**3GPP TSG-RAN WG2 Meeting #109e-bis R2-20xxxxx**

**Electronic meeting, April 20 – April 30**

**Agenda item:** 6.1.6

**Source:** Qualcomm Incorporated (Rapporteur)

**Title:** [AT109bis-e][022][IAB] RLF Handling (Qualcomm)

**Document for:** Discussion

# Introduction

This document handles offline email discussion:

* [AT109bis-e][022][IAB] RLF Handling (Qualcomm)

Scope: Treat RLF handling to close open issues and make correction if applicable, [R2-2003813](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_109bis-e\Docs\R2-2003813.zip), and [R2-2003726](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_109bis-e\Docs\R2-2003726.zip)

Expected outcome: Decisions taken in this email discussion shall be taken into account in the other email discussions on CRs: RRC, possibly BAP, Possibly Idle Mode TS.

Deadline: April 24 0700 UTC

Since the report from [Post109e#36][IAB] RLF Handling Open Issues was not handled during the webinar session, this conclusion section will include the proposals from that session. These proposals (in short) were:

**Proposal 1-1: IAB-DU behavior after RLF declaration is left up to implementation. IAB-DU should be able to send RLF notification when RLF recovery fails.**

**Proposal 1-2: Fast MCG link recovery is supported for NRDC and ENDC.**

This offline discussion aims to address further issues that have not been properly resolved during the post-109e email discussion or that have been identified in contributions to R2#109e-bis. It will *not* address topics which were properly addressed in post-109e email discussion and did not result in any proposals. It will not discuss support for Rel-15/16 features.

**We should aim for functional freeze in this meeting since it is the second-to-last of the WI. The timeframe of this offline is very short. Therefore, we can only move forward with proposals that get broad support.**

# Discussion

2.1 SCGFailureInformation report includes a new failure type

This issue was raised by two companies during the discussion in the post-109e email discussion.

**Proposal 2-1: SCGFailureInformation report includes “reception of RLF recovery failure” as new type.**

**Q: Do you agree with proposal 2.1?**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment |
| Ericsson |  | The issue of new failure type for SCGFailureInformation and MCGFailureInformation was discussed in [Post109e][035] and there was a consensus to have a new failure type. The draft CR (offline-021) has already included the ASN.1 signaling for these new failure type.  So, we suggest not to discuss this issue again.  The issue is which failure type to select in FailureReportSCG. Since no legacy existing failure type seems to really fit the scenario of parent BH link failure recovery, it is reasonable to introduce a new failure type. The same should be included also in MCGFailureInformation.  That being said, this has already been discussed in the IAB RRC email discussion, and the RRC details are being discussed in offline-21. Thus, no need to discuss again here. |
| Nokia | Yes | The same is applicable to MCG failure. As mentioned by Ericsson, probably there is no use to discuss this again. |
| Lenovo | Yes | The majority has supported to have a new failure type for both SCGfailureinformation and MCGfailureinformation. We do not need to discuss it again. In addition, failuretype IE is mandatory in the legacy failure message. |
| Futurewei | Yes | As discussed by other companies above, this issue along with similar discussion for MCG failure type was discussed in previous e-mail discussion, and there was strong majority support.  If there are further concerns about the majority view, then these can be discussed in offline-21. |
| Kyocera | Yes | We think it was concluded in the email discussion [Post109e][035][IAB] for RRC open issues. |
| CATT | Yes | It was concluded in the email discussion [Post109e][035][IAB] for RRC open issues. |
| Apple | Yes |  |
| Intel | Yes |  |

2.2 Reestablishment at former parent node

The IAB-node should *not* attempt reestablishment at its former parent node for some time after receiving BH RLF notification. This was proposed by R2-2003302 and R2-2003314.

We need to agree if anything should be captured:

**Proposal 2-2: Specification captures that the parent node, which sent BH RLF notification, should not be considered for reestablishment for some time.**

**Q: Do you agree with proposal 2.2?**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment |
| Ericsson |  | We agree with the intention of this proposal. However, we believe that given the limited time, it is not necessary to specify that in Rel.16, it can be handled via implementation. |
| Nokia | No | This can be achieved by implementation as reestablishment is based on cell selection. The node which sends the RLF indication may also disable IAB support indication to prevent IAB-MTs from attempting to connect. |
| Lenovo | Yes | It is helpful for IAB MT to avoid re-establishment failure if the same parent node is re-selected. |
| Futurewei | No | Agree with Nokia, the desired behavior can be achieved by disabling IAB support indication from cells of the IAB-DU.  Not sure if we need to explicitly capture this in the normative text, but it would be nice to somehow capture this if there is consensus (e.g. adding a note to appropriate TS?) |
| Kyocera | Yes | We think the IAB-MT excludes the cell which sent BH RLF Notification from cell selection candidates for this RRC Reestablishment, even if the parent node still broadcasts IAB-Support in its SIB1. |
| CATT | No | Agree with Nokia. This can be left to UE implementation. No specification is needed. |
| Apple | No | We do also understand the intent here. However, from our view deployments might not always cause this to happen and will therefore fall back to implementation specifics. So keeping it up to implementation will be sufficient. |
| Intel | Yes | We think it is clear that the MT should avoid the cell that sent the BH RLF notification (given that recovery has failed). |

It needs to be decided if the time frame is up to implementation or configurable.

**Option a: Time frame is up to implementation**

**Option b: Time frame is configurable.**

**Q: Which option do you prefer?**

|  |  |  |
| --- | --- | --- |
| Company | Preferred option (a, b) | Comment |
| Ericsson | a | This should leave to implementation. |
| Nokia | a | It should be up to network implementation how to handle this. No specification is needed. |
| Lenovo | Option a | Left for implementation. |
| Futurewei |  | We can already see that considering proposal 2-2 results in opening many additional points to discuss. At this late stage, we prefer not to open new topics to discussion. Therefore, we prefer to address this issue with the simplest solution possible. |
| Kyocera | other | We think it could be simply hard-coded with e.g., 300 seconds as usual or only applicable to “this” RRC Reestablishment. |
| CATT | a | Agree with Futurewei. At this late stage, we prefer not to open new topics to discussion. No specification effort is needed for this issue. |
| Apple | A | See comment above |
| Intel | A |  |

2.3 Support of other types of RLF indication

Types ½/3 RLF indications were established in an email discussion during last year. They were further proposed in post-109e email discussion as well as in R2-2002855, R2-2002991, R2-2003302, and R2-2003314. These types of RLF indication can help avoiding that the IAB-node tries to re-establish at its own descendant nodes.

Getting agreement on such a complex issue at this late stage of the WI is a rather adventurous undertaking. There are lots of different options to be considered. We will try to explore the space.

Type-1/2 indication allows fast propagation of RLF problems throughout the subtree. Here is how this would work:

If a single-connected IAB-node has determined BH RLF or received a BH RLF indication (which is different from the RLF notification sent after recovery failure) from its parent node, it sends an RLF indication to its child node, removes the “IAB-supported” indicator in SIB1 and blocks IAB-MT access.

This already contains a lot of material, but there is little benefit in breaking it further down.

**Proposal 3-0a: If a single-connected IAB-node has detected a BH RLF, it may send an RLF detection indication (type-2) to its children nodes.**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment |
| Ericsson | Yes | This proposal is needed to allow the child node to prepare for possible performance degradation at the parent node or search for alternative parents, up to the implementation. |
| Nokia | Yes | We described our overall “vision” of how additional types of RLF indications should work in the reply to Proposal 3-1. This proposal seems to be aligned with that. |
| Lenovo | Yes | When child IAB node receives the indication of RLF detection, the received child IAB node may suspend the transmission with its own downstream node. It can be left for implementation because of the limited time. |
| Futurewei | No | We already discussed this topic online and offline in several previous meetings. It seems that every proponent has a different understanding of what information different BH RLF indications would convey, and what response child IAB nodes should take.  At this late stage, we prefer not to re-open discussions that have already been concluded. |
| Kyocera | Yes | We think this is the original concept of Type ½ BH RLF Notification.  As commented in Proposal 3-1 below, we think the IAB-MTs (and hopefully the UEs), that have already connected with the parent, should stop transmitting SR (and possibly other UL transmissions), upon reception of Type ½ BH RLF Notification. |
| CATT | No | Share the same view as Futurewei. To re-open discuss the issues on other types of RLF indication is not preferred at this stage. |
| Apple | Yes | We agree with E///’s view here |
| Intel | Agree with proposal but not sure if we can do this in the remaining time | We see value in doing this. However, it is not clear that at this late stage this can be done (i.e., addition of another indication and defining corresponding behavior). |

**Proposal 3-0b: If a single-connected IAB-node has recovered from BH RLF, it may send an RLF recovery indication (type-3) to its children node.**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment |
| Ericsson | Yes | This proposal is needed to inform the child node that the parent has recovered the connection so that it can resume normal operations. |
| Nokia | Yes | We described our overall “vision” of how additional types of RLF indications should work in the reply to Proposal 3-1. This proposal seems to be aligned with that. |
| Lenovo | Yes | After receiving the RLF recovery indication, child IAB node may resume the transmission with its own downstream node. It can be left for implementation because of the limited time. |
| Futurewei | No | We already discussed this topic online and offline in several previous meetings. It seems that every proponent has a different understanding of what information different BH RLF indications would convey, and what response child IAB nodes should take.  At this late stage, we prefer not to re-open discussions that have already been concluded. |
| Kyocera | Yes | We think this is the original concept of Type 3 BH RLF Notification. |
| CATT | No | Share the same view as Futurewei. To re-open discuss the issues on other types of RLF indication is not preferred at this stage. |
| Apple | Yes |  |
| Intel | Agree with proposal but not sure if we can do this in the remaining time | This is needed only if 3-0a is agreed. |

**Proposal 3-1: If a single-connected IAB-node has determined BH RLF or received a BH RLF indication (which is different from the RLF notification sent after recovery failure) from its parent node, it sends an RLF indication to its child node, removes the “IAB-supported” indicator in SIB1 and blocks IAB-MT access.**

**Q: Do you agree with proposal 3.1? Any variation?**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment |
| Ericsson | No | It is not needed to propagate the RLF indication along the path since the parent node can try to recover the connection. That can also be complicated in terms of message overhead, depending on the topology structure. So better leave this aspect (what the child node does when receiving the indicators) to implementation,  For example, no need to specify behavior at child/parent node upon receiving/sending such RLF notification, such as modifying SIB or blocking other MT access. |
| Nokia | No | We did not bring the paper on this issue to this meeting, but our views are expressed in the paper we had in RAN2#109-e meeting in R2-2001056. We think that actions performed upon receiving BH RLF indication by the IAB-DU should be left to network implementation. We think that we just need to specify what events trigger different notifications. We propose the following:   * “RLF recovery failure” triggered by RRC Reestablishment failure, already specified * “RLF detection” triggered by RLF being declared * “RLF recovery” triggered by successful RRC Reestablishment   We think we only need to specify that upon such events the indications are provided to BAP. What to do at BAP layer, i.e. whether to send them to child nodes or not, can be up to implementation. We also do not think we need to specify the behavior on the receiving end for those two additional indications. |
| Lenovo | No | When IAB MT does not need to stop ‘IAB-supported’ after receiving RLF indication since it may be recovered. In general, IAB DU may stop broadcasting IAB-supported only after IAB MT receives the RLF notification. We have agreed to leave for implementation. |
| Futurewei | ?? | I guess this question is pertaining to the “additional” BH RLF indication(s) of proposals 30-a & 3-0b.  If so, then I think it is clear from this and the subsequent questions why we should not be entertaining re-opening of concluded discussions, particularly at this late stage. Re-opening these already concluded discussions will only open the door to a myriad of follow up issues that need to be discussed and concluded. |
| Kyocera | Yes | We think the IAB-MTs (and hopefully the UEs), that have already connected with the parent, should stop transmitting SR (and possibly other UL transmissions), upon reception of Type 1/2 BH RLF Notification. |
| CATT | No | At this late stage, we prefer not to discuss those issues for optimization. |
| Apple | No | Agree with Lenovo here This is up to implementation |
| Intel | Yes | I understood this question to be independent of 3-0a and 3-0b (i.e., this is referring to the RLF indication that we already have, which is sent after RLF recovery failure).  Blocking MT access in this situation is clearly needed and the natural way to do this is by turning off IAB supported. |

If the “MT-access blocking” state was triggered by local RLF, it can be reversed upon recovery. Otherwise, it can be reversed after expiration of a (configurable) timer or upon reception of a type-3 indication.

**Option 1: The IAB-node reinstates “IAB-supported” indicator in SIB1 and readmits IAB-MT access attempts upon RLF recovery or after some time.**

**Option 2: The IAB-node reinstates “IAB-supported” indicator in SIB1 and readmits IAB-MT access attempts upon RLF recovery or after reception of a type-3 indication.**

**Option 3: Child/parent IAB node actions upon receiving/sending the RLF notification/recovery are left to implementation.**

**Q: Which option do you prefer?**

|  |  |  |
| --- | --- | --- |
| Company | Option preferred | Comment |
| Ericsson | 3 | Assuming that the RLF indication signaling is in place, it could be left to the implementation of the child/parent node how to behave. |
| Nokia | 3 |  |
| Lenovo | 3 |  |
| Futurewei |  | Prefer not to re-open discussions which have already been concluded. Please see comments to Proposal 3-1 above. |
| Kyocera | 2 | We also think Type 3 BH RLF allows the IAB-MTs (and hopefully the UEs) in RRC Connected to resume UL transmissions including SR. |
| CATT |  | At this late stage, we prefer not to discuss those issues for optimization. |
| Apple | 3 | Upto implementation … One major concern with all these “upto” implementations we have is UL latency. |
| Intel |  | Fine to leave this to implementation. Even option 1 is basically implementation. |

In case of Option 1, the time frame might be based on implementation or based on a configurable timer:

**Option 1.1: Time frame up to implementation**

**Option 1.2: Time frame configurable**

**Q: In case of option 1, which sub-option do you prefer?**

|  |  |  |
| --- | --- | --- |
| Company | Option preferred | Comment |
| Nokia | 1.1 |  |
| Lenovo | 1.1 |  |
| Futurewei |  | Prefer not to re-open discussions which have already been concluded. Please see comments to Proposal 3-1 above. |
| CATT | No | At this late stage, we prefer not to discuss those issues for optimization. |
| Apple | 1.1 |  |
| Intel | 1.1 |  |

In case of option 2: If multiple BH links in a chain have link quality issues their RLF indicators and radio-link recovery (RLR) indicators may overlap in time and create a state of uncertainty among the descendant nodes. To avoid such a situation, the BH RLF indicator and BH RLR indicator should contain, e.g., the node’s BAP address to avoid such conflicting information.

**Q: In case of option 2, should the BAP address (or another identifier) be included in the RLR indication?**

|  |  |  |
| --- | --- | --- |
| Company | BAP address in included in RLF/RLR indication (yes/no) | Comment |
| Ericsson | No | We do not see this scenario as really an issue, given that the RLF indication and RLF recovery success/unsuccess are sent to the child. |
| Nokia | No | This can also be left to network implementation. If we try to over-optimize, then indeed this task seems to be too complicated. We think a simple scheme of additional RLF indications with no extra information is something that we should aim for. |
| Lenovo | No |  |
| Futurewei |  | Prefer not to re-open discussions which have already been concluded. Please see comments to Proposal 3-1 above. |
| Kyocera | No | We think the BH RLF Notifications always come from its parent, so we don’t assume any confusion. |
| CATT | No | At this late stage, we prefer not to discuss those issues for optimization. |
| Intel | No | The purpose of this is not clear. Knowing the BAP address does not help the child node MT in avoiding/not measuring the IAB node. |

Dual-connected IAB-nodes with RLF on one of the BH links might be able to use the other link for backhauling. If the dual-connected IAB-node receives a RLF indicator from the parent node, however, it does not know if the failed link resides on a subset of paths or on all paths. In prior case, it should make itself available to allow access by orphaned IAB-nodes, in the latter it shouldn’t.

Options considered might be:

**Option A:** Dual-connected nodes do not send RLF and RLR indications.

**Option B:** Dual-connected nodes do send RLF and RLR indications.

**Option C:** Nothing needed in this release.

**Option D:**

**Q: How should dual-connected nodes behave?**

|  |  |  |
| --- | --- | --- |
| Company | Option (A, B, C…) | Comment |
| Ericsson | C |  |
| Nokia |  | This can be left up to network implementation |
| Lenovo | C | The data in the link associated with the reception of RLF detection can be forwarded to the available link. |
| Futurewei |  | Again, this is a topic which we have already concluded in previous meetings. For reference here are the relevant agreements from RAN2 #107bis:   * When NR DC is configured for the IAB-node, 2.1 RLF is detected separately for the MCG-link and for the SCG-link, and 2.2 existing UE procedures are used for MCG-link and SCG-link failure handling. * The following is agreed as working assumption: BH RLF recovery for DC case reuses UE’s MCG and SCG failure recovery procedures specified in Rel-16.   ….   * For DC case, the IAB-node considers the radio link is failed and uses RRC existing or Rel-16 Mechanism (e.g. MCG or SCG failure report, RRC reestablishment) if “Recovery Failure” notification is received from parent nodes on MCG-link or/and SCG-link. * R2 assumes that RLF notification “recovery failure” would be triggered when RRC reestablishment has failed. FFS whether this need to be specified   We think behavior of Dual-connected IAB nodes is quite clear from these agreements. |
| Kyocera | B, if… | We think Type 1/2 BH RLF Notification is sent if RLF happens on both MCG and SCG, i.e., upon it initiates RRC Reestablishment procedure.  We also think Type 3 BH RLF Notification is sent if BH link is successfully recovered, i.e., RRC Reestablishment succeeds. |
| CATT |  | Share the same view as Futurewei. |
| Apple | C | Agree with Futurewei and agree that nothing more needs to be done here and the existing agreements can be used. |
| Intel | C | An alternative path is available in this case (some routing configuration may need to be updated – but that is unrelated to the BH RLF and recovery). |

**Q: Anything forgotten?**

|  |  |
| --- | --- |
| Company | Comment |
| Futurewei | There was the issue of RLF in mixed ENDC/SA deployment scenarios. In the [Post109e#36] email discussion we expressed our willingness to address this in Rel. 16, as long as any proposed solution can be done with minima spec impact.  Several other companies (AT&T, Apple, Intel, Huawei) seem to support such a view.  I think Huawei had provided a simple text proposal to address this scenario towards the end of the e-mail discussion. Perhaps it would be useful to consider this TP. |
| Apple | Yes. We agree with Futurewei here and think that come text in regards to ENDC scenarios and mixed ENDC/SA scenarios need to be also put in. |
|  |  |

2.4 Include BAP address into MCG or SCG failure report

This was proposed by R2-2002855. It provides the CU with more detailed information on where the RLF occurred.

**Proposal 4-1: The IAB-MT includes its BAP address in the MCG and SCG failure report.**

**Q: Do you agree with proposal 4-1?**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment |
| Ericsson | No | The CU already knows to which node(s) the IAB-MT is connected to. When the CU gets the MCG/SCG failure report, it implicitly will know which node experienced the BH RLF. |
| Nokia | No | Isn’t that already clear that the failure information is about IAB-MTs MCG or SCG? |
| Lenovo | No | We don’t see the use case that CU needs to know the accurate information. CU just needs to know whether the transmitting IAB MT itself detects RLF or receives the RLF notification from the parent node. |
| Futurewei | No | Similar view as other companies above. It does not seem that this is necessary. |
| Kyocera | No | We think the CU already knows all BAP addresses of IAB nodes within its topology, since these are configured by the CU. Also, the CU is reported which link is in RLF by MCG/SCG failure information with a new failure type “reception of RLF recovery failure”, if agreed. So, we assume the CU can properly change the routing configuration. |
| CATT | No | We think this is not necessary. |
| Apple | No | The CU already has this information and can re-configure the links as it sees fit in that particular situation. Up to implementation. |
| Intel | No |  |

2.5 Max timer for MCG recovery

This proposal by R2-2003099 is conditional on Proposal 2, i.e. support for MCG recovery. The max time value for T316 for MCG recovery presently is 2000ms. For IAB-nodes, a longer timer might be advantageous since the BH can still operate on the SCG link.

**Proposal 5-1: The max-time of T316 for MCG recovery can be configured to larger values than 2sec for IAB-MT.**

[Lenovo] In R2-2003099, ‘infinity’ is proposed to be a value for T316 for IAB.

**Q: Do you agree with proposal 5-1?**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment: Please include the max time value for MT |
| Ericsson | No strong view | We believe 2 sec is enough for the time being. |
| Nokia | No | 2 seconds is already a long time and should be sufficient to make MCG operational and in case this is not possible, then there is probably something wrong with MN connection in general, so the IAB-MT should not continue operation in such case forever. |
| Lenovo | Yes | According to legacy specification, UE initiates re-establishment procedure upon T316 expiry even if SCG link is still available. Then, UE stops data transmission on both MCG and SCG link even if SCG link is still available after UE initiates re-establishment procedure.  In NR DC, IAB node connecting to a single IAB-donor CU has concurrent BH RLC links with two parent nodes. (see figure)  IAB node need not initiate re-establishment procedure if SCG link is still available because UE can forward data to the SCG link. Therefore, we suggest that **Timer T316 is allowed to be configured as ‘infinity’.**  If T316 is set to ‘infinity’, UE will initiate re-establishment procedure when RLF in SCG link is also detected according to the current specification. It can avoid service interruption when SCG link is still available. |
| Futurewei | No strong view |  |
| Kyocera | Fine | However, we don’t think the value “infinity” is useful since the UE needs to wait forever in case the RRC Reconfiguration does not come from MCG due to e.g., another backhaul problem. |
| CATT | No strong view | We think we can rely on the current max-time, i.e., 2 seconds. |
| Apple | Neutral | We agree with Kyocera’s sentiment here. |
| Intel | No | 2 seconds is quite long. If recovery does not happen in this period, MT can still go to idle and attempt access from idle periodically. |

* 1. RLF indication in SIB1 for UEs

R2-2003314 proposes to have SIB1 send an RLF indicator to allow UEs to perform reestablishment. This, of course, would only be applicable to Rel-16+ UEs.

**Q: Do you agree with proposal 6-1?**

|  |  |  |
| --- | --- | --- |
| Company | Agree with proposal | Comment |
| Ericsson | No | The starting point of IAB rel-16 was to not impact the UEs and we should keep this principle. Otherwise, we should reconsider many of the agreements we have taken as some of them were based on the initial principle that UEs cannot be affected.  We do not see a big benefit from it at the moment. UEs can simply use legacy rules to determine RLF. Additionally, before those legacy RLF conditions are met, maybe the IAB node has already reestablished to an alternative path, and it is better if UEs remain attached to such IAB node, rather than performing reestablishment themselves. |
| Nokia | No | We agreed we will not introduce impact to Access UEs. |
| Lenovo | No | The normal UE is not expected to be affected. |
| Futurewei | We understand the utility of the proposal from Kyocera | This would be nice to have, and during our online discussions for RLF indication, we preferred a MAC or SIB indication over BAP indication precisely because if applicability to UEs in addition to IAB nodes.  It seems that per our current agreements, child IAB nodes have earlier indication of a BH RLF recovery failure at their parent node, than do UEs served by this same parent IAB node.  On the other hand, if we agree to add a RLF indication to SIB1, then do we really need the currently agreed RLF indication in BAP? |
| Kyocera | Yes | We think Rel-16+ UEs, which still don’t have BAP layer, should be somehow released from the cell which no longer has BH link, since the DU behavoiur is up to implementation and some companies thought the DU still transmits SSB after its BH link is lost in RAN2#107bis (Chongqing). Otherwise, the UEs has to wait for a long time without any service. |
| CATT | No | Share the same view as Ericsson. |
| Apple | Yes | We agree with the Kyocera sentiment here. The biggest worry for us is in terms of UEs maintaining QoS. Some of the scenarios which the vendors are promising don’t happen in single hop links (non-IAB scenarios). These are new and an indication to the UE in some form would be very helpful. However, we are ok to wait until Rel-17 for this. |
| Intel | Agree with the rationale but not sure if we can do this in the remaining time |  |

# Conclusion

…