3GPP TSG-RAN WG2 #113e Tdoc R2-20xxxx

Electronic meeting, 25th January – 5th February 2021

Agenda Item: 8.4.1

Source: Ericsson

Title: Summary of [AT113-e][030][eIAB] Reply LS DAPS-like solution (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This paper addresses the following email discussion:

* [AT113-e][030][eIAB] Reply LS DAPS-like solution (Ericsson)

Scope: Achieve common understanding of what is to be achieved by request by R3 in R2-2100038. Collect comments to facilitate efficient on-line discussion on how to reply. Can Take submitted papers on the topic into account e.g. to determine the options.

Intended outcome: Report with organized options / comments

Deadline: To be treated on-line Thursday Feb 28

The rapporteur would like to set the following deadline:

**Deadline: Thursday, 28th Jan. 1500 UTC**

# 2 Discussion

This email discussion aims at discussing how to reply to RAN3 LS R2-2100038. For convenience, the LS is reported here:

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| 1. **Overall Description:**   RAN3 discussed the “DAPS-like” solution, and the following agreement is achieved:  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 solution (“DAPS-like”) of an IAB node should allow at least simultaneous DL reception of BH traffic carried on BH RLC channels on the paths from both donors  However, RAN3 cannot reach agreement for the UL simultaneous transmission since it may have impact to IAB-MT part. Thus, RAN3 would like to ask RAN2’s advice on whether simultaneous UL transmission can be supported in Rel-17. **2. Actions:** **To RAN2:**  **ACTION:** RAN3 respectfully asks RAN2 to take the above into account and to provide feedback. |

Hence, according to the request in the above LS, RAN2 should discuss in this email discussion whether simultaneous UL transmission can be supported in Rel.17.

Regarding this topic, the following contributions submitted to RAN2#113e were explicitly treating this topic:

* [R2-2100360](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100360.zip), [Discussion on RAN3 LS of DAPS-like solution](https://ericsson.sharepoint.com/R2-2100360.zip), Intel Corporation
* [R2-2101450](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101450.zip), [LS on DAPS-like solution for service interruption reduction](https://ericsson.sharepoint.com/R2-2101450.zip), Ericsson
* [R2-2100226](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100226.zip), [CHO and DAPS](https://ericsson.sharepoint.com/R2-2100226.zip), CATT

## 2.2 Rel-17 DAPS-like solution for IAB

## From RAN3#110 chairman notes the following agreement is captured:

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| **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.** |

Before discussing whether simultaneous UL transmission can be supported in Rel-17 for “DAPS-like” IAB, Rapporteur would like to discuss what is a “DAPS-like” solution from a RAN2 protocol architecture and taking into account the above RAN3 agreement.  
Rapporteur would set the following definition:

“A DAPS-like solution for IAB consists of two independent protocols PHY/MAC/RLC/BAP defined in the MT”

**Q1: Do you agree with the definition that a DAPS-like solution for IAB, from a RAN2 protocol view, consists of two independent protocol stacks “PHY/MAC/RLC/BAP” defined in the MT? If no, please provide your definition.**

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| **Company** | **Preference (Y/N)** | **Comments** |
| Nokia | N | The RAN3 agreement is (the green sentence only): “dual-protocol-stack solutions 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.”  To meet the requirements, DAPS-like solution for IAB, from RAN2 protocol view, would be feasible once similar to DC: PHY/MAC/RLC would be independent. However, BAP is a common entity and cannot be independent since UL/DL BAP routing happens in the BAP layer. DAPS-like solution should involve a single BAP entity.  Furthermore, DAPS is defined for HO to reduce interruption in UE data transmission. Similarly, if DAPS-like were adopted for IAB-nodes, it should be specified for reduction of service interruption in case of IAB-node migration, not for specifying another multiconnection scheme for IAB-nodes.  DL and UL redundancy is already supported with DC. Therefore, there is no need to specify an alternative option for the redundancy. |
| Sony | Y | In general agree but BAP could be common to both. It is good to inform RAN3 that DAPS like applies to single MT only. |
| Ericsson | Y | Rel.16 DAPS is based on 2 independent protocols; hence it seems natural to assume that a DAPS-like solution for IAB also consists of two independent protocol stacks.  Additionally, since the protocol stack for an IAB node consists of “PHY/MAC/RLC/BAP”, then our conclusion is that a DAPS-like solution for IAB should consist of two independent protocol stacks of “PHY/MAC/RLC/BAP” defined in the MT.  That seems also aligned with the RAN3 discussion noted above. |
| Qualcomm | N | There are two RLC stacks underneath one common BAP entity on the MT. There can only be one BAP entity on the MT, since it has the task to perform routing between both links, i.e., RLC stacks. This has already been done for NRDC in Rel-16 IAB. |
| vivo | N | We prefer to have single MT with single BAP entity. We should maximize the similarity with DC protocol stacks. |
| Futurewei | N | There is no “PHY/MAC/RLC/BAP” independent protocol branch in DAPS operation. DAPS can’t be directly applied to IAB nodes. If the intention is to specify a new “DAPS-like” protocol structure for IAB, it should be discussed in RAN2 first. |
| Huawei |  | It seems companies are discussing different issues:   1. What does R3 mean by “DAPS-like”? 2. What’s the preferred solution for simultaneous transmission? 3. What’s the DAPS if it applies to IAB? 4. Whether we have the single or separated BAP?   Not sure on the discussion point of this question. |
| Samsung | N | As indicated in LS, DAPS-like solution is necessary for reducing service interruption. We think this service interruption is owing to the migration of IAB node between two donors. Otherwise, at least we think RAN3 should give us about what the problem to solve is. Moreover, DAPS is not used standalone but used with handover in stage 2 definition in RAN2.  Assuming the problem is to make HO with reduced service interruption time, we think two independent protocol stacks “PHY/MAC/RLC” could be the baseline for the discussion. For BAP stack there could be variations, common part or separate part which could be determined by the further details of the required function. |
| Lenovo&MM | N | If DAPS is used in the IAB system, the BAP should be maintained for both source and target at the same time. We slightly prefer one common BAP entity in order to align with the legacy IAB specification. |
| Intel | N | From RAN3 agreement: “**Discuss how to support simultaneous connectivity with 2 donors, to reduce service interruption; potential solutions may include dual-protocol-stack solutions (“DAPS-like”);**” DAPS-like solution is proposed to reduce service interruption, which is similar to Rel-16 DAPS HO. In DAPS HO, two independent protocols only exist **temporarily** and go back to single protocol after successful HO. Hence, it would be clear to add explanation to clarify how long the dual protocols exist in the IAB-MT.  **We propose following definition with changes from RAN2 perspective:**  **“A DAPS-like solution for IAB consists of two independent protocols PHY/MAC/RLC/BAP defined in the MT during HO/IAB node migration”.**  Besides, we should also ask RAN3 to clarify the definition of “DAPS-like”. In Multi-MT solution, IAB-MT **always** consists of dual protocol stack, and aim to achieve load balancing. We should avoid mixing definition between these two solutions. |
| ZTE | N | For IAB node migration with DAPS, two independent RLC/MAC/PHY protocol stacks are necessary for migrating IAB-MT. These two set of RLC/MAC/PHY protocol stacks are used for the processing of packets from source and target cells respectively. However, one BAP entity could be shared for the two protocol stacks. |

## The RAN3 LS asks whether simultaneous UL transmission can be supported in Rel-17 for “DAPS-like” IAB. Looking that legacy DAPS, tt is noted that a capability signalling already exists indicating whether the UE supports simultaneous UL transmission in source PCell and target PCell during an inter-freq DAPS handover, i.e. *interFreqMultiUL-TransmissionDAPS-r16*. However, Rapporteur´s understanding is that after random access completion on the target cell, there is an uplink data switching at PDCP level from source to target which makes not possible simultaneous UL transmissions on source and target after the handover completion.

Companies are asked to provide their views on the legacy DAPS functionality when it comes to simultaneous UL transmissions on source and target

**Q2: Do you agree with the following Rapporteur´s understanding on the Rel.16 DAPS functionality related to UL simultaneous transmissions on source and target? If not, please provide your view or clarification if needed.**

* *interFreqMultiUL-TransmissionDAPS-r16* already indicates whether the UE supports simultaneous UL transmission in source PCell and target PCell during an inter-freq DAPS handover.
* After random access completion on the target cell, there is an uplink data switching at PDCP level from source to target which makes not possible simultaneous UL transmissions on source and target after the handover completion.

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| **Company** | **Preference (Y/N)** | **Comments** |
| Nokia |  | After successful RA there is UL switch. Simultaneous UL **data** transmission is not possible after the handover completion. |
| Sony | Y |  |
| Ericsson | Y |  |
| Qualcomm | Y | Agree with Nokia. |
| vivo | Y |  |
| Futurewei | Y | Simultaneous UL data transmission is not supported in DAPS. |
| Huawei | Yes in general, but see comment | It seems the R16 status is as following:  **Rel.16 DAPS does support simultaneous UL transmission optionally before HO completion, but NOT after HO completion.** |
| Samsung | Yes but, | There are lots of characteristics to be considered for making DAPS-like solution for some problem. For the baseline, DAPS handover is not supported for FR2-FR2 handover in Rel-16. This decision must come from RAN4/RAN1 discussion. Therefore we should be careful to mimic the legacy DAPS HO to adopt in IAB node situation since some design might be affected by this.  Regarding UL simultaneous transmission, we think rapporteurs two points looks conflict each other. So there should be clarification on these. In the PDCP new data level, only one cell either source Pcell or target Pcell can receive the UL from the UE after RA completion. However, even after RA completion, still RLC control PDU, PDCP control PDU, HARQ retransmission will be transmitted to the source cell too. And if these UL for source and other UL (which could be new data ) for target collide in time, then UE will drop the source one. So far this behaviour is mandatory capability. If above capa *interFreqMultiUL-TransmissionDAPS-r16* is indicated, then there will be no collision for the UL Tx by the UE capa, and UE will transmit simultaneously to both cells. But please note that this is only possible in inter-frequency case.  There is another capability info, ***intraFreqDAPS-***r16 which means***:***  Indicates whether UE supports intra-frequency DAPS handover, e.g. support of simultaneous DL reception of PDCCH and PDSCH from source and target cell. A UE indicating this capability shall also support synchronous DAPS handover, single UL transmission and cancelling UL transmission to the source cell for intra-frequency DAPS handover.  So, in summary, there is no simultaneous UL transmission on PDCP new data level in DAPS HO |
| Lenovo&MM | Y | After successful RA, the UL data will be switched to the target link. The data for service will not be transmitted in the source link for new transmission. But the information related with HARQ, ARQ and ROHC will continue in source link until the UE releases the source link after receiving the release indication from target cell. Therefore, we can consider that simultaneous UL transmissions for normal data on source and target will not happen in the legacy DAPS HO. |
| Intel | Y | We share the same understanding with rapporteur that simultaneous UL transmission is not supported in Rel-16 DAPS HO.  *interFreqMultiUL-TransmissionDAPS-r16* only means the UE can send the feedback (including CSI feedback, HARQ feedback, layer 2 RLC feedback, ROHC feedback, HARQ data re-transmissions, and RLC data re-transmission) in source cell and new data in target cell. This is different from UL simultaneous transmission where both source and target cell receive new data in UL simultaneously. This is also captured in TS38.300 subclause 9.2.3 “For DAPS handover”:  The UE transmits UL data to the source gNB until the random access procedure toward the target gNB has been successfully completed. Afterwards the UE switches its UL data transmission to the target gNB.  Followings are also agreed in RAN2 #106 meeting on DAPS UL transmission:  - Simultaneous UL PUSCH transmission does not need to be supported for the HO interruption solution.  - There is a point in time where the UL PUSCH switches from source to target.  Regarding to *intraFreqDAPS-r16* mentioned by Samsung, it is agreed in RAN1 that “For intra-frequency DAPS, UE drops and cancels source cell transmission when source and target cell transmission overlap”, which means UE never perform multiple UL transmissions simultaneously even during intra-frequency DAPS, so that **RAN2 agreed to dummify the field *intraFreqMultiUL-TransmissionDAPS* from *intraFreqDAPS-UL****.*  The same assumption should be taken account when we consider IAB DAPS-like HO. |
| ZTE | Y | The *interFreqMultiUL-TransmissionDAPS-r16* specified in TS38.306 indicates the ability for UE’s simultaneous UL transmission during DAPS HO. According to TS38.323, after random access completion on target cell, DAPS handover UE will perform uplink data switching procedure to switch UL UP transmission from source path to target path for new data. At the same time, UL transmission on source path is still valid to support UL feedback or UL re-transmission(e.g. RLC STATUS PDU, RLC AM retransmission of un-successful data, HARQ retransmission of un-successful data, BSR, PHY... ). |

## Related to DAPS-like solution for IAB, according to [R2-2100360](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2100360.zip), simultaneous UL transmission for IAB DAPS should not be supported in Rel.17 either, while according to [R2-2101450](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113-e/Docs/R2-2101450.zip) that should be possible. Before agreeing on whether simultaneous UL transmissions for IAB DAPS can be supported in Rel.17, Rapporteur would like to ask companies how to support simultaneous UL transmissions for an IAB DAPS-like solution from a RAN2 point of view, and which changes (if any) can be foreseen in RAN2 specifications. Companies are also invited to provide the reason for the envisaged changes.

**Q3: How could simultaneous UL transmissions be supported using a DAPS-like solution in RAN2 specifications and what is the foreseen RAN2 standard impact?**

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| **Company** | **Changes foreseen to RAN2 specifications** | **Reason for the change** |
| Nokia | New concept for the controlling entity above PHY/MAC/RLC: BAP routing and routing tables needs to be redefined  Configuration of IAB nodes (more changes to F1AP since BAP is mostly configured by it) | Instead of MCG and SCG there will be a primary stack and secondary stack  New option for the topological redundancy needs to be configured. |
| Sony | In our understanding, configuration of multiple BH RLC channels is already supported in RRC and higher layers may take care of reordering and duplication detection. |  |
| Ericsson | RRC specification:   * No changes foreseen for the support of simultaneous UL for IAB DAPS. Normative text in TS38.331 does not present any specific clause/procedure that limits UL simultaneous transmissions with Rel.16 DAPS. * Changes required to establish/configure the new BAP entity and associated BH RLC channels when DAPS for IAB is configured. Some clarifications might be also needed to specify that the PDCP entity is not affected when a DAPS for IAB is configured (since the IAB DAPS-like operates at BAP level):   BAP specification:   * No changes foreseen to TS38.340 to support simultaneous UL transmissions. Each BAP layer of the dual protocol stack can operate independently, and there is no need to specify any interaction when it comes to simultaneous UL transmissions. * RAN2 should discuss if changes are needed in the receiver side to route the data to the right transmitter side according to the RRC configuration. However, that can be left also unspecified as it was done in Rel.16 for local routing after RLF or for NR DC SA.   PDCP specification:   * No changes foreseen, since DAPS for IAB does not impact PDCP, i.e. the uplink data switching for the PDCP entity which limits simultaneous UL transmissions in source and target is not applicable in this case | RRC: The mentioned changes are needed to configure the dual protocol stack for IAB, and to clarify that PDCP is not affected in this case  BAP: The mentioned changes might be needed to allow the IAB node to perform a local routing of data to the right protocol stack. However, RAN2 should discuss if that is really needed or if it can be left to implementation.  Note however that the above-mentioned changes are not directly related to the support of UL simultaneous transmissions, which as mentioned, are only explicitly prevented at PDCP layer which is not present in an IAB node. |
| Qualcomm | Simultaneous support of RLC channels is already part of DAPS and need to be extended to BH RLC channels.  No changes to BAP routing, UL mapping, etc, for intra-donor DAPS since NRDC solution defined for Rel-16 intra-donor redundancy can be reused.  Inter-donor DAPS should wait for RAN3 progress on inter-donor IAB-node migration. |  |
| vivo | The major complexity comes from BAP change: BAP modelling, BAP entity setup procedure, BAP routing and BH RLC channel mapping, especially for inter-donor case. |  |
| Futurewei | From RAN2 side (there may be RAN1 impact too), changes are foreseen to RRC, PDCP, MAC, BAP specifications. | The underline assumption of DAPS is to apply it only during transient period of HO for 0ms interruption time of DL transmission. Hence, there is no specification support for DAPS to work together with CA, DC, multi-TRP etc to achieve maximal throughput and spectral efficiency.  ROHC is effectively disabled when DAPS is configured.  New UE capability signalling (for MT) is needed to support simultaneous UL transmission in DAPS across different band combinations. |
| Huawei | Again, not sure if companies are discussing the same solution:   1. The “DAPS-like” proposed by rapporteur   The IAB specific DAPS solution. |  |
| Samsung | Since we don’t know how BAP related functions work for DAPS-like yet, we assume Rel-16 DAPS for the spec impact.   * Resource configurations might be necessary for avoiding resource level conflict which cannot be solved by the UE capability. | * If we concern physical resource level simultaneous transmission, then there is no clear specification on how to support that but it is just a capability of a UE. Actual resource level conflict in IAB MT will be different with normal UE since MT will be restricted by collocated DU, and the resource availability must be coupled with the DU, and its neighbour IAB nodes. So we need RAN1 consult for the feasibility. |
| Allowing simultaneous UL transmission in PDCP not switching. | * And for RAN2 spec point of view, Rel-16 DAPS HO has the operation of switching the UL in PDCP spec. this should be relaxed. |
| Determination of UL direction for each PDCP PDU between two links. |  |
| Lenovo&MM | RAN2 needs to discuss the UE behaviour if simultaneous UL in source and target can be supported. e.g one packet is delivered to one of source link and target link or both? |  |
| Intel | As explained in R2-2100360, DAPS-like solution can be understood in two directions: DAPS-like HO and DAPS-like Multi-MT. We should reach the common understanding from RAN2 perspective on Q1.  Regarding to DAPS HO, in TS38.323, it is captured that the PDCP will only provide data to the target after UL switching. As discussed in R2-1906057, to support simultaneous UL transmission, RAN2 specification changes on PDCP layer is required to support RoHC to different cells, security operation, packet reordering and duplication discarding between source and target before delivery to upper layer, etc.  Considering those enhancements are not supported for normal UE, simultaneous UL transmission in inter-donor IAB DAPS is also limited. RAN2 should wait for the progress of UL simultaneous support in legacy DAPS, then study the specification changes to IAB DAPS, especially for inter-donor IAB DAPS. |  |
| ZTE | Determine when the simultaneous UL transmission ends and to release the corresponding RLC/MAC/PHY protocol stack with source cells. | The fundamental idea of DAPS is to improve the service continuity and the usage of DAPS should be limited to a short period of time during HO. Even if IAB node is allowed to support simultaneous UL transmissions after RA at target node, it should be stopped soon. For the long term simultaneous UL transmissions toward two parent nodes, we think NR-DC is a better choice. |
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Depending on the changes foreseen in the previous question, Rapporteur would like to ask now whether RAN2 foresees any fundamental issue for not supporting simultaneous UL transmissions in IAB DAPS. An additional option could be that RAN2 asks RAN1 whether that is feasible from their point of view, since also their specifications might be eventually impacted.

**Q4: Given the changes foreseen in Q3, do you see, from a RAN2 point of view, any fundamental issue for not supporting simultaneous UL transmissions with an IAB DAPS-like solution? Please explain your answer.**

* **Option 1: No**
* **Option 2: Yes**
* **Option 3: RAN2 asks RAN1 whether simultaneous UL transmissions can be supported in Rel-17 from their point of view**

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| **Company** | **Option(s)** | **Detailed Comments** |
| Nokia | Option 2 | IAB Rel16 already supports the topological redundancy with DC which allows simultaneous transmissions and load balancing in both DL and UL. There is no need to specify an alternative (multi-MT) option for the same functionality as proposed in R2-2101449. |
| Sony | Option 1/3 | We think RAN1 involvement is needed |
| Ericsson | 1, 3 | From RAN2 point of view there seems to be no fundamental issue for the support of UL simultaneous transmissions in a DAPS-like IAB solution.  RAN1 may be anyhow asked to check if there are any other limitation from their point of view. |
| Qualcomm | Option 3 | We don’t see a fundamental reason to NOT support simultaneous UL transmission since this is already supported for NRDC. In fact, DAPS would become an alternative to NR-DC in this case. We should still be polite and ask RAN1. |
| vivo | Option 3 | There is no essential issue to support simultaneous UL TX for RAN2. RAN2 should further ask RAN1 to study the feasibility. |
| Futurewei | Option 2 | The question is a bit convoluted. If simultaneous UL transmission is not supported, BAP and overall IAB operation is impacted, as DL/UL operation is defined together for them.  If simultaneous UL transmission needs to be supported, there’d be significant impact overall on RAN2 and RAN1 specifications, as explained in our answer to Q3. |
| Huawei | Option 3 | We need to check with R1. Maybe it’s better to let R3 send the LS to R1 with the clear definition of “DAPS-like”. |
| Samsung | Option 3 | Please see the answer in Q3. |
| Lenovo&MM | Option 3 | We don’t see the fundamental issue. But it is beneficial to reduce the UL interruption during IAB mobility since some child IAB node(s) and the served UE(s) are also involved. |
| Intel | Option 3 with comments | Additionally, even if we can support simultaneous UL transmission for HO by some enhancement, considering IAB-MT would normally inherent UE features, we still think that such enhancement in UL for HO should be first agreed/considered in mobility WI (supporting normal UE’s UL simultaneous transmission), rather than in IAB WI.  Moreover, so far there’s no intra-frequency DC is not supported, from our understanding, simultaneous UL transmission is also not supported in intra-frequency NR-DC for normal UE and IAB-MT. It would be good to check with RAN1 and RAN4 whether simultaneous UL transmission can be support or not, considering inter-frequency and intra-frequency between dual protocol stacks located at IAB-MT.  For DAPS-like solution “Multi-MT”, since it aims to achieve load balancing between two IAB donor CU, there’s no need to duplicate UL packets into two paths which are connecting to different IAB donor CUs. Hence, simultaneous transmission for Multi-MT connected to multiple donor CUs simply means transmit different upstream packets in different routing path simultaneously for inter-frequency scenario. | |
| ZTE | Option 3 | We think RAN1 should be involved. | |

# 3 Conclusion

To be updated