**3GPP TSG-RAN WG3 #111-e R3-** **211222**

**25 January – 4 February 2021**

**Online**

Agenda Item: 13.2.2

Source: Nokia (moderator)

Title: Summary of email Discussion on Reduction of Service Interruption reduction

Document for: Approval

# Introduction

**CB: # 36\_IAB\_Reduction\_of\_SrvInt**

**CATT**

**Parent node reconfigures itself until it receives a RRC reconfiguration complete message from child node.**

**Introduce an indication message to child node to trigger TNL redirection procedure after parent node migration complete.**

**consider the TNL redirection procedures for all IAB nodes go on simultaneously.**

**Extend Xn HO req message to a per topology signaling to request the migration of all IAB nodes and UEs.**

**Introduce ctxt list in migration request message.**

**Ctxt list includes:**

**- ctxt of migrating IAB node and its descendant node(s)**

**- UE ctxt of UE(s) under the migrating IAB node**

**- UE ctxt of UE(s) under the descendant node(s) of migrating IAB node**

**consider other signaling to replace the ctxt setup procedure for child nodes and UEs between parent nodes and target CU.**

**consider the enhancement to reduce packet loss and unnecessary transmission.**

**SS**

**to support DL transmission over the source path, IAB-MT part can keep the BAP layer related configurations (e.g., BAP address, BH RLC CH configuration, IP address of the source path) and the F1-U tunnels over the source path on per-BH RLC CH basis.**

**IAB-DU can delay transmission of RRCReconfiguration message when certain condition is satisfied, e.g., success RACH at top level migrated node, receive RRCReconfiguration message by the collocated IAB-MT at the descendant node(s).**

**legacy CHO procedure can be reused, and the IAB donor CU can balance the fast recovery and resource reservation by implementation.**

**to combat the UL packet loss, the UL DDS can be applied when the inter-donor-DU re-routing is not applicable, and the enabling of UL DDS can be configured to the IAB node to enabling the packet buffering.**

**to avoid the unnecessary transmission of DL packets, the IAB node can keep the old configurations at source path till the final on-the-fly packet indication is received.**

**QC**

**revisit descendant-node reconfiguration before IAB-MT handover due to potential failure conditions.**

**discuss viable procedures for descendant-node reconfiguration via source path.**

**discuss procedures for concurrent TNL migration of all descendant nodes during intra-donor topology adaptation to reduce interruption time.**

**Extend the NR-UP protocol to support uplink data delivery status reports to enable recovery of packet loss during intra-donor migration.**

**consider local rerouting to reduce packet loss in intra-donor topology adaptation.**

**liaise RAN2 on the local rerouting to reduce packet loss in intra-donor topology adaptation.**

**Intel**

**Immediately upon receiving the RRCReconfiguration message from source path, the parent IAB node should stop granting further UL transmission to its descendant node**

**Fuj**

**consider the following options for F1AP enhancement:**

**- Indicating to migrating node to reuse the old context as the new context of UEs/child IAB-MTs during F1 setup procedure; or**

**- Indicating to migrating node to reuse the old context as the new context of UEs/child IAB-MTs by UE context modification procedure.**

**RRC indication should help the migrating node to differentiate whether the TNL address added is for old F1-C or new F1-C.**

**Nok**

**discuss whether the conditional RRC message delivered via the source path is stored in the migrating IAB-DU or delivered to descendant IAB-nodes.**

**use MOBIKE to reduce the service interruption during inter-Donor-DU topology adaptation.**

**HW**

**In Rel-17, IAB-node still perform RRC Re-establishment for BH RLF recovery.**

**take the procedure shown as a baseline for the inter-CU BH RLF recovery.**

**study the mechanism for IAB-DU recovery (e.g. F1 connection re-establishment, rather than setup) in inter-donor-CU RLF recovery case, to avoid signaling storm in F1 interface between IAB-DUs and new IAB-donor-CU and avoid long term service interruption for connected UEs.**

**discuss behaviors of the descendent IAB-nodes/UEs of the IAB-node recovering to a new IAB-donor-CU via new path, in the following two aspects:**

**- How can descendent IAB-nodes and UEs be aware of the CU change?**

**- Whether descendent IAB-nodes and UEs should re-establish to new IAB-donor-CU with the recovery IAB-node?**

**AT&T**

**A new F1AP-based IAB parent migration indication should be introduced, possibly as part of the CU to DU RRC Information IE to be used for indication of parent IAB node migration to descendant nodes.**

**The proposed F1AP-based IAB parent migration indication should be used to trigger buffering of RRCReconfiguration at the parent IAB-DU of descendant IAB node.**

**The RRCReconfiguration message buffered at the parent IAB-DU of descendant IAB node should be released and delivered when the IAB-MT collocated with the parent IAB-DU of descendant IAB node receives its own RRCReconfiguration message.**

**Discuss procedures to perform concurrent migration of F1 associations of descendant IAB nodes to new TNL addresses along the target path after successful RRC reconfiguration of descendant IAB nodes to reduce service interruption time.**

**ZTE**

**Rel-16 re-routing mechanism is reused in intra-donor DU migration scenario.**

**If inter-donor DU local re-routing is not applicable, the solution of re-transmitting by UE (e.g. delayed RLC status) or re-transmitting by access IAB node (e.g. UL DDS) could be considered.**

**the procedure given is taken as baseline for inter-CU BH RLF recovery.**

**introduce a new XnAP procedure for transmitting the IAB-DU context and F1AP UE context, which is stored at the old IAB-donor-CU from the old IAB-donor-CU to the new IAB-donor-CU.**

**same mechanism is used in both inter-donor migration and RLF scenario to F1-C migration between the migrating/recovery IAB-DU and the target/new donor CU.**

**determine which procedure (RRC Re-establishment or HO) is baseline for updating AS security for descendant nodes of the IAB-node performing inter-CU recovery and consider above options as candidates to update AS security for descendant nodes.**

**E///**

**study solutions for inter-donor RLF recovery, where resource reservation is not done in advance.**

**To avoid packet losses and, consequently, unnecessary UL/DL transmissions during migration, IAB nodes may be provided with the new configuration/actions which is/are executed when an indication (e.g. via BAP or F1AP) is provided to the IAB nodes.**

**\*\*\*\*\***

**- XnAP aspects: ctxt list in XnAP message? (“group HO”?) New XnAP procedure?**

**- F1AP aspects: migration indication?**

**- Behavior w.r.t. reception of RRC reconfiguration?**

**- Any UP aspects?**

**- How to update AS security info to descendants?**

(Nok - moderator)

Summary of offline disc [R3-211003](file:///C%3A%5Ctemporary%5CRAN3%5CRAN3%20Jan21%5CCB%20discussions%5CCB%2036_IAB_Reduction_of_SrvInt%5CInbox%5CR3-211003.zip)Rev in R3-211222

The discussion has two phases:

Phase 1: Enhancements to IAB service interruption (and others) to be discussed in Rel-17

Phase 2: TBD

The deadline for Phase 1 is Thursday, Jan 28th, 12:00 UTC. This allows us to have some further discussion based on the 1st round feedback and discuss intermediate stage in Monday online session. We might be able to already achieve some agreements at this stage.

The deadline for Phase 2 is the same as for all email discussions, i.e., Tuesday, Feb 2nd, 12:00 UTC.

# For the Chairman’s Notes

Propose the following:

**Agree following proposals:**

**For intra-Donor migration:**

Proposal 1: agree using concurrent TNL migration of all descendant nodes during intra-donor topology adaptation to reduce interruption time.

Proposal 2: RAN3 consider following options to support transferring RRCReconfiguration for descendant IAB over source path

* Solution 1: the RRCReconfiguration for the child IAB is buffered in the parent DU, and it is only sent to the child IAB when a condition is satisfied.
* Solution 2: the RRCReconfiguration for the child IAB is buffered in the child IAB-MT, and it is only executed when a condition is satisfied.
* Solution 3: the RRCReconfiguration for the child IAB is not buffered in the parent DU or child IAB-MT, and is executed by the child IAB-MT upon reception. The uplink RRCReconfigurationcomplete message and TNL migration messages from child IAB-MT are buffered in the parent DU until the migrating IAB-MT complete migration.
* Solution 4: by CU proper implementation. CU control the time to send RRCreconfiguration for each descendent IAB-node, the parent node of each IAB-node does not need to buffer their RRCReconfiguration, and each IAB-node can apply the RRCReconfiguration just when receiving it.

Proposal 3-1: agree inter-donor-DU re-routing can be used to address UL packet loss. FFS on other enhancement when re-routing cannot address UL packet loss or re-routing is unavailable; FFS on enhancement to address unnecessary DL transmission

Proposal 4-1: Working Assumption: MOBIKE can be used to reduce service interruption during Intra-CU Topology Adaptation. FFS whether it affects RAN3 specification.

Proposal 4-2: Agree the draft LS (R3-211223) to SA3 for feedback on using MOBIKE in IAB system.

**Continue discussion on following:**

* FFS whether/how Group Signaling can be used during intra-donor topology adaptation to reduce interruption time

# Discussion

## High-level aspects for Reducing Interruption Time for Intra-donor Topology Adaptation

Contribution ([3]) discuss Rel-16 migration procedure “Rel-16 IAB indicates that the steps of performing RRC Reconfiguration and switching F1-C connections and F1-U tunnels to new TNL addresses can be performed by the descendant IAB-nodes *after* or in *parallel* with the handover of the migrating IAB-node.”

* Observation 1: The bottom-up procedure for reconfiguration of the descendant nodes before IAB-MT handover may incur large delays if the TNL migration is attempted before the target path becomes available.
* Observation 2: The nested procedure for reconfiguration of the descendant nodes before IAB-MT handover may incur large delays if the TNL migration is attempted before the target path becomes available.

Contribution ([3][8]) propose to discuss procedures for **concurrent TNL migration of all descendant nodes during intra-donor topology adaptation to reduce interruption time**.

**Change**

**Q1: Please share your view on using concurrent TNL migration of all descendant nodes during intra-donor topology adaptation to reduce interruption time.**

**To**

**Q1: Please share your view on descendant IAB’s TNL migration can be performed in parallel of parent IAB’s TNL migration, i.e. when descendant IAB starts the TNL migration, it does not need to wait for the completion of parent’s TNL migration.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| QC | Yes, concurrent TNL migration of all descendant nodes may significantly reduce interruption time and should be discussed.  |
| Samsung  | Yes. Precisely speaking, it should be **nearly concurrent TNL migration**.  |
| CATT | It is reasonable, and we also support it in our paper. |
| Intel | The nested bottom up approach as depicted by [3] and [8] with pre-sending the RRCReconfiguration save time by not having to send RRCReconfiguration on the target path. So, once the migrating IAB has completed the handover and the target path is available. The TNL migration of the descendant can started right away |
| Lenovo | Yes, concurrent TNL migration for all descendant nodes as much as possible. |
| ZTE | Agree to use concurrent TNL migration for descendant nodes. |
| Huawei | To be honest, we are not convinced on the obvious benefit of the concurrent TNL migration, especially when considering the cost of potential new specification impact (e.g. solution 1 and solution 2 in the following 3.2 part) to achieve that. From our view, the key point for the service interruption reduction if intra-CU migration, is not be the strict concurrent TNL migration. Instead, the key issue is that the descendent nodes and the top-level IAB-DU should initiate the TNL migration as soon as possible **after** the target path is available. Then the F1 transmission can be resumed fast, and will be beneficial for reducing service interruption time. However, this can also be achieved by CU’s proper implementation. For example, as one possible case, CU send RRCReconfiguration to the descendent nodes via the **target path** as soon as possible after the migrating IAB-node access the target parent node. Compared to such simple solution which has been supported in R16, the only gain of pursuing concurrent TNL migration is saving the time which is needed for CU to send RRC reconfiguration to the parent node of each descendent IAB node, since this step can be done in advance via the south path. However, the whole time for such F1AP message(including the RRCreconfiguration to the descendent nodes) is short, and CU can send RRCReconfiguration to different descendent nodes concurrently, so the gain will be very limited. And it is not worthy to discuss variable solutions for pursuing such limited gain.Besides, as another case, CU decides when to send the RRCReconfiguration to descendent node **via the source path** first and when to the migrating IAB-node, so it can ensure the time interval be short enough, and the descendent nodes need time to proceed with the RRCreconfiguration as well as prepare the TNL migration related messages. At the same time, the migrating IAB-MT performs access to the target parent node. Therefore, if the time interval is controlled properly, the time need from the descendent nodes to success its TNL migration will not so long.  |
| **Ericsson** | The idea of expediting the migration is sensible, but we should not spend efforts on multiple approaches. For example, the bottom-up approach should be deprioritized as it is inherently slower. **Why do we need multiple approaches in the first place?**Based on QC and AT&T proposal, we propose to generalize the discussion as follows:**Proposal: RAN3 to consider reduction of service interruption time at migration by means of group signaling.** |
| AT&T | We agree with Ericsson’s proposal |
| Nokia | The term “concurrent” causes confusion. It is not accurate. In Rel-16 topology adaptation, the descendant IAB can only initiate the TNL migration after its parent has completed the TNL migration. This causes delay, especially for the descendant IAB. Contribution ([3]) propose the descendant IAB can start TNL migration, **without waiting for the completion of the parent’s TNL migration.** So the descendant IAB’s TNL migration may be performed in parallel of parent’s TNL migration. Regarding to HW comment, if the RRCReconfiguraiton to child IAB is sent via the **target path**, this RRC is first sent to the DU in migration IAB via F1AP msg. This means the TNL migration has to be completed for the migration IAB (e.g. IPSec is setup, new SCTP is setup, F1-C is migrated). This is same as Rel-16. The issue is described in 2.1.2 of Contribution ([3]). Without enhancement, sending via source path does not work, e.g. when CHO is used for the migrating IAB. Regarding to Ericsson comment, this question does not care the group signaling (or do not know what the group signaling means).  |
| Fujitsu | Yes, concurrent TNL for descendant nodes should be supported. |

**Summary:**

* 8 out of 11 companies agreed with using concurrent TNL migration of all descendant nodes during intra-donor topology adaptation to reduce interruption time, i.e. when descendant IAB starts the TNL migration, it does not need to wait for the completion of parent’s TNL migration.
* 2 companies proposed to use group signaling. Since no contribution proposed group signaling, it is unclear how it works, and whether the group signaling is related to the concurrent TNL migration. It is suggested to have further discussion on group signaling, e.g. call flow, in next meeting.
* 1 company have question on the benefit of concurrent TNL migration.
* Considering the majority view, it is proposed to agree “using concurrent TNL migration of all descendant nodes”

**Potential Proposal:**

**Proposal 1: agree using concurrent TNL migration of all descendant nodes during intra-donor topology adaptation to reduce interruption time.**

**To be continued in next meeting:**

* FFS whether/how Group Signaling can be used during intra-donor topology adaptation to reduce interruption time

## Transfer RRCReconfiguration for descendant IAB over source path

Last meeting agreed:

The RRCReconfiguration to the descendant IAB can be transferred via the source path, i.e. before the migrating IAB detach from source parent cell.

Contribution ([2][3][8]) propose the RRCReconfiguration is buffered in the parent DU and the parent DI deliver the buffered RRC message to child IAB when a condition is satisfied (e.g. when the migrating IAB connect to target parent).

Contribution ([6]) propose to also consider another option that the RRCReconfiguration is buffered in the descendant IAB, and the buffered RRC message is executed only when a preconfigured condition is satisfied (e.g. when the migrating IAB connect to target parent).

* Solution 1: the RRCReconfiguration for the child IAB is buffered in the parent DU, and it is only sent to the child IAB when a condition is satisfied.
* Solution 2: the RRCReconfiguration for the child IAB is buffered in the child IAB-MT, and it is only executed when a condition is satisfied.
* Solution 3: the RRCReconfiguration for the child IAB is not buffered in the parent DU or child IAB-MT, and is executed by the child IAB-MT upon reception. The uplink RRCReconfigurationcomplete message and TNL migration messages from child IAB-MT are buffered in the parent DU until the migrating IAB-MT complete migration.
* Solution 4: by CU proper implementation. CU control the time to send RRCreconfiguration for each descendent IAB-node, the parent node of each IAB-node does not need to buffer their RRCReconfiguration, and each IAB-node can apply the RRCReconfiguration just when receiving it.

Following aspects need to be considered:

* In Solution 1, how does the parent DU know which RRCReconfiguration message should be buffered?

Contribution ([8]) proposes Donor-CU includes an indication in the F1AP message, to inform the parent DU that the *CU to DU RRC Information* IE contains an RRCReconfiguration message that needs to be buffered due to an upstream IAB node migration.

* How to handle the buffered RRCReconfiguration in case the migration of the parent node fails?

For Solution 1, Contribution ([3]) proposes 2 options: 1) **Option 1**: Release the child node’s buffered RRC Reconfiguration message to the respective child node. The released message may carry an obsolete configuration which will be overwritten by the BH RLF recovery procedure. 2) **Option 2**: Forward a buffered dummy message to the child node and discard the child node’s buffered RRC Reconfiguration message. The dummy message carries the same PDCP SN as the child node’s buffered RRC Reconfiguration message and is received from the IAB-donor-CU as part of the same F1AP message as the child node’s RRC Reconfiguration message. A child node that receives a dummy message may further release a dummy message for its own grand-child node. This needs RAN2 feedback.

For Solution 2, this may need to be discussed in RAN2.

* What happens if Donor-CU wants to send another RRCReconfiguration message to the descendant IAB-MT while the RRCReconfiguration message due to parent IAB-node migration is still pending?

**Q2-1: Please share your view on how to deliver the RRCReconfiguration for descendant IAB via source path (e.g. solution 1, or solution 2, or any other solution).**

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| **Company** | **Comment** |
| QC | Both solutions work for INTRA-donor migration.For solution 1, the release of the RRC Reconfiguration messages creates a hop-by-hop indication that triggers the TNL migration at the next-tier nodes, which is very fast.For solution 2, a separate indication has to be defined to trigger the application of the new configuration at the child IAB-MT in order to achieve the same purpose.NOTE: Solution 1 can also be applied to UEs for INTER donor migration. Solution 2 can NOT be applied in this case. |
| Samsung | We prefer to Solution 1. As analyzed by QC, solution 1 is fast and can be applied for both intra-/inter- donor migration. Moreover, solution 1 introduces less impact, which is only in RAN3.  |
| CATT | We also discussed this issue in R3-210102, and we prefer other solution. Specifically, the child node executes the RRC reconfiguration message and sends the RRC reconfiguration complete message to parent node. Due to the redirection of TNL between parent node DU and donor CU is not happened, the RRC reconfiguration complete message can only be sent to parent node. When the parent node receives RRC reconfiguration complete message from child node, it begins to reconfigure procedure. There is a similar problem as solution 2, how to parent node recognize a RRC reconfiguration complete message from child node. One potential solution is introducing one bit in BAP packet to indicate that it is a RRC reconfiguration complete message from child node. i.e., indicate parent node to start reconfigurationFurthermore, the sentence of solution 2 would cause some misunderstanding. “Precondition” is not clear. Solution 2 requires an indication from parent node rather than precondition. |
| Intel | Solution 1 is preferable as it does not require a new indication |
| Lenovo | We prefer to Solution 1. |
| ZTE | Except for solution 1 and 2, another potential solution is that the RRCReconfiguration for the child IAB is not buffered in the parent DU or child IAB-MT, and is executed by the child IAB-MT upon reception. And the uplink RRCReconfigurationcomplete message and TNL migration messages from child IAB-MT are buffered in the parent DU until the migrating IAB-MT complete migration.  |
| Huawei | Based on our feedback in Q1, we think the motivation for pursuing concurrent TNL migration is unclear, so we suggest to delay discuss the solutions until we have consensus on Q1. And we provide solution 4: by CU proper implementation. CU control the time to send RRCreconfiguration for each descendent IAB-node, the parent node of each IAB-node does not need to buffer their RRCReconfiguration, and each IAB-node can apply the RRCReconfiguration just when receiving it.Besides, the intention of the solutions is to ensure that the TNL migration of descendent IAB nodes being performed as soon as possible after the target path via top-level IAB-MT is ready. So UE does not need to be considered.  |
| **Ericsson** | We prefer solutions 1 and 4. |
| **AT&T** | We prefer Solution 1 because it has less specification impact, is faster, and works for both intra- and inter-donor migration cases.  |
| Nokia | For Solution 1, it has some issues, e. g. the last bullet above Q2-1, taking into account the following aspects:* An RRCReconfig buffered at parent DU consumes a PDCP Sequence number on the SRB of the child MT / UE;
* Receiving PDCP SNs out of order results in reordering delay at PDCP of the child MT / UE, including (and particularly) on SRBs;
* For security reasons the donor CU cannot send out different RRC messages that are protected using the same PDCP SN.

The scenario could be:* mobility of a UE from its parent IAB node;

occurrence of one particular migration event after several possible ones have been prepared.For Solution 2, it may be highly up to RAN2. For Solution 3, it does not work when CHO is used for the migrating IAB. Even for using normal HO, it may have the issue, e.g. when the migrating IAB reconnect to a different parent, how to handle the Complete message? For Solution 4, it is same as Rel-16. The issues is discussed in our comment on Q1. Since solutions have RAN2 impact, this may need to be checked with RAN2 before make a decision.  |
| Apple | We prefer solution 1 as it has the minimal spec impact. Solution 2 is up to RAN2 to decide. Solution 3 in some sense is an extended Solution 1 which can add additional complexity.  |
| Fujitsu | Agree with QC’s analysis. Solution 1 introduces less impact and effect than Solution 2 from RAN3 perspective. Solution 2 relies more on RAN2. |

**Q2-2: Please share your view on the impact to RAN3, e.g.**

* **For Solution 1, it requires new indication in F1AP message, etc.**
* **For Solution 2, any impact to RAN3?**

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| **Company** | **Comment** |
| QC | Solution 1 needs indicator in F1AP.Solution 2 needs an indicator in RRC. Solution 2 also needs an additional L2 message to kick off RRC execution. This requires RAN2 input. |
| Samsung | Agree with QC. The impact of solution 2 is in RAN2 scope |
| CATT | Solution 1: F1AP is neededSolution 2: it required a BAP indication (maybe) to trigger RRC reconfiguration of child node after parent node connect to target path  |
| Intel | Agree with QC |
| Lenovo | Solution 1 needs indicator in F1AP.Solution 2 needs further discussion for RAN2, if needed. |
| ZTE | For solution 1 and 2, agree with QC. For solution 3, an indicator is needed in F1AP message which includes Reconfiguration messages. Also new L2 message is needed to indicate whether the migrating IAB-MT has migrated.  |
| Huawei | Solution 1 requires new indication in F1AP, and need to solve additional problem e.g. how to handle the buffered RRCReconfiguration when BH RLF, and how to proceed with new RRCReconfiguration if the old one still buffered at parent node?Solution 2 do not has RAN3 impact, instead, some RAN2 work will be necessary. Solution 3 proposed by ZTE seems can be achieved by parent IAB-node implementation. Solution 4 does not have spec impact. |
| **Ericsson** | Solution 1 incurs F1AP impact. Solution 2 RRC or BAP impact. |
| **AT&T** | Agree with QC |
| Nokia | Agree with QC. RAN3 impact from Solution 2 depends on how the trigger indication from the parent DU is specified. |
| Apple | Also agree with Qualcomm. Solution 2 has RAN2 work but not RAN3.  |
| Fujitsu | Solution 1 needs new indicator in F1AP. The evaluation and impact of solution 2 is RAN2 scope. |

For Solution 1, Contribution ([2]) proposes the condition for sending the buffered RRCReconfiguration message could be:

* In the migrating IAB, the condition could be when the migrating IAB completes the RACH.
* In the descendant IAB, the condition could be when the IAB receives its own RRCReconfiguration. For example, when IAB2 receives its own RRCReconfiguration, IAB2 send the buffered RRCReconfiguration to its child IAB (e.g. IAB3).

Contribution ([1]) proposes “Parent node reconfigures itself until it receives a RRC reconfiguration complete message from child node.” This seems indicate the descendant IAB only execute the RRCReconfiguration after the child IAB completes the Reconfiguration.

For Solution 2, since the descendant IAB-node is not aware when the parent IAB-node has successfully connected to the target, a new indication from the parent DU to descendant IAB-node has to be introduced. This indication could, for instance, be a BAP control PDU. The condition to execute the buffered RRCReconfiguration could be the reception of the indication from parent node.

**Q2-3: Please share your view on the condition (i.e. the condition to send the buffered RRCReconfiguration and when execute the RRCReconfiguraiton in Solution 1, the condition to execute the buffered RRCReconfiguration in Solution 2)**

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| **Company** | **Comment** |
| QC | Solution 1: The migrating IAB-node should send the buffered RRCReconfiguration AFTER successful RA procedure, and the descendent nodes should send the buffered RRCReconfiguration AFTER reception of the RRC Reconfiguration from its parent node. The RRCReconfiguration should be executed upon reception.Solution 2: The migrating IAB-node should send the L2 indication AFTER successful RA procedure, and the descendent nodes should send the L2 indication AFTER reception of the L2 indication from its parent node. The RRCReconfiguration should be executed upon reception of the L2 indication. |
| Samsung  | Agree with QC |
| CATT | Agree with QC |
| Intel | Agree with QC. It also need RAN2 input on adding a new indication |
| Lenovo | Agree with QC for Solution 1.Solution 2 needs further discussion for RAN2, if needed. |
| ZTE | Agree with QC |
| Huawei | First, we think it is essential to first get consensus on Q1 before we discuss these possible solution 1 and solution 2.Regarding this Q2-3, besides the condition proposed by QC, another possible condition for sending the buffered RRCReconfiguration in solution 1 is that migrating IAB-node receives its own HO command, and such condition also applicable for solution 2 (the migrating IAB-node send indication to child node after receiving its own HO command) |
| **Ericsson** | In principle, wrt Solution 1, we agree with QC, but **we should first converge on Q2-1.**Regarding **solution 2,** we think the discussion could be generalized i.e. **other triggers may be considered as well.**So, we should **discuss at the preconditions for configuration activation,** since it is a bit **difficult to speculate without high-level procedure in place.** |
| **AT&T** | Agree with QC |
| Nokia | Agree with QC |
| Apple | Agree with QC  |
| Fujitsu | Agree with QC. |

**Indication to descendant IAB**

Contribution ([1]) propose to introduce an indication message to child node to trigger TNL redirection procedure after parent node migration complete, e.g. Step 14 and 16 in below figure.



Figure 1 Intra-CU migration for reducing service interruption

**Q2-4: Please share your view on the indication to descendant IAB**

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| **Company** | **Comment** |
| QC | The indication in this figure represents the L2 indication of solution 2.The procedure shown in Figure 1 is a bottom-up procedure. Note that this procedure ONLY works with solution 2. The float chart is NOT correct: Step 5 should occur AFTER step 16, and step 8 should occur AFTER step 14. Note that the nested procedure works with both, solution 1 AND solution 2. |
| Samsung | Agree with QC’s analyze. The idea of this indication is aligned with the solution 2. So, we don’t need a separate discussion for this.  |
| CATT | The indicator messages in the step 14 and step 16 are not used for trigger RRC reconfiguration for child node, they are used to kick off TNL redirection procedure of child node after parent node finished the TNL redirection. Since the child node does not know when to trigger a TNL redirection procedure.  |
| Intel | The indicator is needed for the bottom up approach |
| Lenovo | This is not aligned with principle of the Q1. |
| ZTE | Agree with Samsung. |
| Huawei | If with solution 2, the indication to descendent IAB nodes are needed. But not sure, why some companies restrict this to the bottom-up procedure? It can also be the nested procedure also, but the sequence is not so important for this issue. |
| **Ericsson** | We are against bottom-up procedure**,** but we **agree with Huawei that this is not necessarily tied to the bottom-up** approach. |
| **AT&T** | Agree with QC. We prefer the nested procedure and don’t like the bottom-up approach. |
| Nokia | This is for the Solution 3 mentioned in Q2-1 section. (not for Solution 2. In Solution 2, Step 5 should occur AFTER step 16, and step 8 should occur AFTER step 14. ) |
| Apple | Agree with Samsung and QC here.  |
| Fujitsu | Agree with QC’s view that this figure is used only with solution 2. However, we understand this flow chart can be used for both bottom-up procedure and nested procedure.Step 5,8,10 execute new TNL configuration and then set up new F1 association with the target donor since the RRC configurations in step 4,7,9 configure the new TNL and trigger the new F1-C setup. Step 12,14,16 trigger TNL redirection and BH link, BAP routing reconfiguration, and then step 13,15,17 carry out the TNL redirection and the BH link, BAP routing configuration along the target path. |

**Summary:**

**For Q2-1:**

* 7 out of 12 companies prefer Solution 1.
* 2 companies prefer Solution 2.
* 2 companies prefer Solution 3.
* 2 companies prefer Solution 4.
* It is suggested to agree a Working Assumption to adopt Solution 1. This also gives companies opportunity to further study the issue in next meeting.

Other questions can be discussed when the Solution 1 is confirmed as agreement in next meeting.

**Potential Proposal:**

**Proposal 2: Agree Working Assumption “Solution 1 is adopted to transfer RRCReconfiguration for descendant IAB over source path”**

* Solution 1: the RRCReconfiguration for the child IAB is buffered in the parent DU, and it is only sent to the child IAB when a condition is satisfied.

[Huawei]:Disagree with this proposal, since some solutions (e.g. solution 2) still pending RAN2 analysis. And some companies also proposal new solutions (solution 3 and 4) need more comparison. At current stage, suggest to keep all the solutions and discuss for further step. So we suggest remove Proposal 2.

Moderator: Based on most comments, it is proposed as a WA, which still allow companies to further study it in next meeting.

## UL Packet loss and unnecessary transmission

During inter-Donor-DU migration, some UL/DL packets may be lost.



Figure 1:Packet loss during intra-donor migration: 4a: Packet loss in downlink, 4b: Packet loss in uplink

For DL, donor CU can discover the packet loss via current DDDS or PDCP status report, and recover the packet loss via retransmission. There may be no need for any enhancement.

For UL:

* Contribution ([2][3]) propose to introduce an uplink version of the F1-U DDDS (UL DDS).
* Contribution ([1] [3] [9]) proposes to also consider re-routing.
* Contribution ([9]) proposes the solution of re-transmitting by UE (e.g. delayed RLC status) or re-transmitting by access IAB node (e.g. UL DDS) could be considered, if re-routing is not applicable.
* Contribution ([10]) proposes IAB nodes may be provided with the new configuration/actions which is/are executed when an indication (e.g. via BAP or F1AP).
* Additional proposal to consider: prior to migration, the parent can poll a child IAB node (IAB-MT) to send a BSR, which speeds up the delivery of UL packets.

The unnecessary transmission is related to the “on-the-fly packets are buffered at the intermediated nodes towards the destination”. If these packets are transmitted after the migration, they may be discarded. It may waste the resource if continuous the transmission for the related packets.

* Contribution ([2]) propose the IAB node can keep the old configurations at source path till the final on-the-fly packet indication is received, to avoid the unnecessary transmission of DL packets.
* Contribution ([4]) proposes “Immediate upon receiving the RRCReconfiguration message from source path, the parent IAB node should stop granting further UL transmission to its descendant node.”
* Contribution ([10]) proposes IAB nodes may be provided with the new configuration/actions which is/are executed when an indication (e.g. via BAP or F1AP) is provided to the IAB nodes.

**Q3: Please share your view on how to address the UL packet loss, and unnecessary transmission?**

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  | QualcommUL packet loss can be mitigated using UL DDS which has the same merits as DDDS. As DDDS, UL DDS relies on packet loss for packet recovery.Local rerouting avoids unnecessary transmissions by reducing packet loss assuming packets are not filtered at the target-path donor DU. This means that local rerouting may NOT always work for inter-donor-DU migration.The F1AP or BAP indicator needs more discussion. It could be combined with the RRC Reconfiguration discussed in solution 2 above (section 3.2). In solution 1, the parent node could send a L2 indicator to the child node to stop UL transmission as soon as it has received and buffered the child’s RRC Reconfiguration message. |
| Reducing grants for UL transmission is up-to-implementation.Samsung  | For UL packet loss:UL DDS and inter-donor re-routing can solve the problem. If inter-donor re-routing is always available, UL DDS may not need. However, this requirement cannot be always guaranteed. So, we need UL DDS as well when inter-donor re-routing is not available, i.e., * Inter-donor re-routing
* Configurable UL DDS, i.e., configure to use UL DDS if inter-donor re-routing is not available.

For unnecessary transmission The intention is to deal with the on-the-fly packets buffered at the migrated IAB node and its descendant node(s). Moreover, we need discuss it for DL and UL separately.  For DL, each of those node should keep the configuration of the source path. When to release those configurations is determined by when the final packet from the source path is received. Thus, a *final on-the-fly packet indication* needs to be sent to the IAB node.  For UL, the on-the-fly packets contain the old source IP address, old BAP routing ID. The old source IP address cannot be updated since IAB node protocol stack indicates that IP layer processing is not allowed. To solve this problem, the configurable UL DDS or inter-donor rerouting can work. The old BAP routing ID may not be routable in the target path. To solve this problem, either updating BAP routing ID or a default BAP routing for all packets without matched routing entry can be applied.  |
| CATT | For UL packet loss, we support local re-routing and UL DDS. If local re-routing cannot work, we may consider the UL DDSFor unnecessary transmission, it means in-flight packets which are sending on the source path while migrating IAB node is migrating or already connected to target path. For UL, as long as source donor DU does not remove the context of migrating IAB node and descendant nodes, the UL in-flight packet can be sent to donor DU via source path (between source donor DU and migrating IAB node). For DL, a finial indication added by donor CU is needed. |
| Intel | * UL packet loss:
* UL DDDS is complicated, it introduces a new protocol
* RAN3 should support local rerouting
* Delayed RLC status need RAN2 input
* F1AP or BAP indication: Agree with QC comment. We can combine then with RRCReconfiguration buffering scheme

Unnecessary Transmission:* If we adopt the pre-sending and buffer the RRCReconfiguration message at parent node according to [3], then it is good idea to let the parent know that blocking uplink transmission is permissible. If we just let implementation to do it, then each IAB node will behave differently.
 |
| Lenovo | For UL packet loss:Since inter-DU re-routing will be supported in this release. And it’s sufficient to resolve the UL packet loss problem during migration.For unnecessary transmission:UL: The UL packet can continue to be transmitted to boundary IAB node, and then rerouted to the target path. Therefore, there is no problem for UL unnecessary transmission.DL: In order to correctly receiving the in-flight downlink data in the source path, IAB node can keep the old configurations at source path. However, the time to release the configuration can be up to implementation. |
| ZTE | For UL packet loss, re-routing could be used if it is available. If re-routing is not available, the solution of re-transmitting by UE (e.g. delayed RLC status) or re-transmitting by access IAB node (e.g. UL DDS) could be considered. And the former one is slightly preferred since no RAN3 impact is needed. For downlink unnecessary transmission, stop indication needs to be delivered to migrating IAB node’s upstream nodes in order to avoid that packets are delivered via source path after migrating IAB node migrates to target path. In addition, migrating IAB node and downstream nodes can keep the old configurations at source path and the release of the old configurations could be up to implementation. For uplink unnecessary transmission, migrating IAB-DU and downstream nodes could stop UL scheduling after receiving the HO cmd message for the collocated IAB-MT.  |
| Huawei | UL packet loss: prefer local re-routing. The UL DDS can solve the intra-CU packet loss problem but not applicable for inter-donor case, with the cost that the access IAB node buffer a large number of UL packets for a long time. In contrast, the intra-donor DU re-routing is supported in R16, and R17 will support the inter-donor-DU re-routing according to the agreements in last meeting. So the local re-routing is enough to solve the packet loss problem.For unnecessary transmission: With local re-routing, the UL packet will be forwarded to the original destination (e.g. the source CU) and can be deciphered correctly. Then there is no “unnecessary transmission” for UL.For DL, the DL packets has not been forwarded to the migrating IAB node will be discarded when the context related to the migrating IAB node is released. So no enhanced solution is needed. |
| **Ericsson** | UL packet loss:* We are against the UDDS as it is a very complex solution. Besides, we agreed at RAN3#109-e that **end-to-end UL flow control is deprioritized in Rel17.**
* The problem can be addressed as proposed in [10] - IAB nodes may be provided with the new actions which are executed when an indication (e.g. via BAP or F1AP). RAN3 should discuss what these actions could be.
* **(Additional proposal):** prior to migration, the parent can poll a child IAB node (IAB-MT) to send a BSR, which speeds up the delivery of UL packets.
* Rerouting can also be considered

Reduction of unnecessary transmissions:* We could consider proposals in [2] and [10].
 |
| **AT&T** | Our preference is to as far as possible avoid using solutions that have UE impact. |
| Nokia | On packet loss, both re-routing and UDDS may work.On unnecessary transmissions, contributions to RAN2 are proposing indications by which IAB nodes can indicate to the parent and child nodes about BAP destinations that, from the indicating node’s point of view, have become unreachable. In this context, a migrating node could indicate that to its child nodes, the migrating node’s former parent could indicate to its parent nodes, and that information could propagate to further descendants and ancestors. |

**Summary:**

**To address UL packet loss:**

* 8 out of 10 companies commented re-routing can be used.
* 3 companies commented re-routing may not always possible, and UL DDS should be developed.
* 1 company commented IAB nodes may be provided with the new actions which are executed when an indication (e.g. via BAP or F1AP), or parent poll child IAB-MT to send a BSR.
* 1 company commented avoid solution that have UE impact.
* Considering the majority view, it is proposed to agree re-routing can be used to address UL packet loss. FFS on other enhancement when re-routing cannot address UL packet loss.

 **To avoid unnecessary transmission:**

* For UL, it is unclear whether the issue still exist when re-routing is supported. 2 companies commented parent send a L2 indication to child to stop UL transmission.
* It is suggested to further study whether the unnecessary UL transmission still exist when re-routing is supported.
* For DL, it is unclear whether this can be addressed by implementation, i.e. the IAB keeps the source configuration for a while, thus all DL transmission becomes “necessary”. 3 companies proposed to introduce a stop indication.
* It is suggested to further study whether any enhancement is needed to avoid the unnecessary DL transmission.

**Potential proposal:**

**Proposal 3-1: agree re-routing can be used to address UL packet loss. FFS on other enhancement when re-routing cannot address UL packet loss.**

**To be continued:**

* whether the unnecessary UL transmission still exist when re-routing is supported.
* whether any enhancement is needed to avoid the unnecessary DL transmission.

## MOBIKE

Contribution ([6]) propose to use MOBIKE (RFC4555) to reduce the interruption. Rel-16 Intra-CU migration is shown in below call flow.



Step 12 contains multiple sub-steps:

• 12a: IAB setup IPSec tunnel and get a new inner IP address. **This is a 4-way handshake.**

• 12b: IAB-DU use new inner IP address to setup new SCTP association with CU. **This is a 4-way handshake.**

• 12c: IAB-DU initiate F1 procedure to inform CU for the new SCTP association and migrate F1-C to new SCTP association. **This is a 2-way handshake**.

• 12d: CU initiate F1 IAB UP Configuration Update, to get IAB’s new inner IP address for DL F1-U, etc. **This is a 2-way handshake**.

• 12e: CU-CP inform CU-UP for IAB’s new inner IP address for DL F1-U. The UL/DL F1-U can be resumed over the target path. **This is a 2-way handshake**.

Step 12 has 14-way handshake in total. By using MOBIKE, Step 12 can be reduced to 6-way handshake as below:

* 12a: IAB initiates MOBIKE procedure to update the outer IP address. The previous assigned inner IP address can be reused with the new outer IP address. **This is a 2-way handshake.**
* 12b: **this sub-step can be omitted**. Since the inner IP address is unchanged, the previously established SCTP association can be used over the new outer IP address.
* 12c: IAB-DU initiates a F1AP procedure to inform CU that inner IP address is reused, and F1-C/U can be resumed via current SCTP association and F1-U tunnel. **This is a 2-way handshake.**
* 12d: **this sub-step can be omitted**. Since the inner IP address is unchanged, no change to DL F1-U tunnel.
* 12e: CU-CP informs CU-UP to resume DL F1-U transmission. 2-way handshake. **This is a 2-way handshake.**

If needed, SA3 can be consulted on MOBIKE.

**Q4: Please share your view on using MOBIKE to reduce the service interruption**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| QC | We agree with the benefits of MOBIKE. RAN3 should support this solution. Also, MOBIKE messages can be sent in parallel with other traffic, which can further reduce the number of signaling handshakes for F1 migration. Since MobIKE is an IETF standard, which has been used elsewhere in 3GPP, we don’t believe SA3 approval is necessary. |
| Samsung | Sounds reasonable. We are not sure if there is any specification impact. To us, it is an implementation issue. In our specification, step 12 indicates the main purpose of such step. How to achieve it depends on the practical implementation.  |
| CATT | It is a good option to reduce the number of handshakes.  |
| Intel | We discussed this in RAN3#109 and concluded we SA3 input |
| ZTE | Agree with Samsung. It seems to be up-to-implementation whether MOBIKE is used. |
| Huawei | Agree with Intel, SA3 input may be necessary.  |
| **Ericsson** | Interesting idea. We are open with either leaving it to implementation or consulting SA3. |
| **AT&T** | It is reasonable to explore the use of MOBIKE to reduce number of handshakes. |
| Nokia | MOBIKE does help. We think this does not need approval from SA3, since it is a further enhancement to IKE. But if companies strongly preferred, we can send a LS to SA3. |
| Apple  | We do agree that MOBIKE might be beneficial but think that an LS to SA3 is needed before going further. |
| Fujitsu | We understand this is depending on implementation and need not be specified in 3GPP standard. |

**Summary:**

* 9 out of 11 companies commented it is beneficial to consider MOBIKE to reduce service interruption
	+ 3 companies commented this may be up to implementation, and no spec impact
* 3 companies prefer LS SA3.
* It is suggested to agree a WA to consider MOBIKE, and LS SA3

**Potential proposal:**

**Proposal 4-1: Working Assumption: MOBIKE can be used to reduce service interruption during Inter-CU Topology Adaptation by implementation.**

**Proposal 4-2: LS SA3 for feedback on using MOBIKE in IAB system.**

if the proposals are agreed in online session, a draft LS to SA3 will be prepared.

## Inter-CU RLF

Contribution ([7][9][10]) discuss the inter-DU RLF.

* Contribution ([7][9]) propose to use RRC Re-establishment for the migrating IAB.
* Contribution ([7]) propose to study

1) Avoid signaling storm in F1 interface between IAB-DUs and new IAB-donor-CU.

2) Avoid long term service interruption for connected UEs.

Contribution ([7]) also propose to discuss how to handle the UE/descendant IAB, e.g.

1) How can descendent IAB-nodes and UEs be aware of the CU change?

2) Whether descendent IAB-nodes and UEs should re-establish to new IAB-donor-CU with the recovery IAB-node?

* Contribution ([9]) propose Xn procedure for transmitting the IAB-DU context and F1AP UE context, which is stored at the old IAB-donor-CU from the old IAB-donor-CU to the new IAB-donor-CU. Contribution ([9]) also propose to discuss which procedure (RRC Re-establishement or Handover) is the baseline procedure for updating AS security for descendant nodes of the IAB-node performing inter-CU recovery, and to consider the above options as candidate solutions to update AS security for descendant nodes.
* Contribution ([10]) propose Xn procedure for context store, where resource reservation is not done in advance.

**Q5-1: Please share your view on high level aspect of inter-CU RLF, e.g. whether use RRC Re-establishment procedure for the migrating IAB, whether the context for UE/descendant remains in Source Donor-CU or is moved to Target Donor-CU, etc.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| QC | This is discussed in AI 13.2.1/CB 34. Both options, i.e., keep context in source CU vs. target CU, can and should be supported. |
| Samsung | Share the view as QC.  |
| CATT | Related to CB 34. |
| Intel | Should discuss it CB34 |
| Lenovo | RRC Re-establishment procedure is the baseline for inter-CU RLF, and the scheme for IAB-DU context fetch needs further study. |
| ZTE | We think that the context for UEs/descendants needs to be transferred from the source donor-CU to target donor-CU. |
| Huawei | We think the RRC Re-establishment procedure should be used for inter-CU RLF. And for the context of UE and descendent nodes, both options are worth to be considered.  |
| **Ericsson** | **Only the top-level IAB-MT** should do the RRC-reestablishmentOnly the context of top-level MT should be migrated, IAB-DU, child MT and UE contexts should remain in the old CU. |
| AT&T | This should be discussed in CB34. |
| Nokia | Agree with EricssonOk if majorities prefer to discuss it in CB34 |
| Apple | To be discussed in CB34 |
| Fujitsu | Using RRC Re-establishment procedure for the migrating IAB and using re-establishment or handover for the descendant nodes/UEs.  |

**Q5-2: in case the context for UE/descendant IAB needs to be moved to target Donor-CU, whether need new Xn procedure, and how to handle the UE/descendant IAB, e.g. using HO procedure or RRC re-establishment procedure.**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| QC | Same as Q5-1 |
| Samsung  | This can be discussed after inter-donor migration is clear. We assume the procedure used for inter-donor migration can be simply applied for recovery case.  |
| CATT | If the context for UE/descendant IAB needs to be moved to target Donor-CU, the new Xn procedure can be considered |
| Intel | Should discuss it in CB34 |
| Lenovo | Agree with Samsung. |
| ZTE | For the first question, agree to introduce a new Xn procedure in case the context for UE/descendant IAB needs to be moved to target Donor-CU. It is FFS whether the new Xn procedure applies for both inter-CU handover case and inter-CU RLF recovery case.For the second question, RRC re-establishment procedure can be taken as the baseline for descendants. Note that the descendant IAB-MTs/UEs of an IAB-node performing inter-CU migration should be treated differently in RLF recovery case and handover case. For example, the RRC Reconfiguration from the target gNB could not be sent to the descendants via the source path in RLF recovery case. |
| Huawei  | We agree that the existing Xn procedure for IAB-MT recovery can not support the context transfer for UEs and descendent IAB nodes. some enhancement are inevitable to support that, this may be achieved through new Xn procedure or enhance of some existing ones.Both options, i.e. using HO procedure or RRC re-establishment can be considered for UE/descendent IAB nodes. |
| **Ericsson** | **In case** RAN3 decides that contexts of descendant devices should be migrated, early context fetch (where resource reservation is not done in advance) should be applied, as proposed in [10]. |
| AT&T | We should discuss this in CB34. |
| Nokia | Ok to discuss it in CB34. |
| Apple | To be discussed in CB34 |
| Fujitsu | New Xn procedure should be considered under handover case of the UE/descendant IAB. For re-establishment case of the UE/descendant IAB, the context is fetched after the target donor-CU receives the RRC re-establishment request.  |

**Summary:**

Most companies prefer this issue to be discussed in CB#34. So this issue can be closed in this CB.

**Potential proposal:**

## Inter-Donor migration (Non RLF)

Contribution ([1][5]) discussed some proposals on inter-Donor migration (non-RLF). Moderator suggest that those enhancements for inter-Donor migration (non-RLF) can be discussed later, for example, once the basic inter-Donor migrating solution is agreed in AI 13.2.1.

## CHO and DAPS

All proposals related to CHO and DAPS will be handled in CB: # 35\_IAB\_CHO-DAPS.

## Other issues/enhancements

**Q8: Please list other issues/enhancements that should be considered? Please include assessment of expected benefit, impact on specification, implementation, other WGs.**

**Proposal (E///): RAN3 to consider reduction of service interruption time at migration by means of group signaling.**

Moderator: There is no contribution on Group Signaling. Let’s continue the discussion in next meeting.

# Part II…[if needed]

If needed

# References

1. R3-210102, Reducing the Service Interruption for IAB (CATT)
2. R3-210217, Discussion on service interruption reduction for Rel-17 IAB (Samsung)
3. R3-210348, Interruption time reduction for Intra-donor IAB-node Migration (Qualcomm Incorporated)
4. R3-210390, Mitigation of Unnecessary Transmission (Intel Deutschland GmbH)
5. R3-210459, Discussion on reduction of service interruption (Fujitsu)
6. R3-210488, Discussion on Reduction of Service Interruption during Intra-Donor Topology Adaptation (Nokia, Nokia Shanghai Bell)
7. R3-210548, Inter-CU RLF recovery procedure (Huawei)
8. R3-210657, Service interruption reduction for intra-donor migration of IAB-node with descendant nodes (AT&T)
9. R3-210716, Discussion on reduction of service interruption in intra-donor migration and RLF recovery scenario (ZTE)
10. R3-210723, Reduction of Service Interruption in IAB Networks (Ericsson)