3GPP TSG-RAN WG3 #111-e R3-211006

Online, 25 January-04 February, 2021

Agenda Item: 13.3.2

Source: Huawei (moderator)

Title: Summary of Offline Discussion on IAB Multi-Hop Performance

Document for: Approval

# Introduction

This paper is for the following offline discussion:

|  |
| --- |
| **CB: # 39\_IAB\_MultiHopPerf**  **CATT**  **consider inter-donor-DU local re-routing in topology redundant scenario.**  **IAB node is configured mapping relationship between the source path BAP address to target path BAP address.**  **consider the mapping relationship via F1AP message.**  **consider opt1 and opt2 to address source IP filter in inter-DU local re-routing.**  **further analyze whether to support inter-donor-CU local re-routing.**  **SS**  **IAB donor CU can configure the old IP address to the new donor DU to avoid the UL packet loss due to the source IP filtering.**  **the default configuration, e.g., default BAP routing ID and default BH RLC CH, can be configured to the migrated IAB node and its descendant IAB node(s) to transmit the buffered on-the-fly packets.**  **QC**  **Local inter-donor-DU rerouting to be selectively supported for a subset of IAB-donor-DUs.**  **ask RAN2 for the support of inter-donor-DU local rerouting configurable for a subset of inter-donor-DUs.**  **Nok**  **wait for RAN2 decision on inter-Donor-DU re-routing.**  **If inter-Donor-DU re-routing is needed, operator input is required on whether it can be implemented via disabling the source address filtering in the Donor-DU and transport network node.**  **HW**  **Inform RAN2 about support of inter-donor-DU re-routing.**  **To avoid re-routed packets being dropped by the target IAB-donor-DU because of the source IP filtering, the target IAB-donor-DU may disable the source IP filtering for short while, or update the allowed source IP address list based on CU’s configuration.**  **Len,Moto**  **UL packet local rerouting to another IAB-donor-DU by BAP address and path ID modification, both for the intra-CU and inter-CU topology.**  **IP address(es) of the UL packet originally transmitted to source IAB-donor-DU can be notified to target IAB-donor-DU in order to avoid discard of the rerouting UL packet due to IP filter.**  **Packet rerouting can be triggered by reception of the BH RLF notification for RLF detection in parent IAB node.**  **ZTE**  **To support inter-donor-DU re-routing, the re-routing path selection should disregard the destination BAP address. To be specific, the IAB node select one entry in the routing table whose BAP address does not matches the destination BAP address in BAP header and whose egress link corresponding to the next hop BAP address is available.**  **When the inter-donor DU re-routing path is selected, IAB node need to update the BAP header of the data packet to include the BAP routing ID of the selected path.**  **If the BAP header is not updated during the inter-donor DU re-routing, it is necessary to update the donor DU’s UL receiving operation, e.g., no matter the destination BAP address in BAP header matches its own BAP address or not, the donor DU removes the BAP header and delivers the data packet to upper layer.**  **In order to support inter-donor DU re-routing, it is necessary for the donor CU to inform the IAB node/donor DU whether the ingress filtering/inter-donor DU re-routing is enabled.**  **\*\*\*\*\***  **- Current agreement to let RAN2 discuss some sub-topics first, any progress in RAN2?**  **- inter-donor re-routing via destination BAP address via e.g. destination BAP address manipulation/disabling source IP filtering? Further options/details?**  **- if agreeable, capture WAs/principles**  (HW - moderator)  Summary of offline disc [R3-211006](https://ericsson-my.sharepoint.com/personal/filip_barac_ericsson_com/Documents/WORK/3GPP.exe/Meetings/RAN3%23111-e.exe/1.%20IAB/IAB%20CBs/CB%20%23%2039_IAB_MultiHopPerf/Inbox/R3-211006.zip) |

The following papers will be covered as assigned by the chairman:

[1] R3-210103, Inter-donor-DU local re-routing in IAB (CATT).

[2] R3-210221, Discussion on inter-donor-DU local re-routing in Rel-17 IAB (Samsung).

[3] R3-210351, Inter-donor-DU local rerouting for IAB (Qualcomm Incorporated)

[4] R3-210491, Discussion on Inter-Donor-DU re-routing (Nokia, Nokia Shanghai Bell)

[5] R3-210551, Inter-donor-DU re-routing for IAB (Huawei)

[6] R3-210616, Discussion on IAB packet rerouting (Lenovo, Motorola Mobility)

[7] R3-210719, Considerations on inter-donor-DU re-routing (ZTE).

Phase I：Please give your feedback before Thursday, 28th January, 2021, 23:59 UTC. This allows us to discuss intermediate stage in Monday online session (1st February, 2021).

Phase II：TBD

# For the Chairman’s Notes

Suggest to agree the following proposals:

**Proposal 1.1: To address the potential packet discarding problem in the inter-donor-DU re-routing case, RAN3 discuss the following solutions：**

* **The target IAB-donor-DU is provided with the source IP address of re-routed packets；**
* **Suspend/disable the source IP filter in target IAB-donor-DU and transport network node(s)；**
* **Only allow re-routing among a configured subset of IAB-donor-DUs, where source IP filtering is not activated.**

**Proposal 2.1: In the inter-donor-DU re-routing case, the issue 2, i.e. how to achieve the BAP routing towards the target donor DU for re-routed packets should be discussed by RAN2.**

**Proposal 2.2: RAN3 send liaison to RAN2 to design solutions for the BAP routing issue of the inter-donor DU re-routing.**

# Discussion

All the 7 submitted papers focus some issues the inter-donor-DU re-routing which is agreed to be supported in last RAN3-110e meeting, based on the all the contributions, the following 2 issues are worth to be discussed to enable the inter-donor-DU re-routing.

## Issue 1: Source IP filtering

As mentioned in all the 7 contributions, the source IP filtering may be configured at the IAB-donor-DU, and the re-routed packets still use the old IP address. Then the target IAB-donor-DU may still drop the received re-routed packets which are supposed to be forwarded to the source IAB-donor-DU, since the source IP filtering checking may fails. Consequently, RAN3 need to discuss how to avoid such packet dropping due to source IP filtering to support the inter-donor-DU re-routing, in case of source IP filtering mechanism being deployed in the IAB-donor-DU.

There are several candidate solutions for solving such source IP filtering problem, as listed in the follows:

**Option 1:** **Configure old IP address for source IP filtering in target IAB-donor-DU**[1][2][5][6]**.** This option will update the allowed source IP address in the target IAB-donor-DU, based on some information of the old IP address(es) exchanged among source CU and target CU.

**Option 2: Suspend/disable the source IP filter in target IAB-donor-DU**[1][2][4][5][7]. This option will disable the source IP filtering mechanism at the target IAB-donor-DU for a short time to allow the re-routed packets being successfully transmitted. As mentioned by [2] and[4], operators’ input about this option is expected.

**Option 3: Update the source IP address of each re-routed packets** [2]. This option will change the source IP address of the re-routed packets. From the moderator’s view, the intermediate IAB node does not contain IP layer in the E2E protocol stack, it is impossible for the IP address info of the re-routed packets being updated by an intermediate IAB node unless changing the protocol stack.

**Option 4: Only allow re-routing among a configured subset of IAB-donor-DUs** [3]. This option aims at restricting the applicable area of inter-donor-DU re-routing to only a subset of IAB-donor-DUs. But the inter-donor-DU topology adaptation may occur among two donor DUs which are not belong to same subset, then the re-routing is also necessary for mitigate packet loss.

Please provide your comments on the above 4 candidate solutions.

**Q1: About how to solve the potential discarding problem for the re-routed packets which is resulted from the deployed source IP address filtering mechanism in the target IAB-donor-DU, which solution should be used?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred option** | **Comments** |
| Samsung | Option 1 | If operator inputs allow to disable the source IP filter, option 2 can be applied. However, since source IP filter is related to the network security, we are wondering if this is a safe method. Option 1 is an efficient method to ensure the security, and it is still under operator’s control. Anyway, let’s hear operator’s voice first. |
| ZTE | Option 2 | Option 1 may not work if the IP addresses of different IAB-donor-DUs are within different subnets.  Option 3 can only work in access IAB-nodes rather than in intermediate IAB-nodes.  Option 4 seems also workable. However, operator’s input about this deployment scenarios is expected.  Option 2 is acceptable, it can solve the issue under operator’s preference. |
| **Ericsson** | Look right | Opt1, and we can consider Opt4. We feel that perhaps operator input and further analysis may be needed for Opt1,2, and 4. For now, let us exclude Opt2. |
| QC |  | **Options 1 and 2 don’t work** since source-address-based packet filtering may be applied on any router of the wireline IP network, not only IAB-donor-DU.  **Option 3 doesn’t work** since IPsec will discard packets if their SRC and/or DST IP addresses on header do not match those established with the security association.  **Option 4 is the only feasible option.** It implies that source-address-based packet filtering on the wireline network (including IAB-donor DUs) is **not** activated. |
| Nokia |  | Option 1 and 2 do not work if the transport network node also perform source IP filtering. refer to our contribution (4)  Option 3 does not work when the receiver SEG use the source IP address to identify a security association. If the source IP address is modified, the SEG will not be able to find a related security association.  Option 4 have the restriction on the deployment.  As discussed in our contribution (4), re-routing is mainly in RAN2 scope. We prefer this should be discussed in RAN2. If RAN2 require support from RAN3, then RAN3 will discuss the solution. |
| Huawei | Option 1 | Option 1 and option 2 can ensure packet lossless for all the possible inter-donor-DU topology adaptation case, but option 2 may need more input from operators.  About the concern of Nokia for the responsible WG of the re-routing, we think the source IP filtering issue is mainly RAN3 territory, how to achieve the BAP layer routing is mainly RAN2 scope. |
| Lenovo | Option 1 | As the descriptions by moderator, both option 3 and option 4 have their limitations.  And option 2 may introduce unexpected security risk. |
| CATT | Option1  option 2  option 4 | Option 1 may suitable for both intra-CU and inter-CU local re-routing. The donor CU only exchanges the IP address between different donor DUs in IAB case.  Option 2 is simplest but the operators’ input is needed  Option 3 is not clear how to modify source IP address of the re-routed packets  Option 4 We are wondering if the CU also need to exchange IP address between two different donor DU. FFS in detail |
| Intel | Option 2 | No spec changes |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Summary:

9 companies replied.

5 companies prefer option1, and think this solution is suitable for both inter-CU and intra-CU re-routing case.

3 companies prefer option 2, 2 companies think option 1 does not work considering the source IP filtering may also be applied on any router of the wireline IP network. And some other companies would like to hear operators’ input on option 2.

2 company prefer option 4 and 1 company can considered this option, while other companies expressed this option will restrict the deployment. In addition, as explained by one proponent company, this option implies that the source IP filtering is not activated on the wireline part. so this is similar to option 2.

No one in favor of option 3 and this may have problem if the source and/or destination IP address not match the established IPsec association.

About other routers in the IP network, it seems the source IP filtering configuration can also be updated or deactivated, if this is workable for the IAB-donor-DU, but this can rely on the operator’s policy and is out of our RAN3 scope.

It seems option 1 has majority support, while option 2 and option 4 has similar problem on not activate the source IP filtering in the wireline IP network, and more input from operators are expected. So the following potential proposal is proposed:

**Proposal 1.1: To address the potential packet discarding problem in the inter-donor-DU re-routing case, the target IAB-donor-DU can be provided with the source IP address of re-routed packets, this is applicable to both inter-CU and intra-CU re-routing scenarios.**

**Proposal 1.2: The following two options pending operators’ input:**

* **Option 2: Suspend/disable the source IP filter in target IAB-donor-DU**
* **Option 4: Only allow re-routing among a configured subset of IAB-donor-DUs**

## Issue 2: BAP routing towards the target IAB-donor-DU

Another issue of the inter-donor-DU re-routing is how to enable the re-routed packets being routed to the target donor-DU, since the BAP routing ID in the re-routed packets still carry the old BAP address which indicates the old IAB-donor-DU. Some contributions proposed the following solutions:

**Option 1: BAP header modification** [1][2][6][7] .This option means that the contained BAP routing ID(at least the destination BAP address part) will be changed to refer to the target IAB-donor-DU, when an IAB-node perform inter-donor-DU re-routing. Some pre-configuration about how to derive the new BAP header info based on the old BAP header info may be necessary.

**Option 2: Using shared BAP address among the subset of IAB-donor-DUs which allow re-routing**[3]. This option corresponds to the option 4 for issue 1. It means that all the IAB-donor-DUs in the subset which allows re-routing among them should be configured with same BAP address. But this option does not align with the R16 assumption that the BAP address of each IAB-node/IAB-donor-DU is unique in the area of an IAB-donor-CU, and may cause some routing confliction for other normal UL packets.

**Option 3: Changing of BAP receiving behavior at the IAB-donor-DU**[7]. This option will not change the BAP header in the re-routed packets, but requires that the IAB-donor-DU submit all received UL packets to the IP layer, without checking the contained BAP address. This option can avoid that the IAB-donor-DU discard packets with a BAP address which is different from the one configured to this donor-DU, but it is still unclear that how to ensure the re-routed packets being properly routed towards the target IAB-donor-DU, at the intermediate IAB-nodes. So ZTE may provide some further explanation of this option. Alternatively, **Introduce Donor-CU BAP address and use it as UL destination address.** The routing tables can be configured using the existing BAP addresses of Donor-DUs as Next Hop nodes and re-routing is done as in Rel16 among the configured paths to the same destination BAP address. Donor-DU is configured with the BAP address of the Donor-CU in addition to its own BAP address and the behaviour is changed such that it accepts packets with BAP address of the Donor-CU in addition to the packets with its own BAP address.

ZTE comment: For intermediate IAB node, it may first select the re-routing path which has the same destination BAP address as the BAP header in the data packet (intra-donor DU re-routing as we agreed in Rel-16). If such inter-donor DU re-routing path does not exist, the intermediate IAB node select inter-donor DU re-routing path which has different destination BAP address with the BAP header and whose egress uplink is available. Correspondingly, the next hop intermediate IAB node perform similar re-routing until the data packet arrives the donor DU. Suppose the data packet is always delivered upward and no routing loop exists, this data packet will anyway arrive one of the donor DUs.

**Option 4: configure a default BH RLC CH and default BAP routing ID**[2]. In this option, the RRCReconfiguration message towards top-level migrated IAB node or descendant nodes can include a default configuration, e.g., default BAP routing ID and default BH RLC CH, which can be used to transmit the buffered on-the-fly packets.

Companies are invited to provide their view on the above options, please share your comments on the questions below.

**Q2: About how to make sure the re-routed packets being forwarded to the target donor-DU, which option is preferred?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred option** | **Comments** |
| Samsung | Prefer to option 4, option 1 can be considered. | For option 4, some further clarifications from our side since it is from our paper:   * The on-the-fly packets contain the old BAP routing ID(s), the routing entry of which may not be configured at the intermediate node(s) of the target path * Option 4 considers to configure a default BAP routing ID and default BH RLC CH. With this configuration, the IAB node can transfer the on-the-fly packets which contain BAP routing ID without configured routing entry. Each on-the-fly packet can change the BAP routing ID to the default one, and the configured default BH RLC CH can be used for transmission. * The default BAP routing ID and default BH RLC CH can be configured when the IAB node accesses the network.   For option 1, it allows to configure the same new BAP routing ID to all on-the-fly packets, which is similar to option 4. However, the bearer mapping in option 1 is not clear, i.e., which BH RLC CH is used for those on-the-fly packets. Thus, if the solution goes to option 1, how to configure the BH RLC CH for transmission needs further discussion. In addition, option 1 may introduce more signaling than option 4 since it may change BAP routing ID of different on-the-fly packets to different BAP routing IDs. |
| ZTE | Option 1, 3 | This issue should be up to RAN2’s decision.  We think Option 1, 3 are all workable. Nevertheless, option 1 is preferred. |
| **Ericsson** | Opt1 and Opt2 | These options seem most elegant and simple. Moreover**, Opt1 enables a unified solution for all inter-donor-CU/DU routing scenarios that we are considering.** |
| QC | RAN2 issue | All of these options may be considered. However, they should be discussed in RAN2. We should send an LS to RAN2 to pick up on this topic. |
| Nokia | See comment | We prefer the re-routing should be first discussed in RAN2.  The issue has 2 aspects:   1. How to route the UL packets to target Donor-DU   Either use “new” routing ID which requires a BAP header modification, or “old” routing ID. Both requires Donor to configure the routing table in target path. Donor just configure different routing table via existing mechanism. There maybe no impact to RAN3.   1. How to pass the BAP address check in target Donor-DU.   The solutions described above are mainly in RAN2 scope, e.g. BAP header modification, using shared BAP address, changing BAP receiver behavior, etc. So we prefer to first discuss this issue in RAN2 scope. |
| Huawei | Option 1 | The new BAP routing info to be added for the re-routed packets can be a default one (similar as the option 4), or be configured per old BAP routing ID.  So in our view, option 4 is one special way of option 1.  Using Option 1, the consequent nodes can still use same BAP routing principle as R16, and this solution will enable unified solution for all inter-CU/DU re-routing case, as pointed by Ericsson. |
| Lenovo | Option 1 and 3 | For option 2, shared BAP address for different IAB-donor-DUs need negotiations between IAB-donor-CUs. And one IAB-donor-DU may belongs to several subsets, which will lead to most of the IAB-donor-DUs have the same BAP address. The length for Path ID field may be insufficient. |
| CATT | Option 1 with modification | We would like to clarify our opinion. We consider introducing a mapping relationship between BAP address of source donor DU and BAP address of target donor DU at least and then involved IAB node(s) will store the two BWP addresses and their relationship.  In upstream, IAB node takes the two DU BAP addresses as one destination internal.  We didn’t suggest BAP header modification.  For BH RLC channel mapping, we think BH RLC channel mapping rule in intra-DU rerouting can be reused. In the redundant path, the backup parent node can deduce egress BH RLC channel ID from ingress link ID and ingress BH RLC channel ID according to BH RLC Channel Mapping Configuration, or select any egress BH RLC channel ID if egress RLC channel ID based on BH RLC Channel Mapping Configuration is not available. |
| Intel |  | This is more a RAN2 issue |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Summary:

9 companies replied.

3 companies think this issue is mainly RAN2 territory and didn’t provide preference.

6 companies can accept option 1 or variant of option 1;

1 company can accept option 2;

2 companies can accept option 3;

1 company prefer option 4 and another company think the option 4 is a special case of option 1.

Majority companies like the option1. But all these options mainly impact RAN2 BAP layer, so the moderator suggest RAN2 should discuss the BAP routing issue first.

**Proposal 2.1: In the inter-donor-DU re-routing case, the issue 2, i.e. how to achieve the BAP routing towards the target donor DU for re-routed packets should be discussed by RAN2 first.**

**Proposal 2.2: RAN3 send liaison to RAN2 to design solutions for the BAP routing issue of the inter-donor DU re-routing.**

From the moderator’s view, no matter which option is chosen by RAN3 for issue 2, the main specification impact is BAP layer design. So RAN2 should be involved for the detailed design, and the moderator will suggest to involve RAN2 to discuss the details of the BAP routing for inter-donor-DU re-routed packets.

**Q3: Do you agree that RAN3 should inform RAN2 to discuss the detailed design for BAP routing towards the target IAB-donor-DU?**

|  |  |
| --- | --- |
| **Company** | **Comment** |
| Samsung | We can determine the solution first. The detailed RRC signaling design can be relied on RAN2.  In addition, if option 1 is selected for issue 1, this is pure RAN3 issue. For issue2, RAN2 involvement is needed. |
| ZTE | Agree |
| **Ericsson** | We think RAN3 should discuss first and ask the RAN2 to provide spec support for it. |
| QC | Agree  On Samsung’s comment: Option 1 for issue 1 doesn’t work. |
| Nokia | This issue should be first discussed in RAN2.  If RAN3 support is needed, then we start the discussion in RAN3. |
| Huawei | Agree, we can send LS to inform RAN2 about RAN3 progress, and RAN2 can provide efforts on the details for BAP routing design. |
| Lenovo | Agree. Any details for BAP routing design need input from RAN2. |
| CATT | RAN2 already kick off the discussion of local re-routing in this meeting. |
| Intel | Agree |
|  |  |
|  |  |
|  |  |

Summary:

9 companies replied.

Almost all companies agree that the RAN2 should be involved in the detailed spec design of the BAP routing issue. However, based on the proposal in Q2, we do not need any additional proposal here.

## Other issues

In [6], the packet re-routing being triggered by receiving BH RLF notification is proposed. But according to the following agreements in last meeting, the moderator suggest the triggering of local re-routing still be discussed by RAN2 first.

**Local re-routing in other scenarios, e.g. congestion mitigation, load balancing can be discussed in RAN2 first.**

**Q4: Any other issues related to the inter-donor-DU re-routing, but not covered by 3.1 and 3.2?**

|  |  |
| --- | --- |
| **Company** | **Comment** |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Summary:

# References

[1] R3-210103, Inter-donor-DU local re-routing in IAB (CATT).

[2] R3-210221, Discussion on inter-donor-DU local re-routing in Rel-17 IAB (Samsung).

[3] R3-210351, Inter-donor-DU local rerouting for IAB (Qualcomm Incorporated)

[4] R3-210491, Discussion on Inter-Donor-DU re-routing (Nokia, Nokia Shanghai Bell)

[5] R3-210551, Inter-donor-DU re-routing for IAB (Huawei)

[6] R3-210616, Discussion on IAB packet rerouting (Lenovo, Motorola Mobility)

[7] R3-210719, Considerations on inter-donor-DU re-routing (ZTE).