**3GPP TSG-RAN WG3 #114-e [R3-215904](https://ericsson-my.sharepoint.com/personal/filip_barac_ericsson_com/Documents/WORK/3GPP.exe/Meetings/RAN3%23114-e.exe/1.%20IAB/CBs.exe/CB%20%23%201306_IAB_Multi-hop/Inbox/R3-215904.zip)**

**1-11 Nov 2021**

**Online**

Agenda Item: 13.3.2

Source: ZTE (moderator)

**Title: Summary of Offline Discussion on CB: # 1306\_IAB\_Multi-hop**

Document for: Approval

# Introduction

**# 1306\_IAB\_Multi-hop**

**- Should the target IAB-donor-DU be provided with the source IP address of re-routed packets**

**- How should tunnelled packets be identified at th target IAB-Donor-DU? Based on BAP header information?**

**- Should a static IP tunnel be established between source and target IAB-Donor-DUs**

**- Try to converge on remaining issues (which seem few) and try to close the discussion**

(ZTE - moderator)

Summary of offline disc [R3-215904](https://ericsson-my.sharepoint.com/personal/filip_barac_ericsson_com/Documents/WORK/3GPP.exe/Meetings/RAN3%23114-e.exe/1.%20IAB/CBs.exe/CB%20%23%201306_IAB_Multi-hop/Inbox/R3-215904.zip)

This discussion has two phases:

**Phase 1: Discuss the data transmission between donor-DUs for inter-donor-DU re-routing.**

**Phase 2: TBD.**

The deadline for Phase 1 is Thursday, November 4, 23:59:59 UTC. This allows the moderator to prepare some proposals on Friday for Monday’s online session.

The deadline for Phase 2 is the same as for all email discussions, i.e., Tuesday, November 9, 12:00 UTC.

# For the Chairman’s Notes

# Discussion

## Issue 1 UL re-routed packet transmission between IAB-donor-DUs

In last RAN3 meeting, inter-donor-DU re-routing was discussed. To address the source IP filtering during inter-Donor-DU re-routing, Option 4 (i.e. IP-based tunneling between IAB-donor-DUs) was agreed to be considered. In this option, UL re-routed packet is transmitted between target donor-DU and source donor-DU. This can be achieved via a tunnel. For example, upon receiving a packet to be re-routed to source donor-DU, target donor-DU adds an additional IP header on top of the packet, where the destination IP address of the additional IP header is anchored at the source donor-DU. Then it sends the new IP packet to source donor-DU via a tunnel. Besides, contribution ([2]) proposes that the UL re-routed packet should be appended with a GTP-U header and an IP header (tunnel IP header) by target donor-DU, where the destination IP address in the tunnel IP header is the IP address of the source Donor DU.

In moderator’s view, data transmission between donor-DUs can be realized without a tunnel. For example, target donor-DU, source donor-DU and routers between them can be configured with a routing table, e.g. by OAM. Upon receiving an UL re-routed packet, they delivers it to the next hop according to the routing table, until the packet is finally transmitted to source donor-CU. This has higher transmission efficiency than tunnel-based mechanism since no additional header needs to be added to the re-routed packets..

***Q1: Please share your view on the UL re-routed packet transmission between IAB-donor-DUs, i.e. what kind of tunnel (e.g.IP-IP tunnel, IP-GTP-GTP-IP tunnel, etc.) should be applied if a tunnel is established between IAB-donor-DUs.***

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| --- | --- |
| Company | Comment |
| ZTE | In our view, data transmission between donor-DUs can be up to implementation. The transmission network or OAM determines how data is transmitted between donor-DUs. For example, routing tables can be configured at target donor-DU, source donor-DU and routers between them. UL re-routed packet is directly forwarded based on the routing table. Alternatively, a static tunnel can be configured between donor-DUs. The type of tunnel, e.g. IP-IP tunnel or IP-GTP-GTP-IP tunnel, to be established depends on transmission network or OAM as well. It is out of 3GPP’s scope.  |
| Lenovo | The Option 4 (i.e. IP-based tunneling between IAB-donor-DUs) has been already agreed in last meeting. So, we should focus on Option 4 instead of diverging.As for option 4, the UL rerouted packets can be transmitted from target-donor-DU to source-donor-DU via an IP-IP tunnel. |
| **Ericsson** | We already agreed that a **tunnel** should be considered. We can discuss at a later stage what tunnel type is to be used. |
| CATT | Option 4 had been agreed. Both tunnel types are Ok, we are open for this now. |
| Samsung  | Just follow the agreement. Why there is tunnel type? We understand the tunnel is referring to GTP-U protocol.  |
| Nokia | Opt 4 was already agreed in last meeting. So no need to confirm “***whether a tunnel is needed***”. Let’s move forward.Theoretically, any tunneling protocol (IP in IP, GTP, GRE…) would work. However, the GTP-U tunnel is widely used in RAN3 interfaces, so prefer to adopt the GTP-U tunnel.  |
| Huawei | In general, we think the main issue here is to configure the source/target and intermediate node, so that the packets will not be discarded, with this understanding, we think a list of source IP address(es) to be used for the re-routed packets will be informed to the target IAB-donor-DU. On the other hand, we are ok that since the establishment of the tunnel is transport layer business, it could be left for implementation, as long as the packets will not be discarded. |
| QCOM | We should first agree that this is a **static** tunnel. If it is static, it is up to implementation, i.e., the operator can configure whatever the donor-DUs support.  |
|  |  |

In last RAN3 meeting, whether static or dynamic tunnel is established between IAB-donor-DUs for option 4 was discussed but no consensus was achieved. Regarding this issue, contributions([3][4][5][7]) propose a static tunnel should be used. While contributions([2][9]) think the tunnel should be dynamic so that it can be established in a more flexible and efficient way. Contribution ([10]) proposes the selection of the static or dynamic inter donor-DUs tunnel should be left to implementation

***Q2: If you agree with the tunnel-based mechanism, please share your view on the establishment of the tunnel between IAB-donor-DUs, i.e. whether static or dynamic.***

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| --- | --- |
| Company | Comment |
| ZTE | A static tunnel is preferred because it has no specification impact, e.g. it can be configured by OAM.If the tunnel is dynamically established, for intra-CU re-routing case, donor-CU needs to configure donor-DUs to setup IP-based tunnel. Furthermore, for inter-CU re-routing case, source donor-CU needs to indicate target donor-CU about the IP-based tunnel establishment. And the information of source donor-DU(e.g. IP address) should also be sent to target donor-CU in order for it to configure target donor-DU. Otherwise, target donor-DU does not know who to build this tunnel with. Considering the specification impact and RAN 2/3 work, it is better to use static tunnel. |
| Lenovo | Static tunnel is preferred for minor specification impacts. |
| **Ericsson** | We prefer **dynamic** management, as it offers better flexibility and granularity. We need to be able to treat different UL packets differently in the QoS sense. Note that this does not preclude setting up tunnels in advance, i.e., well before the migration event.Also, the dynamic option is somewhat better aligned with inter-donor-DU tunneling for avoidance of descendant node reconfiguration, discussed in AI 13.2.2, although the static-based option works as well. |
| CATT | Static tunnel. We do not see a clear benefit for dynamic tunnel. OAM can handle this including QoS per tunnel. The IP addresses of two donor DUs will not be changed frequently and tend to stay the same. |
| Samsung  | Static tunnel is enough. Such re-routing is only used for a temporary case, e.g., in-flight packet transmission during migration, congestion, etc. |
| Nokia | Prefer Dynamic tunnel. Static tunnel can work, but it requires more OAM work, e.g. need to establish multiple tunnels between a pair of Donor-DU (e.g. tunnel per QoS), and multiple tunnels to different Donor-DUs. This is also difficult when the Donor-DU is acting a DHCP proxy that requires IP address from a central DHCP server, and then allocate the IP address to the IAB. The OAM may not know a Donor-DU’s IP addresses assigned by the DHCP server. The signling required for dynamic tunnel establishment is simple. Considering the benefit and small standard work, we prefer a dynamic tunnel. |
| Huawei | For static tunnel mode, the target IAB-donor-DU needs to be pre-configured with the tunnel endpoint of the source IAB-donor-DU. Meanwhile, the intermediate transmission nodes between two donor-DUs should also be pre-configured to ensure the connectivity of the underlying IP network.For dynamic tunnel mode, when to configure the tunnel needs further investigation, but technically the existing procedure should work.We see pros and cons for both approaches, it could be left for network implementation. |
| QCOM | The **static** tunnel is the only reasonable solution: The purpose of this tunnel is to allow UL packet delivery in response to e.g., BH RLF. This means that the tunnel must be in place **before** BH RLF occurs. Since there is no generic way to predict BH RLC the tunnel must be in place all the time.  |
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It is noticed that not all the UL packets arriving at target donor-DU needs to be re-routed to source donor-DU, it is necessary for target donor-DU to differentiate between the re-routed UL packet and the normal UL packet.

Contributions ([3][4][6][7][9][10]) proposes that target donor-DU receives a list of source IP address(es) to be used for the re-routed packets from donor-CU, and determines the re-routed UL packet based on the IP address list. Contribution ([5]) proposes if the source IP address of a received packet belongs to IP-address pool of source IAB-donor-DU, target donor-DU re-routes the packet to source donor-DU. Contribution ([2]) thinks BAP PDU is transmitted via the tunnel, and the packet to be tunnelled should be identified based on the BAP header. Contribution ([8]) considers two cases. If the IP packet is transmitted via the tunnel, target donor-DU can pick out the normal UL packets with source IP addresses within the pool of target donor-DU itself. If the BAP PDU is transmitted via the tunnel, additional explicit or implicit indication needs to be introduced to differentiate between the rerouted UL packets and the normal UL packets.

As we can see, the means for target donor-DU to differentiate between the re-routed UL packet and the normal UL packet depends on the re-routed packet type, i.e. IP packet or BAP PDU packet. So, companies are first invited to provide their views on the re-routed packet type.

***Q3: Please share your view on the type of the re-routed packet transferred between IAB-donor-DUs, whether IP packet or BAP PDU packet.***

|  |  |  |
| --- | --- | --- |
| Company | IP packet or BAP PDU packet | Comment  |
| ZTE | IP packet | Compared with transmitting IP packet, transmitting BAP PDU packet requires more specification impact. Because target donor-DU needs to be configured with the mapping between BAP addresses (or BAP routing IDs) and the tunnels. Otherwise, target donor-DU does not know which tunnel the BAP PDU should be delivered to. However, regarding IP packet, target donor-DU can know the correct tunnel by implementation, e.g. if source IP address of a re-routed packet belongs to IP-address pool of a donor-DU, target donor-DU delivers the re-routed packet to the tunnel corresponding to the donor-DU. |
| Lenovo | Both IP packet and BAP PDU packet are workable |  |
| **Ericsson** | Both could work (BAP option explained in answer to Q5) | One option, pertaining to tunneling of IP packets, could be to use the **BAP header** to **identify the rerouted packets** and use the source address in the **IP header** to **select the appropriate tunnel.**The advantage of the above is that the target Donor-DU would not need to check the list of “to-be-tunneled” source IP addresses for every packet with an “unfamiliar” source IP address, but only when the BAP header indicates a rerouted packet. (Please note that it is also possible that a Donor-DU receives packets with “unfamiliar” source IP address that are not rerouted.)On the other hand, the use of the source address in the **IP header** to identify the rerouted packets would require that the target Donor-DU checks the list of “to-be-tunneled” source IP addresses for every UL packet with an “unfamiliar” source IP address. |
| CATT | Both | BAP packet: BAP routing ID indicates tunnel transmission. It requires that the destination BAP address in the rewrite BAP routing ID is not the real target donor DU’s BAP address. It can be source donor DU’s BAP address or a virtual BAP address.IP packet: Target donor DU received a BAP packet which has the destination BAP address/BAP routing ID corresponding to target donor DU. Then, target donor DU sends it to up layer and reads the IP header. It identifies that the IP address is source donor CU. For this step, the target donor DU is required to disable source IP filter, or target donor DU received source IP address. Otherwise, the IP packet cannot be sent via IP-based tunnelling to source donor DU. |
| Samsung  | IP packet  | BAP PDU cannot work. Let’s take migration case as an example. There are some in-flight packets which has the old source IP address, and needs re-routing via tunnel. The header rewriting will be applied to those packets by using BAP routing ID assigned by CU2. Except those in-flight packets, the packets with updated new source IP address may also use the same BAP routing ID since they are belonging to the same UL tunnel. In other words, for the packets with the same BAP routing ID, some has the old source IP, and some has the new source IP. Apparently, we only re-route the packets with old source IP via the tunnel. In addition, we didn’t any benefit to send the BAP routing ID assigned by CU2 to CU1.  |
| Nokia | IP packet | The BAP header may be re-written by the boundary node.  |
| Huawei | IP packet | We share similar comments as ZTE. BAP PDU requires more specific work, additional work needed to take care of the mapping between BAP address and IP address of a tunnel. |
| QCOM | IP tunneling is fine | IP router functions, such as supported by the IAB-donor-DU, typically support IP tunneling solutions with configurable filter conditions off-the-shelf (filter condition, e.g., if source IP address has following prefix then tunnel to IP address Y). All this occurs on IP layer and can be readily used. **Tunneling the BAP header doesn’t have any benefit.** Also, the BAP address space of donor-DU1 in topology 1 is completely unrelated to donor-DU2 in topology 2. This means that donor-DU1 in topology 1 should not have to know about BAP routing IDs from topology 2. |
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|  |  |  |

***Q4: If your answer to Q3 is IP packet, do you agree target donor-DU determine the re-routed UL packet based on a list of source IP address(es) from donor-CU?***

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| --- | --- | --- |
| Company | Yes/No | Comment  |
| ZTE | Yes  | If the source IP address of an UL packet is in the source IP address list, target donor-DU regards the packet as a re-routed packet. |
| Lenovo | See comments | Based on the source IP address of each UL IP packet, target-donor-DU can pick out the normal UL packets whose source IP addresses within the pool of the target-donor-DU itself, and other UL packets can be regarded as the rerouted UL packets.Since the source IP address(es) are needed informed from donor-CU, target donor-DU can also determine the re-routed UL packet based on the list of source IP address(es). |
| **Ericsson** | Yes, but… | It should be possible to indicate **IP prefixes and/or individual IP addresses** to the target Donor-DU. |
| CATT | Yes |  |
| Samsung  | Yes  |  |
| Nokia | Yes | Agree with Ericsson.  |
| Huawei | Yes | With the list of source IP address(es) from donor-CU configured at target donor-DU side, UL packets will be recognized.  |
| QCOM | No, see comment | The tunneling condition is based on the destination-donor-DU’s **IP prefix**, i.e., all packets that have source IP address of that IP prefix will go into the tunnel. It is therefore not necessary to have a list of individual IP addresses. |
|  |  |  |

***Q5: If your answer to Q3 is BAP PDU packet, please share your view on how target donor-DU differentiate between the re-routed UL packet and the normal UL packet.***

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| --- | --- |
| Company | Comment  |
| Lenovo | For the BAP PDUs transmitted via the tunnel, since BAP routing ID has been rewritten at the boundary IAB node, and the BAP routing IDs used for the rerouted UL packets and the normal UL packets may be the same in the target routing path, then additional explicit or implicit indication needs to be introduced to differentiate between the rerouted UL packets and the normal UL packets. |
| **Ericsson** | How to **distinguish the packets to be tunneled**: by means of an explicit indication in BAP header or a dedicated UL BAP routing ID, used exclusively for BAP header rewriting. |
| CATT | See Q3 ☺ |
| Huawei | See comments above |
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Considering that target donor-DU could have wired connection with several donor-DUs, contribution ([8]) raises target-donor-DU should route each UL re-routed packet to the correct donor-DU via the corresponding tunnel. And it proposes that for the IP packets transmitted via the tunnel, target-donor-DU needs to be informed with the mapping between source IP addresses and the tunnels from CU. For the BAP PDUs transmitted via the tunnel, target-donor-DU needs to be informed with the mapping between new BAP addresses (or new BAP routing IDs) and the tunnels from CU.

***Q6: If your answer to Q3 is IP packet, please share your view on how target donor-DU know which tunnel the re-routed UL packet should be delivered to.***

|  |  |
| --- | --- |
| Company | Comment  |
| ZTE | If source IP address of a re-routed packet belongs to IP-address pool of a donor-DU, target donor-DU delivers the re-routed packet to the tunnel corresponding to the donor-DU. |
| Lenovo | Target-donor-DU needs to be informed with the mapping between source IP addresses and the tunnels from CU, and then forwards the IP packets to the according tunnels |
| **Ericsson** | Target Donor-DU knows this **based on the mapping between tunnel and source IP address pool**. It should be further discussed whether this mapping is configured via OAM or via network signalling. |
| CATT | The local rerouting is between two donor DUs (redundant path), when target donor DU received the IP packet, it can read the IP header is source donor DU (if we agree to configure source IP address to target donor DU). |
| Samsung  | This depends on how the inter-donor-DU tunnel is configured. Since we consider this tunnel can be static, one possible way is to let OAM do the job. Anyway, let’s first to conclude the inter-donor-DU tunnel configuration first.  |
| Nokia | Target Donor-DU checks the source address field of the UL packet, with the configured mapping between tunnel and source IP address. The mapping can be configured via signaling.  |
| Huawei | As long as the target DU was configured with the source IP address(es), we think there should be a mapping relation between IP address and tunnel which is maintained inside target DU, but we don’t see any spec impact for this delivering. |
| QCOM | This is statically configured via OAM. IP routers typically support IP-prefix-based tunneling of this kind. |
|  |  |

***Q7: If your answer to Q3 is BAP PDU packet, please share your view on how target donor-DU know the corresponding source donor-DU the re-routed UL packet should be delivered to.***

|  |  |
| --- | --- |
| Company | Comment  |
| Lenovo | Target-donor-DU needs to be informed with the mapping between new BAP addresses (or new BAP routing IDs) and the tunnels from CU, and then forwards the BAP PDUs to the according tunnels. |
| **Ericsson** | The boundary/migrating node can be configured with **a dedicated UL BAP routing ID to be used exclusively for BAP header rewriting** (not for its own traffic). By knowing the source Donor-DU corresponding to this UL BAP routing ID, the target Donor-DU knows where to tunnel the packet. |
| CATT | Specific rewrite BAP routing ID represents a tunnel toward to source donor DU  |
| Huawei | See comments above |
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Contribution ([7]) mentions the timing of providing the source IP address list to target donor DU, i.e. when target donor-DU receives the information used for distinguishing the re-routed UL packets.

***Q8:Please share your view on when target donor-DU receives the information used for distinguishing the re-routed UL packets.***

|  |  |
| --- | --- |
| Company | Comment  |
| ZTE | This can be up to donor-CU implementation. |
| Lenovo | This can be left to implementation. |
| **Ericsson** | This can be left to implementation because different scenarios may require different timings. |
| CATT | We can set some trigger conditions so that the source CU knows exactly when to provide the IP address to reduce the impact on the behaviour of IP filter at target donor DU e.g., after RRC recovery failure or source partial migration is trigged.  |
| Samsung  | Implementation issue. For migration case, once the CU2 receives the old source IP address via HO REQ message, CU2 can configure it.  |
| Nokia | Up to the implementation.  |
| Huawei | It is up to when donor-CU would like to provide the information, right? If so, we tend to share with ZTE. |
| QCOM | Tunnel needs to be up **before** any BH RLF occurs on any BH link in the topology, where UL rerouting would be beneficial. Indeed, it should be up to implementation.  |

Contribution ([4]) proposes that in some cases, e.g. migration, once the re-routed packets are all transmitted completely, the source IP address list may not be needed. So target donor-DU should release the source IP address list. Contribution ([3]) proposes target donor-DU should be informed on source IP address(es) which are no longer tunnelled. In sum, this is about the release of the information used for distinguishing the re-routed UL packets at target donor-DU.

***Q9:Please share your view on the release of the information used for distinguishing the re-routed UL packets at target donor-DU.***

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| --- | --- |
| Company | Comment  |
| ZTE | In our view, target donor-DU may need to release such information. Otherwise, it would send the packet, which should have been discarded, to source donor-DU. However, both donor-CU and target donor-DU are not clear when to release the information, because they do not know which packet is the final re-routed packet. So we think the release operation is up to target donor-DU implementation. |
| Lenovo | The release can be left to implementation. |
| **Ericsson** | It may be too early to discuss this. It depends on how the solution for setting up the tunnel will look. Perhaps this could be up to implementation. |
| CATT | We are open to discuss it. E.g., after revoke procedure. |
| Samsung  | We support the release operation. However, it is fine to discuss this later.  |
| Nokia  | This can be discussed later.BTW, In case it is static tunnel, how can this release be performed? |
| Huawei | If the tunnel is not used anymore, then it is up to implementation when and how to remove, there is no need to discuss a standardized solution. |
| QCOM | 1) There is **no** source **IP address list**. There is only one **source IP prefix** per destination donor-DU.2) The tunnel should stay up since it may be needed for UL re-routing when BH RLF occurs. Such BH RLF incidences are not known beforehand.3) There is no need to explicitly release anything since the tunnel is static. |

In last RAN3 meeting, 6 options were discussed for inter-donor-DU re-routing and Option 4 was agreed to be considered, i.e. IP-based tunneling between IAB-donor-DUs. Contribution ([10]) raises that Option 6 is also a feasible solution, i.e., the direct forwarding from target IAB-donor-DU to source IAB-donor-CU via IP-based tunnel, among which, the source IP address of the new added outer IP header can be the target IAB-donor-DU’s IP address and the target IP address of the new added outer IP address can be the source IAB-donor-CU’s IP address. However, contribution ([9]) thinks Option 6 does not work in deployments with external security gateways.

Companies are invited to provide their views on the above options.

***Q10: Which option(s) do you prefer to address the source IP filtering during inter-Donor-DU re-routing, e.g. Option 4, Option 6 or Both.***

|  |  |  |
| --- | --- | --- |
| Company | Option(s) | Comment |
| ZTE | Both, but  | We are open for this. Transmitting re-routed packet between target donor-DU to source donor-CU may work if appropriate routing table is configured at target donor-DU and related routers. |
| Lenovo | Option 4 | The down-selection among all options had been done in last meeting. It’s better not to repeat the discussion on it. |
| **Ericsson** | Wasn’t option 4 already as good as agreed? |  |
| **CATT** | Option 4 |  |
| Samsung  | Option 4 |  |
| Nokia | Option 4 | Suggest keep current agreement, and stop discuss other options.  |
| Huawei | Both |  |
| **QCOM** | Option 4 | Option 6 is already off the table. |
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## Issue 2 BAP re-routing towards the target IAB-donor-DU

In this meeting, RAN3 receives an LS[1], which captures RAN2’s agreement on BAP re-routing towards the target IAB-donor-DU:

*For inter-donor-DU re-routing, support the “previous routing ID to new routing ID” BAP header rewriting.*

According to this agreement, IAB node could re-write the routing ID of the UL re-routed packet to a new routing ID, so that the packet can be forwarded to the target donor-DU.

***Q11: Do you think that performing BAP header rewriting for inter-donor-DU rerouting have any impact on RAN3?***

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment  |
| ZTE | No  |  |
| Lenovo | No |  |
| **Ericsson** |  | There is impact on the assumptions that we are taking in RAN3 work, for example on rerouted packet handling at the target Donor-DU.  |
| CATT | No at this stage | May be it impact the option of “BAP packet” on option 4? But please wait for RAN2 progress. |
| Samsung  |  | Wait for RAN2 progress.  |
| Nokia |  | Wait for RAN2 |
| Huawei  | No |  |
| QCOM | Yes | RAN3 may have to provide additional signaling for header rewriting. This is inter-donor header rewriting, i.e., not the same header rewriting as performed for inter-topology transfer!  |
|  |  |  |

# Conclusion, Recommendations [if needed]

If needed

# References

1. R3-214681 Reply LS on inter-donor-DU rerouting (RAN2)
2. R3-214826 Uplink Inter-Donor Rerouting in IAB Networks (Ericsson)
3. R3-214870 IP-based tunneling between IAB-donor-Dus (Fujitsu)
4. R3-214876 (TP to BL CR of TS38.473) Discussion on the inter-donor-DU rerouting (Samsung)
5. R3-214906 Inter-donor-DU local rerouting for IAB (Qualcomm Incorporated)
6. R3-214927 Discussion on inter-Donor-DU re-routing in IAB (ZTE)
7. R3-215016 Discussion on inter-donor-DU re-routing (CATT)
8. R3-215306 Discussion on UL packet transmission for inter-donor-DU re-routing (Lenovo, Motorola Mobility)
9. R3-215347 (TP for BL CR for TS 38.401) Inter donor-DU re-routing (Nokia, Nokia Shanghai Bell)
10. R3-215610 Inter-donor re-routing for IAB and unnecessary transmission during topology update (Huawei)