3GPP TSG-RAN WG2 Meeting #116 Electronic R2-21xxxxx

Elbonia, November, 2021

**Agenda item: 8.4.3**

**Source: LGE (Rapporteur)**

**Title: [AT116-e][032][eIAB] RLF indications**

**WID/SID: NR\_IAB\_enh-Core**

**Document for: Discussion and Decision**

# 1. Introduction

This offline discussion aims to make progress on BH RLF indication as outlined below:

* [AT116-e][032][eIAB] RLF indications (LGE)

      Scope: Progress Type-2/3 RLF indications and related functionality, based on contributions to this meeting. Identify agreements, discussion points, can also capture open issues. Attempt to close open issues.

      Intended outcome: Report

      Deadline: Tuesday W2 (online CB)

The discussion consists of two pahses, Phase 1 and Phase 2, and the deadline of each phase is given below:

Phase 1: to settle scope what is agreeable etc, deadline: Thursday W1 Nov 4 1200 UTC

Phase 2: to discuss further details and formulate agreeable proposals, deadline: Thuesday W2 Nov 9 10:00 UTC.

## Contact

To make it easier to find the correct contact delegate in each company for potential follow-up questions, the rapporteur encourages the delegates who provide input to provide their contact information in this table:

|  |  |
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# 2. Phase-I Discussion

## 2.1 Triggering of Type-2 indication

### 2.1.1 For dual-connected node

We first discuss triggering condition of type-2 indication for the IAB node connected to dual parents. Referring to the contributions in Annex, there are several options being identified, but those options can be classified into two options, option1 and option2, as follows:

* Option1) when the node detects BH RLF on both BHs (i.e., when it initiates RRC re-establishment)
* Option2) when the node detects BH RLF on any BH and further condition, if introduced, is met

The underlying principle of option1 would be that, as long as the IAB node has at least one available BH link, it does not notify the BH failure event to child node(s) but try actions to make child nodes remain transparent to the occurrence of BH RLF. Upon detecting BH RLF on one BH, the node would trigger MCG/SCG failure information procedure to recover from the failure, and at the same time, the node is required to re-route packet flows that are, otherwise, blocked by the BH failure, by using alternative BH available. However, if the IAB node cannot re-route all or some packet flows subject to the BH failure or if the failure recovery procedure is not prompt, these packets flows would suffer from increased latency.

The underlying principle of option2 would be that BH failure should be notified to child node(s) earlier so that the child node(s) can take actions quickly to minimize performance degradation, by performing, e.g., local re-routing, if possible. While the option2 may yield potential gains enabled by earlier actions of child nodes, it should be addressed what actions need to be done by child nodes upon receiving type-2 indication and how to avoid unnecessary actions of child nodes. For example, when a node receives a type-2 indication from its parent node, it is not clear whether the node should trigger local re-route or not, because the node may have no idea whether its parent node is already performing local re-routing or not. This gives the idea that option2 may require introduction of additional condition(s) that should be satisfied to trigger type-2 indication, so as to trigger type-2 indication only when necessary.

#### **Q1. Which option do you prefer between option1 and option2? Please provide your reasoning for your preference.**

|  |  |  |
| --- | --- | --- |
| Company | Option1/2 | Comment |
| Huawei, HiSilicon | Option 2 | Type-2 indication itself is an enhancement to Rel-16 RLF indication. We would like to have a complete solution, and no need to leave room for further enhancements. Option2 seems better in terms of performance. |
| Kyocera | Option 2 | We think Option 2 has better performance than Option 1. Also, Option 2 can be aligned with the single connection case, in terms of IAB-node behaviour. |
| Qualcomm | Option 1 | In Rel-16 we defined INTRA-donor-DU local rerouting. In Rel-17 we define INTER-donor-DU local rerouting under same or different CUs. Why do we define local rerouting if we shall not use it and instead send type-2 indication with BAP routing IDs included? |
| vivo | Option 1 | Agree with QC. But we are also fine to leave it to implementation. |
| Samsung | Option 1 | We think option 1 is enough for now for the simplicity even there might be an increased latency issue. |
| Intel | Option 1 with comment | In general, we agree that type-2 RLF indication is triggered when both BH link is temporarily unavaible due to RLF.  However, we would like to note that option 1 also includes the scenario when MCG link (only) is BH RLF while fast recovery is not configured. In this scenario, even BH RLF is only detected on MCG link, the alternative BH (SCG link) is not available as it is released together with MCG link.  Hence, we suggest to revise option 1 based on RRC procedure, which is suitable for both single-connected and dual-connected IAB-node:  Option 1: when the nodes initiates RRC re-esablishment procedure |
| Fujitsu | Option1 | In our opinion, whether all or some packet flows can be re-routed via alternative BH available deponds on IAB-donor configuration and IAB-donor can configure this based on QoS requirement to avoid unexpected delay for traffic with strict latency requirement.  In addtion, RLF indication is carried by BAP PDU without secerity protection. Option 1 provides a tradeoff between security and performance.  So, we prefer Option 1. |

In case option2 is considered as triggering condition of type-2 indication, we should further discuss if additional condition needs to be introduced. The follong options are considered:

* Option2a) when the node detects BH RLF on any BH without considering additional condition
* Option2b) when the node detects BH RLF on any BH and it cannot perform re-routing for affected traffic (further detailed conditon is FFS)
* [please specify other option, if preferred]

In option2a, detection of BH RLF on any BH is a sufficient condition to trigger type-2 indication.

In option2b, there is additonal condition to be satisfied to trigger type-2 indication, and the condition is in general relate to whether the node detecting BH RLF can perform local re-routing or not. Depending on the details of the condition, several variants are possible for option2b, hence, if RAN2 goes for option2b, we need to further discuss the exact condition, which we can discuss later, if necessary.

#### **Q2. Which option do you prefer between option2a and option2b (and possibly other option)? Please provide your reasoning for your preference.**

|  |  |  |
| --- | --- | --- |
| Company | Option2a/option2b | Comment |
| Huawei, HiSilicon | Option 2b | It can be based on IAB implementation what routing IDs should be indicated to its child nodes for local rerouting. |
| Kyocera | Option 2b | We assume Option 2b should also include the case at least one route is unavailable due to the BH RLF. We think Option 2b can apply the same behaviour to EN-DC case and NR-DC case. |
| Qualcomm | None | Why can’t a node perform local rerouting if local rerouting in all scenarios (intra-donor-DU, intra-CU inter-donor-DU, inter-CU inter-donor-DU) is supported? |
| vivo | None |  |
| Samsung | None |  |
| Intel | None |  |
| Fujitsu | Option2b | Option2b is preferred if we go for option 2. |

Another possibe option is to support both option1 and option2 for Q1, and which option to use is lef to network implementation, i.e. option3 below can be suggested.

* Option3) The IAB node is configured by a donor node with either of option1 or option2, i.e., both options are supported in specifications and which option to use is left to network implementaion.

With option3, a donor node needs to configure each IAB node with either option1 and option2. This option may be preferred as an exit solution just in case option1 and 2 are semi-equally prefred and their technical merits and drawbacks are not relatively outstanding.

#### **Q3. Do you think option3 can be acceptable?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon |  | Acceptable but may not be necessary. We would like to see more views on this. |
| Kyocera | N | We prefer a single solution. |
| Qualcomm | N | Given that local rerouting is supported in all scenarios, there is no reason to support Option 2. This drops Option 3. |
| vivo | No | This adds more complexity compared to the gain. |
| Samsung | N | We think option 1 is enough. |
| Intel | No | Similar as type-4 RLF indicaiton, we think it would be good to specify the trigger condition. Otherwise, unnecessary routing changes will happen. |
| Fujitsu | N |  |

### 2.1.2 For single-connected node

For an IAB node connected to a single parent, RAN2 already agreed that the IAB node sends a type-2 indication to child node(s) if the node detects a BH RLF. Since the node then initiates re-establishment, it is equivalent to say that type-2 indication is triggered upon initiation of re-establishment for this case. Companies are invited to provide comments if the initiation of re-establishment is a sufficient condition or if additional condition should be introduced.

#### **Q4. Please provide comments if BH RLF detection and resulting initiation of RRC re-establishment is a sufficient condition for single-connected node to trigger type-2 indication? If not, please provide your view on what condition should be further introduced?**

|  |  |  |
| --- | --- | --- |
| Company | Y(sufficient) /N(insufficient) | Comment |
| Huawei, HiSilicon | Y |  |
| Kyocera | N | We prefer a common behaviour for both single/dual connection cases, so we think the triggering condition should be aligned with Option 2 above. |
| Qualcomm | Y |  |
| vivo | Yes |  |
| Samsung | Y |  |
| Intel | Y |  |
| Fujitsu | Y |  |

## 2.2 Contents of type-2 indication

### 2.2.1 For dual-connected node

We discuss contents of type-2 indication sent by a dual-connected IAB node. There are basically two options:

* Option x) Type-2 indication does not carry further information related to BH RLF
* Option y) Type-2 indication carries further information to shape the behavior of the node receiving the type-2 indication.

From rapporteur’s understanding, if option1 is taken for Q1, the necessity to take option y seems to diminish and hence option x seems sufficient. On the other hand, if option2 is taken for Q1, the necessity or sufficiency of each option should be investigated depending on whch sub-option of option2 for Q2 is taken.

#### **Q5. Which option do you prefer between option x and option y? Please provide your reasoning for your preference in relation to your choices for Q1 and Q2.**

|  |  |  |
| --- | --- | --- |
| Company | Option x/y | Comment |
| Huawei, HiSilicon | Option y | In line with Option 2 for Q1, at least routing ID should be indicated. |
| Kyocera | Option y | We prefer Type 2 Indication contains the Routing ID(s) which is affected by the BH RLF, since we think it’s useful for the child node to perform proper/efficient local rerouting. |
| Qualcomm | Option x | Type-2 indication should only be sent when parent node has no available link to do local rerouting (Option 1 for Q1). There is no reason then to include BAP routing IDs or other info. |
| vivo | Option x | Agree with the rapporteur that the necessity to take option y seems to diminish if we take Option 1 for Q1. |
| Samsung | x | We think option 1 is enough, and there is no need to carry other information for now. |
| Intel | Option x | How to act (e.g. which routing ID to be rerouted locally) when receiving a type-2 RLF indication is child IAB-node’s decision by implementation, based on its own resource status, scheduling, and traffic priority.  One may propose to indicate routing ID or other granularity in the control PDU, however, RLF indication is different from flow control PDU where congested routing ID or BH RLC CH ID is included in the control PDU. In flow control feedback, considering the buffer and scheduling priority, different routing ID and BH RLC CH ID have different congestion status. However, for RLF indication, similar as type-4 RLF indication, type-2 RLF indication indicates the BH link status of the parent IAB-node.  As discussed in Q1, an IAB-node triggers type-2 RLF indication when RRC re-establishment procedure is initiated (i.e. both links are unavailable due to BH RLF). In this case, all traffic towards this IAB-node are impacted. The child IAB-node (i.e. the one receives the type-2 RLF indication) is able to defer the impacted routing IDs if the corresponding egress link towards the IAB-node which sends type-2 RLF indication.  Additionally, as discussed in Q7, it is proposed no need to include further information in type-2 RLF indication. We think it would be good to keep the same format and content between single-connected and dual-connected IAB-node.  Hence, there’s no need to carry further information related to BH RLF. |
| Fujitsu | Option x) |  |
|  |  |  |

In case option y is considered in Q5, we should further discuss what information should be carried in type-2 indication. companies that prefer option y want to include information related to reachability within type-2 indication, and the intention of the information is to enable a node receiving the indication to choose proper actions e.g., local re-routing. Specifically, there are two options related to reachibility on the table.

* Option y1) Type-2 indication includes routing ID information indicating which routing IDs are not available
* Option y2) Type-2 indication includes BAP destination information indicating which BAP-destinations are not reachable

#### **Q6. Which option do you prefer between option y1 and option y2? Please provide your reasoning for your preference**

|  |  |  |
| --- | --- | --- |
| Company | Option y1/y2 | Comment |
| Huawei, HiSilicon | Option y1 | Type 2 indication with routing ID seems more flexible. Even for the same BAP destination address, different routing IDs may be configured to be routed on different egress links. It is still possible some routing IDs are reachable and some are not even for the same BAP address, upon RLF in an egress link. |
| Kyocera | Option y1 and y2 | We prefer Option y1 in general, especially in case an IAB-node has only one destination. But in some cases, e.g., an IAB-node has different IAB-DUs as the destination, we think Option 2y is beneficial to optimize the signalling overhead. |
| Qualcomm | None | Not applicable to Option x. |
| Intel | N/A | As we comment in Q5, either option y1/y2 needs to include every impacted routing ID and BAP destination informaiton towards the IAB-node (i.e. the one triggers type-2 RLF indication) in the control PDU, as both BH links of this IAB-node are unavailable due to RLF. This introduces higher overhead to RLF indication control PDU. |
| Fujitsu | Y1 | If option y is considered, we think Type-2 indication should include routing ID. Because local rerouting is based on routing ID rather than BAP destiantion. Routing IDs with the same destination address may have different reachability. For example, if inter-donor-DU local re-routing is needed, the routing-IDs belong to the previous routing-ID of BAP header rewriting for rerouting configuration can be reachable after rerouting, while other routing-IDs with the same destination are not reachable. |

### 2.2.2 For single-connected node

For type-2 indication sent by a single-connected IAB node, we need to discuss if there is any necessity of benefit of including information related to BH RLF within the indication. It is rapporteur’s observation that most companies think that type-2 indication sent by a single connected node does not need to carry any further information related to BH RLF.

#### **Q7. Do you agree that type-2 indication sent by a single-connected node does not need to carry any further information related to BH RLF?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon | Y/N, can be up to implementation | There is another related question: do we allow an IAB node (single-connected) to send a type-2 indication to its descendent nodes, if it has received a type-2 indication from its parent with e.g. BAP routing ID?  If this is allowed, the single-connected node may send a type-2 indication from with information such as BAP routing ID. |
| Kyocera | Y | We prefer the common solution for single/dual connection cases as much as possible. So, we think it should be clarified that Type 2 Indication including no information is considered as all routes are unavaialble. |
| Qualcomm | Y | The type-2 indication should not carry further info, whether propagated or not. |
| vivo | Y |  |
| Samsung | Y |  |
| Intel | Y |  |
| Fujitsu | Y | We agree that type-2 indication does not need to carry any further information. |

## 2.3 Behaviours upon reception of type-2 indication

### 2.3.1 Local re-routing

RAN2 agreed that type-2 indication may be used to trigger local re-routing of a node receiving the indication. This is the case when the node receiving the indication is dual-connected.

The first question in this subcaluse is whether we need to specify rules related to triggering of local re-routing or not, i.e., followings two approaches are considered:

* Approach 1) Upon reception of type-2 indication, it is left to implementation of the node whether to trigger local re-routing
* Approach 2) RAN2 specifies rule(s) to govern local re-routing by the node upon reception of type-2 indication

In the first approach, whehter to trigger local re-routing upon reception of type-2 indication is left to implementation. If a node receiving type-2 indication is able to determine what local re-rotuing actions are currently desirable based on the type-2 indication (and implicit information derived from the answer for Q1 and Q5), approach1 can work. In constrat, if the node cannot determine whehter/what local re-routing actions should be triggered, approach1 would result in inefficient or even unprediable routing behaviors.

In the second aproach, RAN2 need to discuss when to trigger local re-routing and which traffic to be re-routed. This discussion is tightly coupled with the discussion reseults for Q1 and Q5. We may need to investigate the rules on a case-by-case basis, unless a generic rule is developed, which we can discuss further, if necessary.

#### **Q8. Which approach do you prefer between approach 1 and 2? Please provide your reasoning for your preference. If approach2 is preferred, please specify your preferred rule.**

|  |  |  |
| --- | --- | --- |
| Company | Approach 1/2 | Comment and preferred rule in case of approach2 |
| Huawei, HiSilicon | Approach 2) | Usually we specify clear behevior for UE side (similarly for IAB-MT), to avoid bad implemention resulting in waste of resources. In this case, we don’t see the complexity to specify the behavior, e.g. the problematic link can be seen as unavailable for routing, as in RLF. Therefore we don’t see a need to leave it to implementation. |
| Kyocera | Approach 2 | We assume Approach 2 does not bring significant specification efforts. We assume the child node’s BAP layer just considers the route(s), which is indicated by Type 2 Indication, as unavailable. |
| Qualcomm | Approach 2 | Local rerouting upon reception of type-2 indication should be applied whenever possible. Otherwise, the node won’t transmit on an available link which can only cause service interruption. |
| vivo | Approach 2 | Similar view with HW. |
| Samsung | 2 | We don’t know then why RAN2 is making and discussing the RLF type 2 indication without its usage. Already rerouting in inter-donor-DU, inter-CU migration and/or dual connection with different CUs is discussed wherein the type2 indication is also considered as the cause. So, it seems there is enough possibility to align this type 2 indication to other BAP related operation. |
| Intel | Approach 2 with clarification | Whether IAB-node can trigger local rerouting upon receiption of type-2 RLF indication need to be configured by IAB-donor CU, i.e. during initiation or reconfiguration. Additionally, if an alternative link is available, triggering local rerouting upon receiption of type-2 RLF indication can reduce service interruption in the uptream. Specifying local rerouting upon type-2 RLF indicaiton is beneficial.  However, how the intermediate IAB-node perform local rerouting upon receiption of type-2 RLF indication is upto implementation if an alternative path/next hop is available, i.e. which traffic to be re-routed.  Hence, we propose to update approach 2 as followings:  Approach 2) Upon reception of type-2 indication, local re-routing is triggered when there’s an alternative avaiable path. It is left to implementation of which traffic to be re-routed. |
| Fujitsu | Approach2 | We prefer a definite rule to trigger local re-routing.  Since we prefer Option 1 in Q1 and Option x in Q5, the trigger for local re-routing is the reception of a type-2 RLF indication, and the traffic to be re-routed is the traffic whose BAP routing ID has the Next Hop BAP Address referring to the parent which sends the type-2 RLF indication.  If we consider Option 2 in Q1, and y1 in Q6, local re-routing can also be triggered at reception of type-2 RLF indication, and the traffic to be re-routed is the traffic with the BAP routing ID included in the type-2 RLF indication and whose Next Hop referring to the parent which sends the type-2 RLF indication.  To support local rerouting, R16 principle can be used. Donor-CU may configure multiple routing IDs with the same destination for local re-routing.  In R17, donor-CU may further configure one or multiple routing IDs with different donor-DU(s) as destination for inter-donor-DU re-routing. In this scenario, a BAP header rewriting is needed when local re-routing is triggered. |

Next question is if a donor node should be able to have at least the capability of enabling or disabling local re-routing of an IAB node receiving type-2 indication. This question is applicbale for both approaches for Q8.

#### **Q9. Do you think that a donor should be able to configure each node with whether local re-routing upon reception of type-2 indication is ALLOWED (in approach 1)/ENABLED (in approach2) or NOT?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon | N | Just not clear what would be behavior if the IAB node receives a type-2 indication but is not allowed/enabled to perform local rerouting.  If there is no other behaviors, shouldn’t the parent refrain from sending type-2 indication instead of disabling the child node to do local-rerouting? |
| Kyocera | Y | We think the donor’s controllability is important for managing topology-wide objectives. |
| Qualcomm | N | Agree with HW that in case of RLF, local rerouting should be performed whenever possible. |
| vivo | Prefer No | We assume the BAP header re-writing table is configured to each IAB-node, therefore it seems to be the IAB-node’s role to decide whether/how to perform local re-routing (with no extra configuration needed) upon reception of Type-2 indication. |
| Samsung | N | In specification perspective, it is the simplest to follow R16 operation where type4 indication means that the link is unavailable, and routing will find the backup path based on the unavilability. For type 2 case is the same, i.e., we can just specify in BAP that type 2 indication means that the link is unavailable. Then BAP routing will do local re-routing based on unavailability. In this perspective, local re-routing itself is mandatory but decision on unavailability based on type 2 indication might be considered to be configurable or not. We are ok with the configurability of type2 indication itself but once type 2 indication is received, the decision of unavilable link on that is quite aligned with legacy operation. |
| Intel | N |  |
| Fujitsu | Y |  |

### 2.3.2 Conditional mobility triggering

RAN2 agreed that conditional mobility is supported for IAB nodes. However, RAN2 has not concluded whether type-2 indication may be used to trigger conditional mobility.

From rappateur’s understanding, if it is the case that a dual-connected node receivies type-2 indication, there is no benefit to trigger CHO/CPC, because local re-routing is much more desirable in this case. So, rapporteru assumes that our focus for this discussion must be the case when a single-connected node receives type-2 indication.

The disscussion on conditional mobilty triggering is formulated as similar to the discussion in section 2.3.2 with one different additional approach3, we have the approaches:

* Approach 1) Upon reception of type-2 indication, it is left to implementation of the node whether to trigger conditional mobility (given that the node is already configured with conditional reconfiguration)
* Approach 2) RAN2 specifies rule(s) to govern triggering of conditional mobility upon reception of type-2 indication
* Approach 3) conditional mobility cannot be triggered by reception of type-2 indication

Approach1 may be undesriable in terms of topological stability, since the resulting topology may be somehow less predictable.

Approach2 may be beneficial for keeping network topology more predicable than approach1. RAN2 needs to discuss detailed rules to decide when to trigger conditional mobility. For example, we need to decide whether the node triggeres conditional mobility only if the node receives type-2 indication or it conditionally triggers conditonal mobility based on the received type-2 indication.

Approach3 is to entirely remove the possibility that type-2 indication triggers conditional mobility.

#### **Q10. Which approach do you prefer between approach 1, 2, and 3? Please provide your reasoning for your preference. If approach2 is preferred, please specify your preferred rule.**

|  |  |  |
| --- | --- | --- |
| Company | Approach 1/2/3 | Comment and preferred rule in case of approach2 |
| Huawei, HiSilicon | Approach 3 | To be realistic, we shouldn’t add any more items to Rel-17 eIAB in order to finish this WI timely. |
| Kyocera | Approach 2 | We think CHO is useful in case the child node has only single connection, i.e., local rerouting cannot be performed. In Rel-16, the IAB-MT performs CHO execution upon Type 4 Indication, if it select a CHO candidate cell. If Approach 2 is supported, the IAB-MT can perform CHO earlier than Rel-16, but it has two options in one procedural flow. So, we think the donor configures the IAB-MT whether CHO is triggered by reception of Type 2 Indication. |
| QC | Approach 3 | CHO should not be triggered since the node may recover from RLF. If recovery fails, CHO will be triggered by type-4 indication. |
| vivo | Approach3 | If other approaches are agreed, an IAB-MT may perform CHO and connect to a new target parent node even if the partent node recovers from BH RLF at a later point, this requires additional configurations on both Routing (for BH link) and RRC (for Uu interface) of the descendant node(s). |
| Samsung | 2 | Single connected case, type 2 indication means there is no connection with the network/donor for a while. We think this feature is configurable by the donor. If donor doesn’t want that level of interruption, it can configure CHO per type2, or it will not otherwise. We think there is enough benefit to use CHO, and already CHO is allowed without type2 indication,i.e., in normal case, there is no drawback specific to IAB case which cannot be bearable.  Regarding the rule, we think at least, the target cell on CHO should be evaluated on whether enough signal strength is guaranteed. Since only type2 indication cannot give that information, IAB node’s should evaluate that by itself. Like A4 event can be used for that evaluation, and this is configured separately specific for IAB. |
| Intel | Approach 3 | We don’t think type-2 RLF indicaiton should trigger CHO with following reasons:  1) Upon receiving type-2 RLF indication from its parent node, a dual-connected IAB-node can trigger local rerouting if the other link is still available, CHO is not necessary.  2) The parent IAB-node (i.e. IAB-node sents type-2 RLF indication) can be recovered from RLF soon. The delay can further be reduced if this IAB-node is also configured with CHO.  3) If CHO is executed when receiving type-2 RLF indication, the delay of service interruption includes RRC reconfiguration of CHO-performing IAB-node and its descendant IAB-nodes, BAP routing configuration update, scheduling information update, and RACH procedure delay (if new parent is under a different IAB-donor CU), which is longer than RLF recovery of its parent IAB-node.  4) Execute CHO upon receiving type-2 RLF indication will introduce more signaling overhead compared with waiting for parent IAB-node RLF recovery. |
| Fujitsu | Approach2 | We think that the reception of type-2 indication may trigger conditional mobility under some conditions.For example, local rerouting cannot be performed or congestion occurs at the alternative path. Also, radio link quality for conditional candidate can be considered. |

Next question is if a donor node should be able to have at least the capability of enabling or disabling   
CHO triggering by a node receiving type-2 indication. This question is applicbale for apprach1 and 2, but not for approach 3.

#### **Q11. Do you think that a donor should be able to configure each node with whether CHO upon reception of type-2 indication is ALLOWED (in approach1)/ENABLED(in approach2) or NOT?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon | N | Let us do CHO for IAB in future, althought we are also interested in CHO. |
| Kyocera | Y | We think the donor should configure the IAB-MT whether it performs CHO or not, upon reception of Type 2 Indication. If it’s disabled, the IAB-MT performs CHO execution upon reception of Type 4 Indication as in Rel-16. |
| Qualcomm | N | CHO should not be triggered since the node may recover from RLF. If recovery fails, CHO will be triggered by type-4 indication. |
| Samsung | Y | Donor should be able to handle this feature per it’s own determination since some level of interruption due to RLF might be bearable by some operator/donor. It that case this feature needs to be disabled. |
| Intel | N |  |
| Fujitsu | Y |  |

### 2.3.3 Further propagation of received type-2 indication downwards

For the case an IAB node receives type-2 indication, it is FFS whether the node should be able to further propagate the indication downward based on some condition. That is, two options are considered:

* Option 1) Received type-2 indication is not propagated further (unless a normal type-2 triggering conditon is met)
* Opton 2) Upon reception of the type-2 indication, the node should propagate the indication to the child if it has no alternative path available.

From the rapporteur’s understanding, option2 is to address the case where the node receiving type-2 inidcaiton is single-connected and hence incable of local re-routing but there is at least one descendent node that is dual-connected. By progagating the indication to the descendent node, local re-routing can be triggered by the descendent node. While this controlled propgation may increase the chance of local re-routing by exploiting the descendent nodes’ capability, we should evaluate whether such potential gain can justify potential side-effects, if any, such as increased signaling overhead and diverged routing.

#### **Q12. Which option do you prefer between option 1, 2, and 3? Please justify your preference.**

|  |  |  |
| --- | --- | --- |
| Company | Option1/2 | Comment |
| Huawei, HiSilicon | Option 3- Leave it to IAB implementation | It is better to leave it to IAB node implementation whether/when to trigger type-2 indication after receiving a type-2 indication from its parent. |
| Kyocera | Option 2 |  |
| Qualcomm | Option 2 | Type-2 indication should be delivered down to the first child/downstream node that can perform local rerouting. |
| vivo | Option 1 | The descendant nodes can evaluate its own situations and check if the triggering condition for type-2 at this IAB-node is met or not, the pure propogation of type-2 indication is not needed. |
| Samsung | 1 | We think this propagation of type 2 indication feature cannot coexist with CHO upon type 2 indication since once Cho is executed upon type 2 indication, there is no need to find other route such as via descendent nodes.  If the option 2’s operation and behavior are the same as rapporteur’s comment, we need to specify that the path using descendent IAB node also should be a backup path based on that descendent IAB node’s situation, i.e., having the other BH link. But as we know backup path is configured by the CU proactively not on-demand. Moreover, how many hops can be allowed to be included in this backup path via descendent node also should be discussed. Moreover, if this is working, then the interrupted packets should go back to the downstream direction, which introduce again the latency. So we don’t know how this new latency and usage of the resources can be better than just waiting in the IAB node and transmitted by new parent node sought by CHO. |
| Intel | Option 1 | As we comment in Q10, the parent IAB-node can be recovered from RLF soon. Also, it is possible that local rerouting is performed at the IAB-node who receives a type-2 RLF indication. In this scenario, the grandchild-node will not be aware of ancestor nodes’ RLF, as its upstream traffic are not impacted (locally rerouted by its own parent IAB-node).  If type-2 RLF indicaiton is propagated to descendant IAB-node, it will increase signlaing overhead as well as lead to an uncontrollable behavior of routing.  Hence, we prefer type-2 RLF indication has the same propagation as type-4 RLF indication, i.e. single hop. |
| Fujitsu | Option1 |  |

### 2.3.4 Disabling UL transmission

For the case an IAB node receives type-2 indication, it is FFS whether the node should suspend UL transmission. Two options can be considered:

* Option 1) Specify that UL transmsision constraints are enforced as mandatory (e.g. SR/BSR are suspended, FFS for details)
* Option 2) It is left to implementation of the node receiving the type-2 indication and also up to scheduling policy of the node transmitting the type-2 indication.
* Option 3) A donor configures each IAB node with whether UL transmission should be suspended or not.

In option1, RAN2 needs to specify UL transmission constraints imposed by reception of type-2 indication. For instance, the IAB node suspend UL transmission including SR/BSR and other uplink physcial channels.

In opion2, RAN2 does not specify UL transmission constraints imposed by reception of type-2 indication. It is entirely left to implementation of IAB nodes that tramsit/receive the indication.

In option3, it is up to a donor’s configuration whethher UL transmission contraints should be enforced or not.

#### **Q13. Which option do you prefer between option 1, 2, and 3? Please justify your preference.**

|  |  |  |
| --- | --- | --- |
| Company | Option1/2/3 | Comment |
| Huawei, HiSilicon | None | The IAB-MT node should perform UL behaviors according to specifications, i.e. no transmission constraints. Please note that the IAB node may still need to transmit uplink data for some BAP routing ID even if it has received a type-2 indication. |
| Kyocera | Option 1 | We think RAN2 already agreed that “Type-2 RLF indication may be used to trigger deactivation or reduction of SR and/or BSR transmissions”, and it’s IAB-MT behaviour. So, we think it should be specified. |
| Qualcomm | Option 2 | The IAB-MT can reduce/stop SR/BSR up to implementation. |
| vivo | Option 1 | Similar view with Kyocera |
| Samsung | 1 | If CHO upon type 2 is agreed, all thease operations to be discussed on the specification can be resolved by following HO procedure. Otherwise, this can be specify. |
| Intel | Option 2 | Different from local rerouting, SR/BSR is an scheduling issue, which can be left to implementation. |
| Fujitsu | Option2 |  |

### 2.3.5 Disabling IAB-support indicator

RAN2 agreed that type-2 indication may be used to disable IAB-support indication in SIB1. However, it is FFS whether disabling or not is left to implemtnation or mandated. Hence two options are considered:

* Option 1 ) RAN2 does not specify that IAB-support indicator is toggled by reception of type-2 indication, i.e., it is up to implementation.
* Option 2) IAB-support indicator shall be turned off upon recepton of type-2 indication

With option2, upon reception of type-2 indication, the node prevents any new child node from accessing the node by turning off the IAB-support indicator until problematic situation is resolved. If the probematic situation is resolved, the node is expected to turn on the indicator, e.g.,when it receives type-3 indication.

The rapporteur observes that

* Given that IAB topology is fairly static in Rel-17 (given that IAB nodes are static), toggling IAB-supprot indicator in case of receiving type-2 indication does not change the situation very much. This is becase there would be not many child nodes attempting to access the concerned node, and hence togging the indicator as poposed in option2 may not change the consequence effectively.
* Even in case there are some access attempts from other nodes to the concerned node, disabling the IAB-supprot indicator as poposed in option2 may enforce other nodes to exclude the concerned node from access candidate longer than necessary, because they may consider the node as barred even after the probematic situation of the concerned node is resolved .

To make a sensible decision, proponents of the option2 is requested to justify if option2 is indeed beneficial, and at the same time, proponets of the option1 is requested to justify that option1 is sufficient. .

#### **Q14. Which option do you prefer between option1 and 2? Please justify your preference.**

|  |  |  |
| --- | --- | --- |
| Company | Option1/2 | Comment |
| Huawei, HiSilicon | Option 1 | Agree with Rapporteur’s analysis |
| Kyocera | Option 1 | We think it’s IAB-DU behaviour, so it can be left up to implementation. |
| Qualcomm | Option 1 | Agree with Rapporteur’s analysis |
| vivo | Option 1 | We agree with the rapporteur’s analysis. |
| Samsung | 2 | We think not only type 2 indicator but also type 4 (BH RLF recovery failure) indicator also need to be considered whether it can trigger to disable this IAB-support bit. In type 4 case, the situation would be worse than type 2 reception case, because there is no guarantee when this node can recovered to the connected mode. |
| Intel | N/A.  We prefer to diable iab-support indicator in ISB when type-4 RLF indication is triggered | Triggering the deactivation of IAB-support by type-2 RLF indication needs to modify system information twice, considering the BH link will be recovered soon and type-3 RLF indication is triggered. The first modification is to mute “IAB support” in SIB1 in order to bar the access to new IAB nodes when sending type-2 RLF indication. The second modification is to modify the system information back to “IAB-support” once RLF is recovered (when sending type-3 RLF indication). However, SIB modification can be very expensive, which makes deactivation of IAB-support by type-2 RLF indication inefficient.  Compared with type-2 RLF indication, type-4 RLF indication is more suitable, as the correponding IAB-node will not be recovered soon. It is more approaporiate to diable iab-support in SIB when type-4 RLF indication is triggered. |
| Fujitsu | Option1 |  |

## Triggering of Type-3 indication

Most companies seem to think that a node can transmit type-3 indication only if it previously sent type-2 indication.

#### **Q15. Do you agree that a node can transmit type-3 indication only if it previously sent typ-2 indication, i.e., type-3 indication cannot be triggered without triggering type-2 indication previously?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon | Y |  |
| Kyocera | Y | However, we don’t see any big issue if Type 3 Indication is sent without previously sending Type 2 Indication, i.e., it’s not harmful from the child node point of view. So, we’re not sure if Q15 should be really specified. |
| Qualcomm | Y |  |
| vivo | Y |  |
| Samsung | Y |  |
| Intel | Y |  |
| Fujitsu | Y |  |

Actual triggering condition of Type-3 indication is dependent of triggerinng conditon of type-2 indication.

Let us first consider the case option1 is taken in Q1, i.e. type-2 indication is triggered if both BHs fail. Then the immediate question is as follow:

#### **Q16a. If option1 is considered in Q1, do you agree that a node can transmit type-3 indication if re-establishment is successful?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon | Y |  |
| Kyocera | Y |  |
| Qualcomm | Y |  |
| vivo | Y |  |
| Samsung | Y |  |
| Intel | Y |  |
| Fujitsu | Y |  |

Regarding the exact condition to trigger type-3 indication in case option1 is taken for Q1, the following options are considered:

* *Option1) Upon successful transmission of RRC reestablishment complete*
* *Option2) [If option1 is not acceptable, please specify your preferred condition]*

#### **Q16b. Please specify exact condition to trigger type-3 indication in case option1 is considered in Q1**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| Huawei, HiSilicon | Option 1 or generally say “upon completion of RRC reestablishement” | There is no need to be too specific in this case. |
| Kyocera | Option 1 |  |
| Qualcomm | Option 1 |  |
| vivo | Option 1 |  |
| Samsung | 1 | Upon successful transmission of RRC reestablishment complete message |
| Intel | Option 1 |  |
| Fujitsu | Option1 |  |

Next let us consider the case option2 is taken in Q1, i.e. type-2 indication is triggered if at least one BH fails and possibly other condition is met, if specified. Then the immediate question is as follow:

#### **Q17a. If option2 is considered in Q1, do you agree that a node can transmit type-3 indication if the failed BH is recovered.**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon | Y | Obvious we think. |
| Kyocera | Y |  |
| Qualcomm |  | We do not support option 2 in Q1. |
| samsung |  | We don’t support option 2 in Q1. |
| Intel | N | We prefer option 1 in Q1 |
| Fujitsu | Y |  |

Regarding the exact condition to trigger type-3 indication in case option2 is taken for Q1, the following options are considered:

* *Option1)* 
  + *Upon reception of reconfigurationWithSync for MCG, if previous type-2 indication is triggered by BH failure on MCG.*
  + *Upon reception of RRCReconfiguration for SCG, if previous type-2 indication is triggered by BH failure on SCG.*
* *Option2)* 
  + *Upon the affected route(s) is available again.*
* *Option3) [If option1 is not acceptable, please specify your preferred condition]*

#### **Q17b. Please specify exact condition to trigger type-3 indication in case option2 is considered in Q1**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| Huawei, HiSilicon | Option 1, or generally say “upon MCG/SCG recovered” | May not need to be specific |
| Kyocera | Option 2 | We think Type 3 Indication is sent when the affected route(s) is available again. |
| Qualcomm |  | We do not support option 2 in Q1. |
| samsung |  | We don’t support option 2 in Q1. |
| Fujitsu | Option1) | The contents of type-3 indication should be aligned with type-2 indication. |

## 2.5 Contents of type-3 indication

This issue can be discussed after RAN2 make progress on the above issues. So we skip this issue in the phase1 discussion.

## 2.6 Behaviours upon reception of type-3 indication

Companies seem to have the common understanding that, upon reception of type-3 indication, the actions triggered upon reception of a previous type-2 indication may be reversed. While the details need further discussion, we can confirm if that is a general understanding in RAN2.

#### **Q18. Do you agree upon reception of type-3 indication, the actions triggered upon reception of a previous type-2 indication may be reversed, if possible?**

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comment |
| Huawei, HiSilicon | Y |  |
| Kyocera | Y |  |
| Qualcomm | Y |  |
| Samsung | Y |  |
| Intel | Y |  |
| Fujitsu | Y |  |

Then following question is whehter we should mandate the reverse behaviors or whether it should be left to implementation.

* Approach 1) Upon reception of type-3 indication, it is left to implementation of the node whether to trigger a reverse action, if possible.
* Approach 2) RAN2 specifies rule(s) to govern whether/when reserve action is triggered by the node upon reception of type-2 indication

If companies think RAN2 should specify rules to govern behaviors upon reception of type-2 indicaton, they may think that reverse behaviours upon reception of type-3 indication also need to be specified. On the other hand, the behaviors upon reception of type-2 indication can be mostly left to implementation, the same approach can apply to behaviours upon reception of type-3 indication. Companies are requested to provide input on the appraches above.

#### **Q19. Which approach do you prefer between approach 1 and 2? Please provide your reasoning for your preference. If approach2 is preferred, please specify your preferred rule with justification. If other approach is preferred, please specify your preferred approach.**

|  |  |  |
| --- | --- | --- |
| Company | Approach 1/2(/other) | Comment |
| Huawei, HiSilicon | 2/Other | Our understanding is that upon receiving type 3 indicaton, the condition for IAB rerouting based on type 2 indication will not meet, and then the IAB node would come back to normal operation. |
| Kyocera | Approach 2 | We assume Approach 1 can work in most cases. However, in case the IAB-node has dual connections and it receives two Type 2 Indications from both links, we think one Type 3 Indication should not revert all behaviours triggered by the two Type 2 Indications. So, we assume some small rule is needed to be specified. |
| Qualcomm | Approach 2 | If type-2 triggers local rerouting, the node must revert to the original central routing configuration upon receiving the type-3 indication.  For SR/BSR transmission and toggling IAB support indicator, it is up to implementation. |
| vivo | Approach 2 | Share similar view with QC. |
| Samsung | 2 | We have the list of possible behavior regarding type 2 indication in this doc, such as local re-routing, CHO, progparation of the indication, disabling UL transmission, disabling IAB-support bit. Fallback of the local re-routing can be specified by noting that reception of type 3 indicates that egress link became available in BAP spec. For CHO, there is no need of fallback (reverting) of type 3 indication, and correspondingly no specification of reverse behavior. Regarding propagation of the type2 indication, the propagation of type 3 needs to be specified. However, disabling UL transmission can be implementation. |
| Intel | Approach 1 |  |
| Fujitsu | Approach2 | If the behavior upon receiving type-2 indication is specified only for local re-routing, it is straight to specify the behavior, i.e. local re-routing back to the recovered BH link upon receiving type-3 indication. |

## 2.7 Terminology

There are proposals of terminomogies for type-2/3/4 indications. We can consider two approaches

*Approach 1 is to define separate names for different indications. For example:*

* Type-2: “BH RLF detection indication” or something else (to be proposed below)
* Type-3: “BH RLF recovery indication” or something else (to be proposed)
* Type-4: “BH RLF recovery failure indication or something else (to be proposed below) or existing name (“BH RLF indication”)

Approach 2 is to use a generic name ‘BH RLF indication’ for them and distinguish them with type indicator

* Type-2: “BH RLF type X indication” or the similar (to be proposed below)
* Type-3: “BH RLF type Y indication” or the similar (to be proposed below)
* Type-4: “BH RLF type Z indication” or the similar (to be proposed below)

Note that we alreay use “BH RLF indication” for type-4 indication from Rel-16. Hence, care must be taken.

**Q20. Which approach do you prefer between two approaches?**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Company | Approach1/ Approach2 | Preferred name | | | Comment |
| Type-2 indication | Type-3 indication | Type-4 indication |
| Huawei, HiSilicon |  | BH RLF detection indication | BH RLF recovery indication | unchanged | For type-4, we need to ensure the alignment between R16 and R17 specs. Otherwise, it would cause confusions to readers. |
| Kyocera | Approach 2 | Type 2 BH RLF Indication | Type 3 BH RLF Indication | BH RLF Indicaiton (i.e., same with Rel-16) | We slightly prefer to keep Rel-16 name for Type 4 Indication. We don’t think the names need to describe how it works exactly. So, we think Rel-17 BH RLF Indications are just Type 2 and Type 3. We don’t think there is no problem if Rel-16 BH RLF Indicaiton does not have “Type” in its name. |
| Qualcomm |  | BH RLF detection indication | BH RLF recovery indication | BH RLF recovery failure indication | In Rel-16, only type-4 indication was defined. In Rel-17, both type-2 and type-4 indications are RLF indications so term BH RLF indication is general. |
| vivo | Approach1 | BH RLF detection indication | BH RLF recovery indication | BH RLF recovery failure | Generally we keep the legacy text intact, but the wording ‘BH RLF indication’ is confusing when it appears with the other RLF indications, which might mislead to the understanding that this is a Type-2 indication (but actually is a Type-4). So we prefer to re-word Type-4 as BH RLF recovery failure so that the consistency among the RLF indication terminologies can be kept. |
| Samsung | Approach 1 | BH RLF detection indication | BH RLF recovery indication | Bh RLF recovery failure indication |  |
| Intel | Approach 1 | BH RLF detection indication | BH RLF recovery indication | BH RLF indication (unchanged) | We prefer use the same name of type-4 RLF indication to keep consistency in both Rel-16 and Rel-17 |
| Fujitsu | Approach1 |  |  | Existing name, i.e. “BH RLF indication” | We don’t want to change existing name for type-4 RLF indication. So, Approach 1 is preferred. |

## 2.8 Other

We can start discussion on the following issues after RAN2 make progress on the above issues during this email discussion:

* Whehter type-2 indication is mandatory or optional?
* Whehter type-3 indication is mandatory or optional?
* Whether fast MCG recovery should be mandatory for DC capable IAB node?
* [Other issue to discuss? If so, please specify here]
  + Fujitsu: CP behavior upon receiving type-2 RLF indication. How to support IAB-MT’s RRC/NAS path change, similar to the local re-routing behaviour of backhaul data.

# 3. Phase-II Discussion

# 4. Conclusion

# Reference

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[R2-2109584](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2109584.zip) Discussion on Type-2/3 RLF indication CATT discussion Rel-17 NR\_IAB\_enh-Core

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[R2-2109749](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2109749.zip) Open issues on (re-)routing Fujitsu discussion Rel-17 NR\_IAB\_enh-Core

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[R2-2109941](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2109941.zip) Enhancements to RLF indications in IAB Qualcomm Incorporated discussion Rel-17 NR\_IAB\_enh

[R2-2110203](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110203.zip) Routing and re-routing enhancements for eIAB Kyocera discussion Rel-17

[R2-2110204](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110204.zip) Details of BH RLF Indications for eIAB Kyocera discussion Rel-17 R2-2107997

[R2-2110291](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110291.zip) Discussion on issues of local re-routing based on congestion vivo discussion Rel-17 NR\_IAB\_enh-Core

[R2-2110292](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110292.zip) Miscellaneous Issues of Topology Adaptation vivo discussion Rel-17 NR\_IAB\_enh-Core

[R2-2110307](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110307.zip) Discussion on local rerouting and local bearer remapping for IAB Lenovo, Motorola Mobility discussion Rel-17

[R2-2110343](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110343.zip) Rel-17 BAP Operations CANON Research Centre France discussion Rel-17 NR\_IAB\_enh-Core

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[R2-2110886](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2110886.zip) On Local Routing and Type 2/3 RLF Handling Ericsson discussion NR\_IAB\_enh-Core

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[R2-2111142](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2111142.zip) Resolving open issues on BH RLF indications LG Electronics discussion Rel-17

[R2-2111156](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2111156.zip) Further discussion on enhancement of local re-routing LG Electronics Inc. discussion Rel-17 NR\_IAB\_enh-Core

[R2-2111157](file:///D:\Documents\3GPP\tsg_ran\WG2\TSGR2_116-e\Docs\R2-2111157.zip) Remaining issues on enhancements of topology adaptation and congestion mitigation LG Electronics Inc. discussion Rel-17 NR\_IAB\_enh-Core