type4 indication/detecting RLF is not the trigger condition for CHO.It means “type 4 indication” will be handled same as “detecting RLF”, and follows the rest R16 procedure (i.e. RLF->RRC re-establishment initiation->cell selection-> if CHO candidate cell selected, then CHO). |
| CATT |  | We agree HW’s clarification of Rel-16 procedure on type-4 RLF indication and CHO.So can we propose: 1) condEventA3 and condEventA5 are applied to IAB-MT as CHO execution conditions; 2) CHO configuration can be used in RRC re-establishment procedure which is triggered by type-4 RLF indication as Rel-16 specification? |
| Ericsson | Yes | All the above execution conditions are already covered in Rel.16. Regarding comment from Huawei and CATT, we believe that there is no need to capture any specific differentiation between condEvents and type-4 RLF. In fact, also in the latter case, the UE/IAB node performs an HO, i.e. it sends an RRCReconfigurationComplete to the target cell (as it would do for a normal HO), rather than an RRCReestablishmentRequest (as it would do in case of ordinary reestablishment).  |
| vivo | Yes | We see no difference from the perspective of migration execution procedure for the 3 triggering conditions. |
| Fujitsu  | Yes, but | We think type-4 RLF indication is different from condEventA3/condEventA5. Type-4 RLF indication is not a condition to decide whether a CHO execution should be performed.Besides, different conditions can be applied in different use cases, e.g. handover and RLF. |
| Qualcomm | Yes | Same as legacy (R16)  |
| Sharp |  | We agree on Kyocera’s comment about type-4 indication. |
| Convida | Yes | Same as legacy (R16) |
| Apple | Yes but  | We agree with Huawei’s clarification too for type-4 RLF.  |
| Futurewei |  | Same as Rel 16 |
| NEC | Yes | Same as legacy (R16) |
| ZTE | Yes | Rel-16 procedure can be used as baseline. When IAB node receives the type-4 RLF indication from parent node, it declare the RLF. On the other hand, when a UE detects RLF, it may performs CHO when the re-selected cell is a CHO candidate cell. It is not necessary to change the current specification to support Condition 3.  |
| Intel | Yes for condEventA3 and condEvent A5 | Type-4 RLF indication is not an execution condition.In Rel-16, IAB node who receives type-4 RLF indication will declare RLF and try to perform RRC reestablishment. As we respond in Q1, RLF declaration is not the execution condition for CHO. Considering that, upon receiving type-4 RLF indication, IAB node who is configured with CHO should follow the procedure for RLF declaration with CHO, that is “select a suitable cell, and if the selected cell is a CHO candidate, then IAB node attempts CHO execution once, otherwise re-establishment is performed”. |

**Q4: Please provide your suggestion on other CHO execution condition(s), such as condition 4 and condition 5 above, and provide your comments/explanations for further discussion.**

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| **Company**  | **Additional CHO execution condition** | **Comments/explanations to your suggested option if any** |
| **Kyocera** | 4 | Regarding Condition 4, i.e., “type-2 RLF indication”, we think it should be configurable by the donor, considering the same indication may be used for local rerouting. If Condition 4 is introduced, we wonder if RAN2 needs further discussion on how the IAB-MT determines the triggered cell for CHO, since Rel-16 CHO considers a cell fulfills Event A3/A5 as the triggered cell but it’s not the case in Condition 4. Regarding Condition 5, i.e., “Event A4”, we assume it was proposed for load balancing purpose, but we’re not sure if it’s aligned for the intention of CHO as in Q1 and/or Rel-16 baseline, i.e., it may not be an IAB-specific enhancement.  |
| **LG** | Only condition4 (reception of type-2 indication) | Condition 5 (event A4) may lead to triggering unnecessary CHOs |
| **Huawei** | None, at least not now | For 4): type2 indication, maybe it is not the best choice for IAB-MT to migrate to target cell, since the target cell does not becomes good enough at the time. Staying at the source cell to wait for the recovery may be the better choice for IAB-MT.For 5): A4. We see nothing new compared to R16 discussion. |
| **CATT** | Not now | Type 2 RLF indication does not instruct a steady state. It is possible for the parent IAB node to recovery successful. If CHO is performed upon receiving type-2 RLF indication, the descendant nodes and UEs may migrate and cause the network changed unnecessarily.But we can list the potential options on which most companies have interest for further discussion.  |
| **Ericsson** | None | We agree with Huawei analysis. For condition 4: Triggering a migration upon type-2 RLF reception might be bring to suboptimal and unnecessary topology change (which implies reconfigurations, service interruptions, signalling overhead), if the parent is then able to recover (i.e. type-3 RLF reception). Type-2 RLF should be mainly used by the IAB node implementation to prepare for a possible RLF recovery failure, e.g. to start evaluating possible target cells, but not to trigger an immediate topology change.For condition 5: We do not see what is the new motivation to include A4 compared with Rel.16. |
| **vivo** | none | “Type 2 RLF indication” can result in undesirable migration, i.e. the IAB node can migrate to a parent IAB node which is not the best one upon reception of Type 2 RLF indication. Afterwards, when the link radio condition to the parent IAB node restores, the CU may have to migrate the IAB node back to the original parent IAB node. There are signaling overhead and service interruptions in this procedure.For condition A4, we think it can cause ping-pong migration procedure due to the fluctuating radio condition caused by environment change, even though the IAB nodes are assumed to be static. |
| **Fujitsu** | Condition 4, condition 5, and | * Condition 6: type-3 RLF indication

Type-3 RLF indication may trigger the descendant nodes fall back to original configuration or trigger execution of CHO.We think these additional CHO execution conditions are configurable by the donor. |
| Qualcomm | None | We do not support CHO execution in case of type-2 RLF indication, unless it is a configurable behavior (i.e., it need not be configured while other type-2 RLF behaviors are configured). Autonomous migration of multiple IAB-nodes may create an unstable topology with unpredictably large interruption times. This should only be supported under severe conditions (e.g. type-4 indication and BH RLF). There may be some borderline cases where it makes sense. To support these borderline cases, this behavior can be configurable.  |
| Sharp | Maybe 4 | We don’t have a strong opinion but tend to agree on Qualcomm’s point about the configurable behavior. |
| Convida | No | Agree with Huawei |
| Apple | None | We agree with Huawei’s analysis.  |
| Futurewei | Neither | We are open to discuss additional triggers for CHO if there is a clear benefit. However, we agree with other companies that neither Condition 4 nor Condition 5 meet this criterion |
| NEC | No |  |
| ZTE | None | Agree with Huawei’s comments on this. |
| Intel | No | Both conditions may lead to unnecessary CHO and cause complexity in topology adaptation. For condition 4, parent IAB node is still possible to recover from RLF, performing CHO and migrate the topology may lead to longer service interruption. |

**Open Issue 2:** **Impacts on descendant IAB-nodes/UEs**

The behaviors of descendant IAB-nodes/UEs were discussed in R2-2100359, R2-2100478, R2-2101283, R2-2100754, R2-2101766, and R2-2101071. Some issues are mentioned as following:

* CHO for descendant IAB-node(s) combined with CHO for migration IAB-node;
* Pre-reconfiguration for descendant IAB-node(s);
* Resource efficiency considering the reserved resources for descendant IAB-node(s)/UEs;
* Etc.

**Q5: Would you like to discuss the impacts on descendant IAB-nodes/UEs? If yes, please provide your comments/explanations for the potential issue(s).**

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| **Company** | **Potential Issues** | **Comments/explanations** |
| Kyocera | None | We wonder if the descendant IAB-nodes really need to perform handover during the intra-donor CHO at the parent, since the descendant nodes are still connected with the same serving cell, i.e., the same DU and CU, or the same parent and donor.  |
| LG | Migration of descendent IAB nodes and UEs | For intra-donor CHO, it is sufficient that intra-donor topology adaptation procedure as already specified in RAN3 spec applies for migration of descendent nodes and UEs.  |
| Huawei | Only one IAB-node is configured with the CHO trigger condition under this CU.Its descendant IAB-nodes/UEs should be (pre)configured with some candidate target configurations, according to the CHO configurations of top-level IAB node. | We got to specify/discuss the descendant IAB-MTs/UEs behavior anyway.The descendant nodes/UE needs to update the configuration accordingly (e.g. the routing table) due to the migration of top-level IAB nodes (applying new routing configuration in target cell).The issue is that source CU may not be aware of the CHO execution of the migration IAB-MT timely. |
| CATT | Migration of descendent IAB nodes and UEs | We are not sure if it is mandatory that IAB-DU cell should not be reconfigured when IAB-MT performing intra-donor/inter-donor migration.If the IAB-DU cell is not changed, descendant IAB-nodes may be reconfigured with new routing information.If the IAB-DU cell is changed, descendant IAB-nodes/UEs should perform RRC re-establishment if CHO is not configured. |
| Ericsson | None (at least in RAN2) | Once the top level has migrated, some reconfigurations are needed to the top level node, as well as to descendant IAB nodes, and to the new ancestor nodes to update their routing tables. RAN3 specification should already cover this scenario. Other inter-donor aspects should be discussed by RAN3. |
| vivo | Migration of descendent IAB nodes and UEs | For intra-donor-DU and intra-CU inter-donor-DU cases, the network topology has been changed for descendant IAB nodes after top IAB node migration. We think at least BAP routing table reconfiguration should be supported for descendant IAB nodes. |
| Fujitsu | CHO for descendant IAB-node(s) combined with CHO for migration IAB-node | Even the migrating node is performing intra-donor CHO, there may be more than one candidate cells which leads to multiple topology configurations for the descendant nodes if the candidate cells belong to different DUs.The descendant nodes and UEs may migrate together with the migration IAB-node, it needs some discussions on how to make the descendant nodes and UEs update their configuration.  |
| Qualcomm | None | The impact on descendant nodes for CHO is the same as for conventional HO and RLF recovery. This has been addressed by RAN3 in Rel-16. Descendant nodes DO NOT CHANGE their respective parent node, so the only thing to be addressed is the change of the BAP and IP transport path.RAN3 is presently working on enhancements to reduce service interruption due to reconfiguration of BAP/IP transport path during IAB-node migration. Whatever they come up with can be readily applied to CHO. UEs should not be affected during intra-donor migration. |
| Sharp | None | As far as we focus on intra-donor migration, descendant nodes should not be affected. |
| Convida | None |  |
| Apple | Migration of both descendant IAB Nodes and UEs | At the minimum, atleast some IAB nodes routing tables need to be re-configured. Same applies to UEs as well and we prefer to discuss this as there is service continuity impact from our view.  |
| Futurewei |  | Agree with Qualcomm’s comments |
| NEC | Migration of both descendant IAB Nodes and UEs | How the descendant node and UE is triggered CHO should be discussed. For descendant node, an additional BAP signaling can be used, but UE can’t receive BAP signaling. So we need a common solution for both descendant node and UE.  |
| ZTE | CHO for descendant IAB nodes and UEs together with the migrating IAB node | If descendant IAB-node(s) need to perform CHO with the migrating IAB-node, new CHO execution condition need to be defined, e.g., an indication indicating that a upstream IAB-node has successfully performed a CHO. The aforementioned CHO condition 1, 2, and 3 could not be directly used for the descendant IAB nodes. In addition, some CHO configuration can be configured to the descendant IAB-node(s) in advance to reduce service interruption. To be specific, the default UL-BAP-Routing ID, default UL-BH-RLC-channel, and new IP address can be sent to descendant IAB nodes in advance via CHO configuration. Upon CHO is triggered, descendant node can immediately sends F1-C signalling to update the F1-C interface and then get the updated BH RLC channel, bearer mapping and routing configuration. Regarding the reserved resources for descendant IAB-node(s)/UEs, we should not focus on “descendant IAB-node(s)/UEs” only. If the BH RLC channel resources are reserved for the migrating IAB-node along the candidate paths, the resources for descendant IAB-node(s)/UEs are actually contained in it. It is not necessary to reserve the resources specific for descendant IAB nodes and UEs.  |
| Intel |  | In RAN2 #112e meeting, we have an agreement “**R2 assumes that Rel-16 specification is the baseline for the configuration of default route, IP address(es) and target path for intra-donor CHO.**”. From our understanding, descendant IAB nodes and UEs will receive their *RRCReconfiguration* messages after CHO completion of migration IAB node. Hence, there’s no need to discuss pre-reconfiguration for descendant nodes.As for resource reservation, since the migrating IAB node is the convergence point of its descendant nodes in both upstream and downstream, the CHO candidate IAB nodes only need to consider reserve resource to guarantee the GBR requested from the migrating IAB node. No additional resource need to be reserved for descendant IAB nodes and UEs. |

**Q6: Do you see any other CHO issues, if not already discussed above?**

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| **Company** | **Other CHO issues** |
| **Huawei** | Do we allow multiple IAB nodes (e.g. one parent node and its child node) are configured with CHO at the same time? What if two IAB-MTs met the CHO trigger condition at the same time? |
| **CATT** | We propose to clarify if the IAB-DU cell should not be changed when IAB-MT performs migration before further discussion. |
| **Qualcomm** | We don’t see any other issues to be handled.On Huawei’s reply: IAB-nodes on multiple tiers can be independently configured with CHO. In this case, CHO should only be executed by the node that experiences BH RLF. The descendant nodes should stay with their respective parent node in the same manner as for CU-controlled IAB-node migration.We agree with CATT’s reply for intra-donor CHO. |
| **Apple** | Not any. We agree with Qualcomm’s analysis that the UEs within the range of descendant nodes will stay with the same node and don’t need a CHO. However, there will still be additional signaling issues as discussed in Q5.  |
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## DAPS-like

RAN3 considered the use cases of load balancing, robustness and reduction of service interruption for inter-donor topology adaptation in LS [R3-211326](file:///F%3A%5C%5C3GPP%5C%5CRAN3%5C%5C2021%5C%5CRAN3%23111-e%5C%5CChairmans_Notes%5C%5CInbox%5C%5CR3-211326.zip). However, RAN3 assumed that a DAPS-like solution for backhauling should be defined by RAN2. Then we can discuss the use cases for DAPS-like solution first.

**Q7: Which use case(s) do you prefer for DAPS-like solution, e.g., load balancing, robustness and reduction of service interruption?**

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| --- | --- | --- |
| **Company** | **Answer** | **Comments** |
| Kyocera | Reduction of service interruption | We think Rel-16 DAPS was introduced for reduction in user data interruption during handover, so it’s still applicable to IAB.  |
| LG | None | RAN3 already consider DC as a baseline for simultaneous connectivity to two parents. Given this, we do not think DAPS-like solution is further needed. Whatever DAPS-like aims to achieve, we think DC based two parent connection can achieve the exactly same purpose.  |
| Huawei | None? | Not sure how to answer this, before we have the definition of “DAPS-like” solution.Please note the R3 LS mentioned “DAPS-like solution **for backhauling**” seems not reusing R16 DAPS to IAB-MT’s traffic. |
| CATT | Reduction of service interruption | We agree with Kyocera about the view of Rel-16 DAPs. But DAPs cannot directly be used in IAB, because IAB-node don’t have PDCP layer. RAN2 should discuss some enhancement on Rel-16 DAPS in order to apply it in IAB. Legacy DC can achieve the load-balance and robustness.So we propose DC is for load-balance and robustness, and DAPs-like is for reduction of service interruption. |
| Ericsson | All of them can be achieved with same architecture | First it should be discussed what DAPS-like means. For us, DAPS for IAB implies that the MT has two protocol stacks as in ordinary DAPS, with the difference that in this case there is no PDCP in the dual protocol stack. Each protocol stack is made up of PHY/MAC/RLC/BAP and it can be configured independently. For example, during inter-donor migration/load balancing one protocol stack can be configured by the source CU, while the other protocol stack by the target CU. Hence, each CU can independently configure all the IAB-specific parameters, such as BH RLC channels, BAP addresses, routing tables, etc. |
| vivo | Reduction of service interruption | The intention of the feature DAPS is to achieve 0 ms user plane latency, i.e., to reduce the service interruption. Essentially DAPS is an HO procedure (during the transition period), but robustness and load-balancing require a continuous state that lasts relatively long (such as DC). Thus we are concerned that DAPS is not an appropriate solution for the robustness and load-balancing use cases. |
| Fujitsu  | None  |  |
| Qualcomm | Reduction of service interruption | There may be some benefits to have simultaneous connectivity on source and target paths during IAB-MT migration to recover in-flight packets from/to descendant nodes. This implies that simultaneous connectivity also needs to be supported on the UL.The benefit may be limited since there are other factors, such as IPsec establishment, which dominate the interruption time.We do not believe that such a DAPS-like solution should be used for load balancing, since load balancing can already be handled via NR-DC.  |
| Sharp | Reduction of service interruption | Although benefits for the use case depend on how the “DAPS-like” solution is designed. |
| Convida | Reduction of service interruption | We agree with Kyocera about the view of Rel-16 DAPs. DAPs-like is for reduction of service interruption. |
| Apple | Reduction of service interruption and maybe load balancing in some use cases | We have some sympathy for E/// views, that a DAPS like solution could be beneficial in the case reduction in service interruption. There might also be some benefits with load balancing options as discussed in Q5 so a further (final?) discussion may be beneficial as the main concern is the amount of spec changes needed to make this kind of solutions work.  |
| Futurewei | Reduction of service interruption for singly connected IAB node | We can consider a DAPS-like approach for reduction of service interruption in the case of single connected IAB node.We agree with other companies in that neither load-balancing nor robustness could be addressed with a DAPS-like solution. We also agree with LG, that reduction of service interruption can also be achieved via DC. |
| NEC | Reduction of service interruption | We think Rel-16 DAPS was introduced for reduction in user data interruption during handover, so it’s still applicable to IAB.  |
| ZTE | Reduction of service interruption | It was already agreed in RAN3 that NR-DC is considered as a baseline for simultaneous connectivity to two parents. In our view, load balancing and robustness could be achieved by NR-DC. For inter-donor migration scenario, DAPS-like solution could be use to reduce the service interruption which is similar as R16 DAPS.  |
| Intel | None | In RAN3 LS, RAN3 discussed DAPS-like solution under the assumption that IAB node is simultaneously connected to two IAB donors. From RAN2 point of view, Rel-16 DAPS is introduced to reduce service interruption during UE handover from one cell to another, where dual protocol stacks only exist during handover (temporarily exist for a short period). Rel-16 DAPS is not introduced for dual connectivity purpose. Besides, as discussed in R2-2100360, there’s a lot of limitation of DAPS HO which may not be beneficial for IAB network.For inter-donor topology adaptation, full migration from one donor to another may only happen 1) when RLF recovery is failed between IAB node and IAB donor direct link (suitable for both single connected and dual connected IAB node migration); 2) load balance. For the first case, DAPS HO is not applicable since the source path is already failed. For the second case, NR-DC can also achieve load balancing. |

In RAN2#112e, RAN2 deprioritized DAPS implicitly because it is not clear how to support DAPS of no PDCP in IAB-node. However, RAN3 agreed DAPS-like solution in RAN3#110e at the same time. Since it is not clear what the DAPS-like solution is, we need to confirm the basic understanding on DAPS-like solution.

Generally speaking, when the migration IAB-node performs inter-CU handover, the serviced UEs (including the UEs in subtree) have to perform handover with PDCP re-establishment. Similar to Rel-16 DAPS handover, dual-PDCP sublayers should be applied. In this case, other nodes (such as IAB-donor, UE’s accessed IAB-node and UE) will be impacted. If the migration IAB-node performs intra-CU migration, it is possible that PDCP sublayer is not involved. In this case, only the migration IAB-node is impacted. So we would like to confirm the involved sublayers and nodes for better understanding.

For clarification, potential DAPS-like architecture discussed in [3] is shown below. Note that during the discussion in [3], it was not decided there are one or two BAP entities in the migration IAB-node(IAB3) for DAPS-like. Our concern is, for inter-donor migration, the two parent IAB-nodes (IAB1 and IAB2) connects to two donor-CUs. If user data come from two donor-CUs and then from two PDCP entities (with independent ciphering, header compression), to reduce service interruption, more issues need to be considered except dual-protocol for the migration node.



Figure 1 Potential DAPS-like architecture for the migration IAB-node

**Q8: Should PDCP sublayer be involved in DAPS-like solution? (Do we need to consider the scenario that user data come from two donor-CUs when IAB-node performs migration?)**

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| **Company** | **Yes/No** | **Comments (if any)** |
| Kyocera | No for migrating IAB-node | The question is a bit unclear to us. We assume no PDCP involvement in the migrating IAB-node since it has no PDCP layer for user data relaying. We agree for inter-CU migration the PDCP entity in the UE needs to be re-established as the rapporteur pointed out, but it’s not in the migrating IAB-node.  |
| LG |  | If DAPS-like solution is merely to support simultaneous connectivity to two parents, PDCP does not have to be necessarily involved, but then DAPS-like solution is not really different from DC based dual-parent connection. For intra-CU migration with DAPS-like migration, descendent nodes and UEs should not be affected from PDCP point of view.  |
| Huawei |  | Not sure if all companies have the same understanding to interpret the “DAPS-like” solution as “PDCP layer involved DAPS”If we are talking about the UE’s E2E traffic, there should be no PDCP layer at any IAB-node. |
| CATT |  | This question is to clarify if we need to consider the scenario that user data come from two donor-CUs when IAB-node performs migration via dual-protocols connected to both source and target IAB-nodes. If yes, the migration node needs to deliver user data to UEs with corresponding PDCP configuration.We think this scenario is worth to be considered. |
| Ericsson | No in the migrating IAB node | As stated above DAPS-like in our point of view is the architecture in which the classical IAB protocol stack is duplicated; thus, since the IAB node does not have the PDCP, there is no reason to involve the PDCP in this discussion. |
| vivo | No | PDCP should not be involved for the intermediate IAB-nodes. |
| Fujitsu  | No |  |
| Qualcomm | No | PDCP is not involved. We will have simultaneous BH RLC channels on source and target path, in the same manner as for NR DC. The BAP layer cannot be duplicated since it is used for routing, i.e., selection between source vs. target paths in the UL direction. This is the same as for NR DC.  |
| Sharp | No | As pointed out by companies, an intermediate node does not have PDCP for relaying. |
| Convida | No | PDCP should not be involved for the intermediate IAB-nodes. |
| Apple | No | There is no need to bring in the PDCP stack into a DAPS-like solution.  |
| Futurewei | No | Agree with other companies. PDCP is not involved at migrating IAB node, or other intermediate IAB nodes.Agree with QCM’s comment. There is no benefit to duplicate BAP layer. We can use the same protocol architecture at the IAB node as NR DC. |
| NEC | No | PDCP should not be involved for the intermediate IAB-nodes. |
| ZTE | No for migrating IAB node, probably yes for UE | For migrating IAB node, there is no PDCP sublayer for BH traffic and PDCP sublayer should not be involved. However, if UEs are also migrated to target donor, DAPS-like solution may be applied to UEs. In this situation, PDCP sublayer is involved in DAPS-like solution for UEs.  |
| Intel | No | PDCP layer doesn’t need to be involved, DAPS-like solution should be the same as NR-DC. |

**Q9: Based on Q8, which node(s) should be impacted by DAPS-like solution?**

* **Option 1: migration IAB-node only;**
* **Option 2: migration IAB-node and other node/UE, such as the UE’s accessed IAB-node.**

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| **Company**  | **Preferred option** | **Comments if any** |
| **Kyocera** | Maybe Option 1 | It’s unclear to us what kind of DAPS-like solution is referred here, but we think RAN2 should aim to minimize the impacts in general.  |
| **LG** | Option1 | Given legacy UEs, UEs should not be impacted by DAPS-like migration.  |
| **Huawei** | ? | The question seems implying that DAPS-like solution only applies to migration procedure for the use case, which gives the answer to Q7. Some clarification is needed here.Not sure about the intention. Is this to ask whether to support intra-CU or inter-CU DAPS? |
| **CATT** |  | It’s too early to ask the question. We need to clarify Q8 first. |
| **Ericsson** | Option 1 | Only the migrating IAB node is impacted. However, obviously the new parent nodes in the target donor need to receive a new routing table configuration. |
| **vivo** | Option 1 | For any case, the NW change should be minimized and the procedure should be transparent to UE. |
| **Fujitsu**  | Option 1 |  |
| **Qualcomm** | Option 1 | We agree with LG, CATT and Ericsson.  |
| **Sharp** | Option 1 |  |
| **Convida** | Option 1 |  |
| **Apple** | Option 1 | We prefer not to bring in UE modifications into this discussion.  |
| **Futurewei** | Option 1 |  |
| **NEC** | Option 1 |  |
| **ZTE** | See comments | We may start from the design of DAPS like solution for migrating IAB node. If time allows, we may further investigate the DAPS support for descendant UEs. If descendant UEs are also migrated to target donor, DAPS-like solution could be applied to UEs in order to reduce service interruption and reduce data loss (e.g., for DL on-the-fly packets) for UEs.  |
| **Intel** | Option 1 | As we discussed in previous questions, DAPS-like solution for load balancing should be the same as NR-DC. The descendant IAB nodes and UEs can perform the same procedure as topology redundancy. |

RAN3 discussed NRDC and DAPS-like solution for inter-donor migration. NRDC has been taken as baseline. Currently, it is not clear the relationship between DC and DAPS-like solution. In Rel-16, only PCell is kept during DAPS handover for UE. We are not sure if this restriction is applied to DAPS-like solution for IAB-node, that is, only PCell is kept for IAB-node during DAPS-like procedure. Another explanation is that IAB-node can receive data from source path and a redundant path simultaneously. It looks like split data actually.

**Q10: Please provide your understanding on the relationship between DC and DAPS-like solution. For example, do you think only PCell is kept for IAB-node during DAPS-like procedure, or the DL simultaneous transmission comes from source path and a redundant path?**

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| **Company** | **Answer** | **Comments** |
| Kyocera |  | We have no strong view. We assume Rel-16 DAPS is the baseline for DAPS-like solution in general, but we see DL simultaneous reception from MCG and SCG during DAPS-like solution may reduce user data interruption during the migration although it may be complicated.  |
| LG |  | It is immature to discuss this until it is clear what DAPS-like solution really is.  |
| Huawei |  | We are also confused about the difference with NR-DC and DAPS-like. It seems DAPS-like does not provide any additional benefits in addition to NR-DC (please note NR-DC was already agreed by R3).Also, before we have the same understanding on “DAPS-like”, it is hard to clarify what’s the relationship with NR-DC. |
| CATT |  | Referring to Figure 1, we assume in DAPS-like solution, the migration IAB-node should connect to only one parent node before migration is started, and after migration is completed successfully. |
| Ericsson |  | From our point of view, DAPS-like and DC are addressing different use cases.However, it would be more interesting to discuss first about the functionalities for inter-donor adaptation, and the requirements needed. For example, a minimum number of nodes should be impacted by the inter-donor migration, minimum interruption times should occur, and minimal standardization impact should be needed. Then, we can discuss if it is better to adapt DC, or DAPS. |
| vivo |  | We could define DAPS like operation for IAB network if we are sure that DAPS like operation outperforms DC operation for the mentioned purposes.  |
| Qualcomm |  | This question depends on the use case. To support reduction of packet loss during IAB-node migration, simultaneous transport on source and target paths need to be provided to recover inflight packets to/from descendent nodes. It may be sufficient on only use the PCell for this purpose since the traffic load due to these in-flight packets can be expected rather small.If we consider the load balancing use case, keeping only the PCell would not be enough. |
| Convida |  | It is immature to discuss this until it is clear what DAPS-like solution really is. |
| Apple |  | Agree with Qualcomm that it depends on the use case here. If we treat them as independently as two different solutions to tackle the overall problem of RLF and handover in terms of service interruption reduction and load balancing there are both benefits and detriments with either solution. We can also have a combination of them which can complicate things further. So a more accurate question and use case would hel analyze this better.  |
| Futurewei |  | Not sure there is any specific relationship between the DAPS-like solution and DC, other than they have similar protocol stacks at the IAB node. DAPS is a solution for migration of an IAB node with single connectivity.We assume that in-flight downstream data packets can still be delivered via the source path during migration to minimize packet loss and service interruption, while new packets would be delivered via the target path. Upstream data packets would be delivered via the target path only. |
| NEC |  | We think DC and DAPS are different. DAPS is used to enforce DL transmission only, but DC can always be there for both UL/DL. |
| ZTE |  | NR-DC and DAPS-like solution aims at different scenarios. As stated in Q7, load balancing and robustness could be achieved by NR-DC, while DAPS-like solution is used in inter-donor migration scenario to reduce the service interruption. So for inter-CU migration scenario, DAPS like solution is only used for migrating IAB node which dual-connect to both donor CUs for only a short period of time to reduce potential packet loss and interruption.  |
| Intel |  | DAPS-like solution for load balancing is the same as DC-based solution. Hence, we don’t see a need to introduce DAPS-like solution, NR-DC framework can be used to configure dual radio links without supporting simultaneous transmission in source and target/redundant path. |

**Q10a: Since it is difficult to discuss further before we know what DAPS-like is, can we agree to take below figure (consist of two independent protocol stacks “PHY/MAC/RLC” defined in the MT, 1 or two BAPs in the migration node is FFS) as the start of DAPS-like architecture discussion?**



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| **Company** | **Answer** | **Comments** |
| Ericsson | Agree, but | We agree with protocol stack represented in figure. However, we are not sure what the “migration arrow” implies. As in DAPS, the DAPS-like solution should imply that a dual protocol stack should be maintained until the DAPS is deconfigured. |
| Qualcomm | See comment | The protocol stack is the same as for the dual-connected IAB-node. There is only one BAP on the migrating IAB-node since BAP is used to for routing, i.e., selection of source vs. target path. Again, we have done all of this already for NRDC. |
| Convida | Agree in general |  |
| Apple | See comments |  Agree with both Ericsson and Qualcomm. Is RAN2 interested in discussing these solutions (DAPS-like) and NR-DC independently as two separate ones?  |
| Futurewei |  | Agree with comment from Qualcomm. We don’t think there is any issue to be discussed regarding the protocol stack. |
| NEC | No | The key idea of DAPS like HO/load balancing is to separate **duplication detection/re-ordering to migrating IAB node, leaving deciphering/ROHC decompression to UE**. So I think we need both BAP1 and BAP2 in IAB3. |
| ZTE | See comments | It is not clear why we need two BAP entities. We think only one BAP entity is enough.  |

Except for above discussion, some other issues could be identified, such as one or two BAP entities for the migration IAB-node which had been discussed in last meeting.

**Q11: Would you like to discuss more detailed issues for DAPS-like solution? If yes, please provide your comments/explanations for the potential issue(s).**

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| **Company** | **Potential Issues** | **Comments/explanations** |
| LG |  | It is hard to discuss this until what DAPS-like solution really is.  |
| Huawei |  | Agree with LG. |
| Qualcomm |  | We need to first converge on the use case (i.e. Q7). Then, we can discuss what this use case implies. Example: Use case = Reduction of packet loss during IAB-node migration. This requires extension of DAPS from PDCP to BH RLC channels. We also need simultaneous UL transport on both paths. Example: Use case = Load balancing. This would also require that DAPS can be used for multiple cells and that both, source and target paths, can simultaneously sustained for an extended period of time.  |
| Apple |  | Agree with Qualcomm. |
| NEC |  | Agree with LG. |
|  |  |  |

# Conclusion

To be updated

# Reference

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