3GPP TSG-RAN WG2 Meeting #115-e R2-210xxxx

Online, 16-27 August 2021

**Agenda item: 8.4.3**

**Source: AT&T**

**Title: Report from [AT115-e][040][eIAB] Reply LS on reduction of service interruption for intra-donor migration (AT&T)**

**Document for: Discussion and Decision**

# 1 Introduction

This document discusses companies’ views on reduction of service interruption for intra-donor migration, in attempting to achieve consensus on a draft Reply LS to RAN3:

* [AT115-e][040][eIAB] Reply LS on reduction of service interruption for intra-donor migration (AT&T)

 Scope: Reply to R2-2106948.

 Intended outcome: Approved LS out

 Deadline: Monday W2 (for CB if needed)

At RAN2#115, LS from RAN3 [1] was received asking RAN2 to provide views on following two solutions for reduction of service interruption during intra-donor IAB-node migration:

Solution 1:

The RRCReconfiguration message for TNL migration of a descendent node IAB-MT is withheld by this descendant node’s parent IAB-DU, and it is delivered only when a condition is satisfied. The indication of buffering and conditional delivery may be provided by the IAB-donor-CU to the parent IAB-DU via an F1AP message including the RRCReconfiguration message. The condition is set so that a sequential delivery and execution of RRCReconfigurations is created downstream.

Solution 2:

The RRCReconfiguration message for TNL migration of the descendant-node IAB-MT is buffered by the descendent-node’s IAB-MT itself, and it is executed only when an indication is received from the parent IAB-DU. The indication of buffering and conditional execution may be included in the RRCReconfiguration. The condition for initiation and propagation of this indication is set so that it causes a sequential execution of RRCReconfigurations downstream.

RAN2#115 received 9 contributions [2-10], providing views on this topic. In this discussion document, the moderator has attempted to develop initial draft content for Reply LS to RAN3 based on received company contributions. After companies provide feedback on this initial draft content, moderator will develop a draft Reply LS to RAN3 for final review. Companies are encouraged to provide constructive feedback to help progress the discussion.

Deadlines for initial feedback and final review are as follows:

Deadline for feedback on initial content for Reply LS to RAN3: Friday 2021-08-20 2300 UTC

Deadline for feedback on draft Reply LS to RAN3: Monday 2021-08-23 2000 UTC

# 2 Views on Solution 1

All company contributions provided views on Solution 1. Contributions [3], [5], [6], and [10] articulated that Solution 1 has no RAN2 impact. Specifically,

* Contribution [3] observed that the explicit indication in the F1AP message to the parent IAB-DU to withhold the RRC Reconfiguration message to the child IAB-MT, and the determination of target path available to release the child IAB-MT’s RRC Reconfiguration message are both in RAN3 scope and there is no RAN2 impact for Solution 1.
* Contribution [5] discussed further details of Solution 1, including condition for release of RRC Reconfiguration to child IAB-MT and proposed that existing procedures can be reused when the parent IAB-node receives another RRC Reconfiguration before the trigger condition is met. This contribution also concluded that Solution 1 has no RAN2 impact.
* Contribution [6] suggested a different solution other than Solutions 1 and 2 for reduction of service interruption but observed that Solution 1 has no RAN2 impact.
* Contribution [10] observed that Solution 1 requires no RAN2 specification work as it is transparent to RRC. The contribution also observed that in case of unsuccessful random access procedure, the withheld RRC Reconfiguration message can with withheld (in case of successful reestablishment) or it can be dropped/deleted by the IAB-node (in case of unsuccessful reestablishment)

Contributions [2] and [4] were not in favour of Solution 1 and pointed out several issues with this solution. Specifically,

* Contribution [2] articulated that Solution 1 has an impact on RAN2 because in Solution 1, the RRC-Container is no longer transparent to the IAB-DU. In the moderator’s view, this is an incorrect understanding of Solution 1. In Solution 1, the indication to withhold the child IAB-MT’s RRC Reconfiguration is provided in an F1-AP message that is visible to the IAB-DU. Therefore, Solution 1 does not require the IAB-DU to look into the RRC-Container. Hence, there should not be a RAN2 impact, at least from this perspective.
* Contribution [4] observed that the release of withheld RRC Reconfiguration message to child IAB-MT should happen after successful TNL migration and F1-based BAP routing table reconfiguration. The contribution also highlighted issues for Solution 1 in case the migrating IAB-MT’s handover fails, or in case the CU sends a new RRC Reconfiguration message to the child IAB-MT.

Contributions [7], [8] and [9] either showed no preference between Solution 1 or Solution 2 or preferred both solutions. However, all contributions discussed either some issues or proposed some enhancements for Solution 1. Specifically,

* Contribution [7] proposed that the trigger condition for release of withheld RRC Reconfiguration should be F1 migration execution by the IAB-node. The contribution also proposed that upon IAB-node migration failure, the descendent node can remove the withheld RRC Reconfiguration message based on type-4 RLF indication. Finally, the contribution proposed some enhancements to Solution 1.
* Contribution [8] observed that Solution 1 is a CHO command delivery procedure. The contribution observed that Solution 1 has no new impact on UE and that it requires larger buffer for upstream migrating IAB-nodes compared to Solution 2. Furthermore, this contribution observed that Solution 1 is applicable when CHO is not used.
* Contribution [9] proposed that the withheld RRC Reconfiguration message is delivered after routing table for target path is updated at IAB node. The contribution also proposed that the withheld RRC Reconfiguration message shall not be delivered to child IAB-MT if parent IAB-MT migration fails, but subsequent RRC Reconfiguration messages could be delivered after expiration of reordering time expiration.

Moderator’s view is that from the perspective of the Reply LS to RAN3, the focus of this offline discussion should be on identifying potential impact to RAN2 or any major show-stopper issues. Also, as observed in [3] since the determination of target path availability for release of withheld RRC Reconfiguration is within RAN3 scope, any discussion related to trigger conditions for release of withheld RRC Reconfiguration message can be postponed until details of the finalized solution are being worked out.

Finally, regarding enhancements to Solution 1 proposed by some of the contributions. Since details of the solutions are still FFS, it is not productive at this stage to have a detailed discussion on proposed enhancements. Those can be discussed at the appropriate time when either RAN2 or RAN3 is working on details of the finalized solution decided by RAN3. Having said that, it is still useful to review proposed enhancements from the contributions to determine if any of those have a major impact on RAN2. Upon reviewing proposed enhancements from the above contributions, no major RAN2 impact was observed.

Based on the above analysis, moderator asks companies for feedback on the following text proposals to be included in Reply LS to RAN3 with respect to Solution 1:

**Text Proposal 1: RAN2 observes that Solution 1 has no significant impact on RAN2.**

**Question 1: Please comment on Text Proposal 1 wrt Solution 1 for the Reply LS to RAN3.**

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| Company | Comment |
| Huawei, HiSilicon | We would suggest to first discuss the issues mentioned in Text proposal 3 below (also in our contribution R2-2107252), and then we can see if there are major impacts to RAN2. So far we see no good solutions for the identified issues for solution 1.It is true that withholding a RRC message at DU doesn’t have explicit impact to RAN2, but the problem is that the RRC message would consume a PDCP SN, and not sending the PDCP PDU (which contains the RRC message) may cause unexpected problems from RAN2’s perspective. Note that RAN2 design has never expected a network node along the route to withhold a packet intentionally. |
| CATT | Solution 1 has no impact on RAN2 specification.But it has impact on RAN2 regarding “**a subsequent RRC Reconfiguration message for that child IAB-MT**” in TP3. As stated in our contribution: “**If the PDCP SN corresponding to the suspended RRC message is out of PDCP window, the suspended RRC message will never be received by the child IAB node.”** Since it can incur RRC message transmission failure, we cannot consider it after RAN3 decision.For example, The PDCP count value of the withheld RRC message is COUNT1 = [HFN(20bit), SN(12bit)]=[0…01,0…01]. The count value of next RRC message is COUNT2 = [HFN, SN]=[0…01,0…10].When the first RRC message is withheld by the parent node and the next RRC message is transmitted, PDCP entity for SRB1 in IAB node will perform PDCP reordering and deliver the next RRC message to upper layer. After PDCP reordering, the lower edge of the PDCP receiving window (RX\_DELIV) is updated to COUNT2+1. Since COUNT1<(COUNT2 +1), the corresponding PDCP PDU will be discarded even if the withheld RRC message is transmitted to the IAB node later.

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| TS38.323- if RCVD\_COUNT < RX\_DELIV; or- if the PDCP Data PDU with COUNT = RCVD\_COUNT has been received before:- discard the PDCP Data PDU; |

**We propose RAN2 discuss this question first before hasty decision.**  |
| Sony | We agree with Huawei and CATT that RAN2 should addressed those issues before making any decision. |
| Interdigital | We agree with the comments above from Huawei, CATT and Sony that further discussion is required before we can answer that solution 1has no RAN2 impact (as that is likely to be the case only if everything succeeds) |
| Qualcomm | RAN2’s proposed reply on solution 1 should be: **Solution 1 has no RAN2 impact. RAN2 emphasizes that for solution 1, the PDCP SN order cannot be disrupted, i.e., it is not possible to discard a RRC Reconfiguration message.**The alleged problem in TS38.323 mentioned by Huawei, CATT, Sony and IDT can be easily addressed.**Solution to Huawei’s, CATT’s and Sony’s problem:****If a new RRC Reconfig arrives, while the buffered RRC Reconfig has not yet been delivered, the parent will deliver both messages to the child. This child will then perform two IP address changes in sequence, which is not issue at all.****NOTE: RAN2 does not have to make a decision right now. RAN2 has solely been asked to assess the situation.** |
| NEC | We checked the PDCP issue proposed by CATT, but lower edge of PDCP receiving window RX\_DELIV is only updated when the first COUNT VALUE of PDCP PDU equals with RX\_DELIV is received. - if RCVD\_COUNT = RX\_DELIV:- deliver to upper layers in ascending order of the associated COUNT value after performing header decompression, if not decompressed before;- all stored PDCP SDU(s) with consecutively associated COUNT value(s) starting from COUNT = RX\_DELIV;- update RX\_DELIV to the COUNT value of the first PDCP SDU which has not been delivered to upper layers, with COUNT value > RX\_DELIV;But we identified another issue that the PDCP receiving window will be stalled by the withheld RRCReconfiguration, which also cause the new receiving PDCP PDU discarded due to the stalled receiving window. However this is a really corner case since compared to DRB, SRB doesn’t have so many PDCP PDU to send. If it withheld the RRCReconfiguration for a very long time, the RAN2 PDCP may need some enhancement or take care of this issue by some implementation based solution.  |

**Text Proposal 2: RAN2 observes that trigger conditions for release of withheld RRC Reconfiguration at parent IAB-DU in Solution 1 may need further discussion. Such discussion is within the scope of RAN3.**

**Question 2: Please comment on Text Proposal 2 wrt Solution 1 for the Reply LS to RAN3.**

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| Company | Comment |
| Huawei, HiSilicon | Does “release of withheld RRC Reconfiguration” mean to forward the message or to discard the message? |
| CATT | Solution 1 will make the RRC Message receiving error. RAN2 don’t suggest Solution 1. |
| Sony | We think the trigger conditions should be within RAN3 scope. |
| Interdigital | We are also a bit confused with the definition of the “release of the configuration”. If it is referring to the forwarding the message to the concerned child IAB-MT, isn’t it the completion of the handover of the parent node that is the trigger or there is an additional trigger condition.If it is referring to the discarding of the message when the handover fails, then isn’t it the detection of a HOF of the parent node that is the trigger? |
| Qualcomm | We agree with Proposal 2.We don’t understand the confusion by other companies. The message cannot be discarded due to SN consistency of PDCP. |

**Text Proposal 3: RAN2 further observes that there may be additional aspects of Solution 1 requiring further discussion, such as addressing the case of IAB-node migration failure, or the case where an IAB-node with a withheld RRC Reconfiguration message for its child IAB-MT receives a subsequent RRC Reconfiguration message for that child IAB-MT. Since further details of Solution 1 are FFS, it is not clear whether such discussions will identify any further RAN2 impact. However, this can be discussed in RAN2, if needed, once RAN3 has finalized the solution for reduction of service interruption for intra-donor migration.**

**Question 3: Please comment on Text Proposal 3 wrt Solution 1 for the Reply LS to RAN3.**

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| Company | Comment |
| Huawei, HiSilicon | Again, we should not conclude that there is no major impacts to RAN2 even before we discuss the issues.  |
| Sony | We are ok with this. |
| Interdigital | We prefer to have something succinct, for example:**RAN2 observes that there are additional aspects of Solution 1 requiring further discussion, such as addressing the case of IAB-node migration failure (e.g., how to handle the buffered reconfiguration message, how to handle subsequent reconfiguration messages the child IAB-MT may receive via another path, etc).**  |
| Qualcomm | We prepose rewording:**Solution 1 has no RAN2 impact. RAN2 emphasizes that for solution 1, the PDCP SN order cannot be disrupted, i.e., it is not possible to discard a RRC Reconfiguration message.**As we pointed out above: If a new RRC Reconfig arrives, while the buffered RRC Reconfig has not yet been delivered, the parent will deliver both messages to the child. This child will then perform two IP address changes in sequence, which is not issue at all.**What else is there that needs to be resolved by RAN2?** |
| NEC | We are fine with this.  |

# 2 Views on Solution 2

All company contributions provided views on Solution 2. Contributions [2], [3], [5], [6], [9], and [10] discussed RAN2 impact for Solution 2. Specifically,

* Contribution [2] identified the following RAN2 impact for Solution 2: i) In RRC specification, a deactivation indication should be added in RRCReconfiguration for TNL migration; ii) In BAP specification, the preconfigured RRCReconfiguration could be activated by BAP PDU from the parent IAB node.
* Contribution [3] identified the following RAN2 impact for Solution 2: i) A condition is required in the RRC Reconfiguration message to the child IAB-MT for the execution of this RRC message; ii) A L1/L2 indication message needs to be defined which is transmitted by the parent IAB-DU to the child IAB-MT to trigger the execution of the RRC Reconfiguration message.
* Contribution [5] identified the following RAN2 impact for Solution 2: i) Define a new message/indication to indicate the successful RACH procedure of the migrating IAB-node, so that the child IAB-node can execute the stored RRCReconfiguration message; ii) For IAB node configured with a CHO target, additional DL RRC MESSAGE TRANSFER messages carrying the corresponding conditional RRCReconfiguration along with ancestor CHO-configured IAB identity need to be sent to each descendant nodes’ parent node.
* Contribution [6] concluded that Solution 2 would impact RAN2 in terms of creating new indications for the RRC Reconfiguration messages.
* Contribution [9] identified the following RAN2 impact for Solution 2: BAP protocol needs to be enhanced, i.e. a new indication should be introduced to indicate child MT to execute the buffered RRCReconfiguration message and the detailed signaling design is FFS. Additionally, this contribution discussed trigger conditions and proposed that the parent IAB-DU shall send the trigger indication to child IAB-MT after routing table for target path is reconfigured at the parent IAB-DU.
* Contribution [10] identified the following RAN2 impact for Solution 2: i) Indication in RRCReconfiguration signal to store the received RRCReconfiguration, or introduction of a new dedicated message for it; ii) Introduction in TS 38.331 of a new variable where to store the received RRCReconfiguration; iii) Procedures for the child IAB node to discard the stored RRCReconfiguration in case the parent IAB node fails the migration (e.g., new action upon reception of BH RLF indication); iv) New BAP control PDU (sent by the migrated parent IAB-node DU to the descendant IAB-node MT) for the execution of the buffered RRCReconfiguration at the child IAB-node MT.

Contributions [4], [7] and [8] discussed issues related to Solution 2 but did not provide clear views on impact to RAN2. Specifically,

* Contribution [4] reiterated the issue of trigger condition for release of buffered RRC Reconfiguration being related to successful TNL migration and F1-based BAP routing table configuration. The contribution also observed that for Solution 2, in case CU sends a new RRCReconfiguration message to the child node after the buffered RRCReconfiguration message, the new RRCReconfiguration message will be delivered to the child IAB-MT’s RRC layer once its PDCP reorder timer expires. In terms of impact to RAN2, contribution [4] suggested very limited standardization effort related to introducing the L2 indication from parent node to child node, which can be carried through new BAP control PDU.
* Contribution [7] observed that for Solution 2, there may be several paths configured for descendant nodes corresponding to candidate cells of the migrating node, and proposed that the migrating node should inform descendent nodes with the target cell or target DU after it executes CHO and the RA to target cell is successful.
* Contribution [8] observed that Solution 2 is a CHO procedure for which handover is triggered upon an indication from parent IAB node. The contribution also observed that Solution 2 has no new impact on UE, and implied that it requires smaller buffer for upstream migrating IAB node for RRC Reconfiguration message buffering compared to Solution 1. Furthermore, this contribution proposed to use Solution 2 when CHO is supported.

As discussed in the previous section, the Reply LS to RAN3 should focus on impact of both solutions to RAN2 and identify any major issues (e.g. show-stoppers). Company contributions did not identify any major issues for Solution 2. However, a majority of companies did identify RAN2 impact for Solution 2. Based views expressed by companies in contributions, the moderator proposes the following summary of RAN2 impact for Solution 2 to be included in the Reply LS to RAN3 with respect to Solution 2.

**Text Proposal 4: RAN2 observes that Solution 2 is expected to have the following impact on RAN2:**

* **Impact to RRC specification (38.331):**
	+ **Buffering indication added to RRCReconfiguration message for TNL migration or new dedicated message for such indication**
	+ **Definition of new variable to buffer received RRCReconfiguration**
	+ **Procedures for the child IAB node to discard the buffered RRCReconfiguration in case the parent IAB-node fails the migration (e.g., new action upon reception of BH RLF indication)**
* **L1/L2 indication (potentially new BAP control PDU) sent by the migrated parent IAB-node DU to the descendant IAB-node MT for the execution of the buffered RRCReconfiguration at the child IAB-node MT.**

**Question 4: Please comment on Text Proposal 4 wrt Solution 2 for the Reply LS to RAN3.**

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| Company | Comment |
| Huawei, HiSilicon | Generally the impact analysis should be fine. Not sure if the “new variable to buffer received RRCReconfiguration” is essential. On the other hand, we believe the impacts to overall RAN2/RAN3 are similar for the two solutions. The difference is that solution 1 may require changes to both RAN2 and RAN3, and solution 2 is more like a RAN2-only solution. |
| CATT | Yes, above issues need to be considered in RAN2. |
| Sony | We suggest to delete “**potentially new BAP control PDU**” as RAN2 haven’t had enough discussion on how to indicate this. |
| Interdigital | We agree the above issues need to be considered.  |
| Qualcomm | We propose the following rewording:* **Impact to RRC specification (38.331):**
	+ **Buffering iIndication for conditional execution to be added to RRCReconfiguration message for TNL migration or new dedicated message for such indication**
	+ **Definition of new variable to buffer received RRCReconfiguration**
	+ **Procedures for the child IAB node to discard the buffered RRCReconfiguration, e.g., in case the parent IAB-node fails the migration (e.g., new action upon reception of BH RLF indication)**
* **L1/L2 indication (potentially new BAP control PDU) sent by the migrated parent IAB-node DU to the descendant IAB-node MT to trigger for the execution of the buffered RRCReconfiguration at the child IAB-node MT.**

We don’t see why a new variable needs to be added to the RRCReconfiguration apart from the indicator.  |
| NEC | RAN3 de-prioritized the discussion of inter-CU mobility, but both RAN2 and RAN3 should try to figure a common solution applies both inter-CU and intra-CU mobility. It seems that solution 1 applies to inter-CU mobility, since the access IAB node can withheld the RRCReconfiguration for the UE, but solution 2 doesn’t apply to inter-CU mobility scenario, since UE can’t wait for a new BAP message to execute the RRCReconfiguration. So we suggest to add this observation.* **Incompatibility with Inter-CU mobility. UE can’t wait for a new BAP message to execute the RRCReconfiguration. So we suggest to add this observation.**
 |

Furthermore, regarding trigger conditions for Solution 2 as discussed by some contributions.

**Text Proposal 5: RAN2 observes that trigger conditions for release of buffered RRC Reconfiguration at descendent IAB-MT in Solution 2 may need further discussion. This is within the scope of RAN2, and such discussion can be had once RAN3 decides on the solution for reduction of service interruption for intra-donor IAB-node migration.**

**Question 5: Please comment on Text Proposal 5 wrt Solution 2 for the Reply LS to RAN3.**

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| Company | Comment |
| Huawei, HiSilicon | Not fully understand the case of “release of buffered RRC Reconfiguration at descendent IAB-MT”. May be better to further clarify. |
| CATT | OK for the TP |
| Sony | Ok with the text |
| Interdigital | Is this referring to the case until when the IAB-MT of the child keeps the buffered reconfiguration message (e.g., if the parent never sends any L2 message to apply it)  |
| Qualcomm | We don’t understand this proposal. The RRC Reconfiguration is buffered by the IAB-MT. The execution of this RRC Reconfiguration is triggered by the L1/L2 signaling messages. What is it that needs to be discussed? |
| NEC | We are fine with the TP.  |

**Text Proposal 6: RAN2 further observes that there may be additional aspects of Solution 2 requiring further discussion, such as applicability with or without CHO support, or the case of IAB-node migration failure. Since further details of Solution 2 are FFS, it is not clear whether such discussions will identify any further RAN2 impact. However, this can also be discussed in RAN2, once RAN3 has finalized the solution for reduction of service interruption for intra-donor migration.**

**Question 6: Please comment on Text Proposal 6 wrt Solution 2 for the Reply LS to RAN3.**

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| Company | Comment |
| Huawei, HiSilicon | Similar to solution 1, we need to discuss these issues first, and see if there are real impacts to RAN2/RAN3. Not useful to just inform RAN3 that there may be additional impacts to be discussed |
| CATT | OK but not sure if we need to inform RAN3 such details. |
| Sony | Ok with the text. |
| Interdigital | We agree with Huawei that we need to discuss further regarding RAN2/3 issues.So maybe a best reply LS will be to have a short response that is common for both solution 1 and 2, saying that there are possible impacts on both solutions, e.g. in the case of the failure of the HO of the parent, that need further discussion. |
| Qualcomm | We are fine with the proposal. |
| NEC | We are fine with the TP. |

# 3 Conclusion

TBD

# 4 Contributions

1. R2-2106948, LS to RAN2 on reduction of service interruption during intra-donor IAB-node migration (R3-212973; contact: AT&T), RAN3
2. R2-2107066, Reducing Service Interruption during Intra-donor IAB-node Migration, CATT
3. R2-2107171, Discussion of RAN3 LS on Interruption time reduction for Intra-donor IAB-node Migration Qualcomm Incorporated, Apple
4. R2-2107252, Discussion on two logical DUs and service interruption reduction for RAN3 LS, Huawei, HiSilicon
5. R2-2107291, Intra-donor CU topology migration, Intel Corporation
6. R2-2107636, Topology adaptation and RLF handling in eIAB networks, Apple
7. R2-2107650, Reduction of service interruption, Fujitsu
8. R2-2107862, Discussion on Migration and Service Interruption, vivo
9. R2-2108140, Discussion on inter-donor migration and service interruption reduction, ZTE, Sanechips
10. R2-2108423, On Intra-donor Migration: Reduction of service interruption and CHO, Ericsson