3GPP TSG-RAN WG2 Meeting #121bis-e R2-2304303

Electronic Meeting, April, 2022

Agenda: x.x.x

Source: InterDigital

Title: Summary of [AT121bis-e][430][Relay] Multi-path relay idle/inactive cases (InterDigital)

Document for: Discussion, Decision

# 1 Introduction

The following email discussion was initiated at RAN2#121bis-e [1]:

* [AT121bis-e][430][Relay] Multi-path relay idle/inactive cases (InterDigital)

Scope: Discuss and attempt to converge on the candidate agreements from the multi-path discussion:

Multi-path at the remote UE is not maintained when the relay UE is moved to RRC\_IDLE/RRC\_INACTIVE in this release.

A remote UE in multipath that is released to RRC\_IDLE/RRC\_INACTIVE can apply legacy cell/relay selection behaviour, thus moving to single-path operation on either path according to implementation.

Intended outcome: Report to CB session

Deadline: Monday 2023-04-24 2359 UTC

This document summarizes the discussion of this email.

# 2 Contact Information

Respondents to the offline discussion are kindly asked to fill in the following table.

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# 3 Discussion

## 3.1 Relay UE in IDLE/INACTIVE

The first discussion based on the proposals in [2] was on the allowable RRC states of the relay UE while the remote UE is in multipath. The attempt was to converge on the following candidate agreement which is effectively to not maintain multipath at the remote UE:

*Multi-path at the remote UE is not maintained when the relay UE is moved to RRC\_IDLE/RRC\_INACTIVE in this release.*

Some of the difficulty in agreeing to the above was based on different interpretation of what is meant by not maintaining multipath. Specifically, when the relay UE moves to RRC\_IDLE/RRC\_INACTIVE, the remote UE can release the configuration associated to multipath and operate in legacy Uu, or it may maintain the configuration for the purposes of being able to re-use it when the relay UE moves back to RRC\_CONNECTED.

**Q1.1) Which option(s) do you prefer for how to handle the multipath configuration at the remote UE when the relay UE moves to RRC\_IDLE/RRC\_INACTIVE?**

* **A) The remote UE releases the multipath configuration (i.e., release SL-RLC entities, SRAP, and bearers having only indirect path).**
* **B) The remote UE maintains the multipath configuration but suspends the SL-RLC path. The remote UE can re-use the suspended indirect path when the relay UE moves back to RRC\_CONNECTED.**
* **C) The remote UE maintains the multipath configuration but suspends the SL-RLC path. The remote UE can re-use the suspended indirect path based on UE decision (e.g., UL data arrival).**
* **D) Other**
* **E) The remote UE inform “relayUE-Uu-RLF” or “relayUE-Uu-RRC-Failure” to gNB, and wait for the reconfiguration from gNB.**
* **F) existing procedure defined in Rel-17**
* **G) The relay UE is not allowed to move to RRC\_IDLE/INACTIVE while it is acting as a relay UE if the remote UE is in multi-path RRC\_CONNECTED**
* **H) existing procedure defined in Rel-17**

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| Company | Response | Comments |
| OPPO | D | We understand remote UE would follow the network command to operate on entity/bearer release, and there is no need to define new behavior on top of the following we reached online.  *Multi-path at the remote UE is not maintained when the relay UE is moved to RRC\_IDLE/RRC\_INACTIVE in this release.* |
| Xiaomi | D | Remote UE is not aware of the RRC state of the relay UE, therefore remote UE is not able to autonomously perform multipath release or suspend.  If the relay UE enter IDLE/INACTIVE due to NW configuration, i.e. RRCRelease, NW should also release the multipath at remote UE.  If the relay UE enter IDLE/INACTIVE due to failure, e.g. Uu RLF, this is handled by multipath recovery.  The UE behavior should follow NW configuration. |
| CATT | E | If the relay UE is acting as relay for the remote UE in RRC\_CONNECTED, it should keep in RRC\_CONNECTED. gNB should not release the RRC connection of it. Therefore, the relay UE moves to RRC\_IDLE/RRC\_INACTIVE is not due to release from gNB. A possible case is Uu RLF is detected by the relay UE or DataInactivityTimer expired. The relay UE should send NotificationMessageSidelink message to the remote UE with cause “relayUE-Uu-RLF” or “relayUE-Uu-RRC-Failure” when Uu RLF is detected. The remote UE should inform “relayUE-Uu-RLF” or “relayUE-Uu-RRC-Failure” to gNB via direct path, and wait for the reconfiguration from gNB. |
| Huawei, HiSilicon | F | Following the current spec as below:  3> store in the UE Inactive AS Context the *nextHopChainingCount* received in the *RRCRelease* message*,* the current KgNB and KRRCint keys, the ROHC state, the EHC context(s), the UDC state, the stored QoS flow to DRB mapping rules, the application layer measurement configuration, the C-RNTI used in the source PCell, the *cellIdentity* and the physical cell identity of the source PCell, the *spCellConfigCommon* within *ReconfigurationWithSync* of the NR PSCell (if configured) and all other parameters configured except for:  - parameters within *ReconfigurationWithSync* of the PCell;  - parameters within *ReconfigurationWithSync* of the NR PSCell, if configured;  - parameters within *MobilityControlInfoSCG* of the E-UTRA PSCell, if configured;  - *servingCellConfigCommonSIB*;  - *sl-L2RelayUE-Config*, if configured;  - *sl-L2RemoteUE-Config*, if configured;  2> suspend all SRB(s) and DRB(s) and multicast MRB(s), except SRB0 and broadcast MRBs;  2> release the SRAP entity, if configured;  (2> release PC5 RLC channels as discussed in 425;) |
| NEC | D | UE behavior should follow the network command, for example, the network can release the connection of relay UE and release the multipath configuration of remote UE in the meanwhile. |
| Nokia | G | To our understanding, this proposal is originated from a question whether the relay UE can move to RRC\_IDLE or RRC\_INACTIVE when no data is coming from the remote UE, which has not been agreed so far and we consider this scenario should be excluded. We added option F, which means the relay UE should not move to RRC\_IDLE or RRC\_INACTIVE based on the data activity but should be under control of the gNB.  Agreements are copied:  [119bis-e]  Multi-path Relay is NOT applicable to RRC\_IDLE [18/18] remote-UE, for scenario-1 and scenario-2.  For multi-path Relay, support RRC\_IDLE/RRC\_INACTIVE target relay UE, for the path switching scenario where there is an addition of indirect path or a change of indirect path. |
| Qualcomm | D,E for Connected state Remote UE  F for Inactive state UE | should clarify the scenario is the Remote UE is in CONNECTED state. Then Remote UE should follow network configuration to release or keep MP configuration.  For Remote UE in Inactive state, as Huawei mentioned, existing procedure on indirect path can be reused. |
| vivo | H | We prefer to let it for NW implementation. New behavior for remote UE is not needed.  In addition to the following agreement:  “Multi-path at the remote UE is not maintained when the relay UE is moved to RRC\_IDLE/RRC\_INACTIVE in this release.”  We have also the following agreements in previous meeting in R2#119:  “[20/21] (modified) Multi-path Relay is NOT applicable to RRC Resume procedure, for scenario-1 and scenario-2. R2 further study how for UE operating in multi-path Relay operate for RRC Re-establishment procedure [5/21].”  In summary, if the relay UE is released to the IDLE/INACTIVE state by the gNB, it should rely on the gNB implementation to release the related configuration for indirect path in the remote UE. |
| MediaTek | D,E for Connected state Remote UE  F for Inactive state UE | Agree with Qualcomm. |
| Lenovo | D, F,G | **Connected remote UE:**   * If there is no traffic for indirect path, network wants to transit relay UE to idle/inactive state, NW will also release multipath configuration for remote UE. Therefore, we agree with G. * If relay UE transits to idle state due to Uu RLF, relay UE will indicate to remote UE according to the legacy. Remote UE may report failure to NW. Then, NW will reconfigure remote UE e.g releasing multi-path or configure a new target relay UE.   **Idle/inactive remote UE:**   * Agree with Huawei. Remote UE will not store the multi-path configuration. |
| Kyocera | D | We assume this question is for the case when the relay UE is released to IDLE/INACTIVE, since the relay UE’s Uu RLF case is handled separately. Then the remote UE in CONN should follow the NW’s instruction, which will likely be to also release the remote UE to IDLE/INACTIVE or maintain connection over only the direct path. |

A similar situation may occur when the relay UE experiences Uu RLF. In this case, based on Rel17 behavior, the relay UE should informs the remote UE using the NoticationMessageSidelink. However, depending on whether the relay UE recovers or not (i.e., successful re-establishment), the relay UE may not move to RRC\_IDLE, and releasing the multipath configuration at the remote UE may be unnecessary.

**Q1.2) Which option(s) do you prefer for how to handle the multipath configuration at the remote UE when the relay UE informs the remote UE of Uu RLF?**

* **A) The remote UE releases the multipath configuration (i.e., release SL-RLC entities, SRAP, and bearers having only indirect path).**
* **B) The remote suspends the multipath configuration and may continue to use it in case the relay UE does not move to RRC\_IDLE/RRC\_INACTIVE (i.e., recovery following Uu RLF)**
* **C) Other**
* **D) handled by indirect path recovery procedure**
* **E) The remote UE inform “relayUE-Uu-RLF” or “relayUE-Uu-RRC-Failure” to gNB, and wait for the reconfiguration from gNB.**
* **F) The remote UE either initiates the indirect path recovery procedure or just waits for gNB reconfiguration based on the gNB configuration without report.**

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| Company | Response | Comments |
| OPPO | C | This can be handled in the context of RLF handling.  *In case of Uu-RLF, at least for split SRB1, if SRB1 is available on indirect path not suspended, trigger report to network via indirect path to report the failure via a RRC message. Otherwise, RRC Re-establishment is initiated. RAN2 is requested to discuss whether the RRC message is the existing message e.g. MCGFailureInformation or a new message.*  Based on the agreement above, PC5 RLF in MP-relay scenario should lead to a suspend operation for the PC5 path. Yet the resume operation does not have to be based on “**in case the relay UE does not move to RRC\_IDLE/RRC\_INACTIVE (i.e., recovery following Uu RLF)**”, but can be based on network reconfiguration (as in legacy to handle CG suspend/resumption)  So we suggest to conclude it as,  *When relay UE informs the remote UE of Uu RLF, remote UE suspends the sidelink transmission.* |
| Xiaomi | D | We understand such case should be handled by indirect path failure recovery, similar as the PC5 RLF, i.e. remote UE reports the failure via direct path if SRB1 is available on direct path. gNB can decide whether to release multipath or change indirect path. |
| CATT | E/D | Same comments as Q1.1. We think E and D are under the same understanding with different description. |
| Huawei, HiSilicon | See comments | It seems CDE have the same meaning, i.e. UE wait for network configuration after failure reporting which is exactly the same as existing SCG/MCG failure recovery. |
| NEC | C/D | After notified by relay UE with Uu RLF, remote UE should suspend the current indirect link and report the failure to gNB. Then it will wait for the command from gNB and solve the RLF according to the command, such as recovery the current indirect link or add another indirect path. |
| Nokia | F or D | D and E may not be the same because we understand that the indirect path recovery procedure is either to report the failure if SRB1 is available or to re-establish otherwise.  Upon Uu-RLF of the relay UE, the relay UE may report the failure by itself, or the remote UE can just live with the direct path while waiting for gNB action, in which cases mandating initiating the indirect path procedure may only lead to unnecessary report or undesirable re-establishment interrupting the data transmission over the alive direct path. Thus, one possibility is let the gNB to configure whether the indirect path recovery procedure is used or not for some cases. How to handle the indirect path without initiating the indirect path recovery procedure, e.g., suspend, can be FFS. |
| Qualcomm |  | Report failure to gNB, and wait for gNB reconfiguration. |
| vivo | D | This should be handled with existing agreements regarding fast RLF recovery procedure. No new behavior is needed. |
| MediaTek | E |  |
| Lenovo | D | If Uu RLF occurs in relay UE side, relay UE will indicate to remote UE according to the legacy. Remote UE will report failure to NW. Then, NW will reconfigure remote UE e.g releasing indirect path or configure a new target relay UE. Anyway, new remote UE behavior (e.g E) is not needed. |
| Kyocera | D or E | We assume this will be handled by the indirect path recovery procedure, whereby the remote UE is informed by the relay UE of the Uu RLF and the remote UE informs the gNB of the indirect path failure over the direct path. The remote UE can follow the gNB’s instruction thereafter. We also assume that D and E are basically the same. |

Finally, the only other notification by the relay UE that would be relevant to the multipath case is the relay UE HO.

**Q1.3) Which option(s) do you prefer on how to handle the multipath configuration at the remote UE when the relay UE informs the remote UE of HO?**

* **A) The remote UE releases the multipath configuration (i.e., release SL-RLC entities, SRAP, and bearers having only indirect path).**
* **B) The remote continues to use the multipath configuration in some cases (e.g., intra-gNB HO) and releases the configuration in other cases (e.g., inter-gNB HO, HO failure, etc)**
* **C) Other**
* **D) handled by indirect path recovery procedure**

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| Company | Response | Comments |
| OPPO | C | Same view as for Q1.2, on the one hand, this should be of the same issue and solution, as a sub-case of PC5 RLF, on the other hand, since we are talking about a remote UE configured with MP, gNB should already send reconfiguration to remote UE before there is handover of serving relay (in R17, the target scenario of this case is more for RRC\_IDLE/INACTIVE remote UE, but here it is only for RRC\_CONNECTED remote UE), so we do not see there is a need for special operation for remote UE. |
| Xiaomi | D | Similar as Q1.2, this should be handled by indirect path failure recovery procedure. |
| CATT | B | Up to gNB configuration. When the relay UE performs intra-gNB HO, gNB may reconfigure the Scell to the remote UE. The remote UE can continue to use the reconfigured multipath configuration. |
| Huawei, HiSilicon | See comments | Same view as for Q1.2, i.e. remote UE should wait for network configuration after failure reporting which is exactly the same as existing SCG/MCG failure recovery. |
| NEC | C | Same procedures as our comments on Q1.2. The key point is that under the control of gNB to solve the problem of indirect path. |
| Nokia | C | So far, RAN2 only agreed to indicate the Uu RLF of the relay UE to the remote UE, and yet agreed explicitly to indicate the HO to the remote UE. However, we assumed it, which needs to be confirmed first.  In addition, the inter-gNB HO is out of scope in this release. For intra-gNB HO, the UE does not need to report it to the gNB as the gNB already knows it. So, remote UE needs not take any action but follows the gNB reconfiguration. |
| Qualcomm | B | gNB knows the Relay is HO and whether HO failure happens, and can keep or release indirect path based on Relay UE HO status. Remote UE does not need to indicate to the gNB |
| vivo | see comments | If there is direct path for the remote UE, the remote UE can just wait for the reconfiguration from the NW. If there is no direct path for the remote UE, the UE can rely on the indirect path recovery procedure. |
| MediaTek | B |  |
| Lenovo | C | If relay UE receives HO command, relay UE will indicate to remote UE according to the legacy. Then, NW will reconfigure remote UE e.g releasing indirect path or configure a new target relay UE. |
| Kyocera | B | We assume the gNB can instruct the remote UE with the updated multipath configuration or release the multipath configuration (i.e., direct path only). |

The remote UE may determine the change in state of the relay directly from the network itself. While this may be straightforward for the case of explicit release, it may be more difficult for cases where the state change is triggered by an error at the relay UE since waiting for the network to detect the condition may incur unacceptable delays. Two such cases are Uu RLF, and expiry of the DataInactivityTimer at the relay UE. In this case, the NotificationMessageSidelink may be referable. Use of NotificationMessageSidelink may also be more scalable to the inter-gNB case.

**Q1.4) How does the remote UE determine the that the relay UE moved to IDLE/INACTIVE in the explicit release case (e.g., relay UE receives a release from the network)?**

* **A) Relay UE informs the remote UE (e.g., using NotificationMessageSidelink)**
* **B) NW reconfigures each remote UE before it releases the relay UE to IDLE/INACTIVE**
* **C) Other**

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| Company | Response | Comments |
| OPPO | B |  |
| Xiaomi | B |  |
| CATT | B | If the relay UE is acting as relay for the remote UE in RRC\_CONNECTED, it should keep in RRC\_CONNECTED. gNB should not release the RRC connection of it. If gNB determined to release the relay UE to IDLE/INACTIVE, it should reconfigure the indirect path of the remote UE in RRC\_CONNECTED via this relay UE. |
| Huawei, HiSilicon | B |  |
| NEC | B |  |
| Nokia | B | It should be up to gNB implementation, i.e., the relay UE needs to be in RRC\_CONNECTED as long as its remote UE is in RRC\_CONNECTED. To move the relay UE to RRC\_INACTIVE or RRC\_IDLE, the gNB should reconfigure the MP, i.e., by changing the relay UE. |
| Qualcomm | B |  |
| vivo | B | When the relay UE moved to IDLE/INACTIVE in the explicit release case, the indirect path for the remote UE should be released as well. The NW should provide associated configurations to the remote UE either via the direct path or via the indirect path before the release of the indirect path. This should be discussed within the scope of “Case C: The remote UE configured with multi-path releases the indirect path;” |
| MediaTek | B |  |
| Lenovo | B |  |
| Kyocera | B |  |

**Q1.5) How does the remote UE determine the that the relay UE moved to IDLE/INACTIVE in the case where the relay UE experiences Uu RLF without recovery or DataInactivityTimer expires?**

* **A) Relay UE informs the remote UE (e.g., using NotificationMessageSidelink)**
* **B) NW reconfigures remote UE after it determine the relay UE is no longer accessible**
* **C) Other**

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| Company | Response | Comments |
| OPPO | B | For Uu-RLF, see our reply to Q1.2.  For DataInactivityTimer, there were old discussion on this, and the conclusion was it is not compatible with SL, so we do not think network would configure it to a UE running SL. |
| Xiaomi | A | Reuse the legacy notification. Maybe one general indication is enough to cover all cases. |
| CATT | B | The remote UE should inform “relayUE-Uu-RLF” or “relayUE-Uu-RRC-Failure” to gNB via direct path, and wait for the reconfiguration from gNB. |
| Huawei, HiSilicon | B | Same view as OPPO and CATT. |
| NEC | B |  |
| Nokia | C | Regarding dataInactivityTimer, it is likely that the gNB would not configure this timer for SL relay because the timer does not take SL transmission into account in a start/restart condition. Even if it is configured, it should be the gNB’s responsibility to keep the relay UE in the RRC\_CONNECTED as long as the remote UE is in RRC\_CONNECTED, e.g., by setting a proper timer value or sending any dummy data.  For the Uu RLF without recovery, we wonder what it means. Does it mean that the recovery fails?  Basically, our assumption is that the remote UE only needs to know the RRC state of the relay UE when the PC5 link is established to determine whether to initiate the RRC setup/resume procedure to bring the relay UE to RRC\_CONNECTED. |
| Qualcomm | B |  |
| vivo | B | No new behavior should be defined.  For Uu RLF of the relay UE, it should be handled via the agreed fast RLF recovery procedure.  For relay UE moving to IDLE/INACTIVE due to DataInactivityTimer expiration, it should rely on the gNB to provide related reconfiguration to the remote UE. For instance, the gNB could release the indirect path for the remote UE via existing procedure. |
| MediaTek | B |  |
| Lenovo | B (A is also fine) | When relay UE experiences RLF on Uu link, the relay UE is still at connected state during recovery e.g re-establishment. Once re-establishment failure happens, relay UE enters into idle state. |
| Kyocera | A | For the case of Uu RLF without recovery, the relay UE should inform the remote UE via NotificationMessageSidelink. It can be further discussed what the contents of the message should be, e.g., failed recovery or possibly the RRC state of the relay UE. |

## 3.2 IDLE/INACTIVE remote UE following a release

The second issue discussed based on proposals in [2] is how to handle the NW initiated release to a remote UE in multipath. In this case, during online session, companies were mostly of the opinion that legacy behaviour can apply which resulted in the following proposed agreement from the chairman.

*A remote UE in multipath that is released to RRC\_IDLE/RRC\_INACTIVE can apply legacy cell/relay selection behaviour, thus moving to single-path operation on either path according to implementation.*

However, it is not clear what legacy behaviour in the case of multipath really means:

* In legacy Uu, a UE that receives a release message on Uu starts by camping on that cell and reselecting to another cell when the conditions related to cell reselection are triggered.
* In legacy relays, a remote UE that receives a release message maintains the PC5-RRC connection to the relay and only triggers cell/relay reselection when the conditions related to cell/relay reselection are triggered.

There is therefore some ambiguity as to which of the above two behaviours is considered as “legacy” for a remote UE in multipath. If both cases are considered value for the UE in multipath, legacy behaviour indicates that the path maintained correspond to the path where the UE received the release message from.

Some companies mentioned that the preferred approach would be for the UE to always camp on Uu, since the PCell is on Uu. However, the relayed path may be the best path, and camping on the direct path upon release may result in releasing the PC5-RRC connection, only to immediately establish it again if the IDLE/INACTIVE remote UE ends up triggering relay selection.

For this reason, [2] proposed to have a NW-based decision (similar to a release with redirection) to remove the ambiguity and avoid path ping-pong during the release. In this case, the network releases the remote UE to the most reliable path, and can also know how to deliver SI and paging to the remote UE following this.

**Q2.1) Upon reception of a release message, how does the remote UE decide between i) camping on Uu and releasing the PC5-RRC connection, or ii) maintaining the PC5-RRC connection and behaving as a Rel17 remote UE in IDLE/INACTIVE?**

* **A) Release message indicates whether to perform i) or ii)**
* **B) Always perform i)**
* **C) Follow legacy behavior (if release is received via Uu, perform I, if the release is received from the relay, perform ii).**
* **D) Other**
* **E) Follow legacy behavior (up to UE implementation to perform i) or ii)).**

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| Company | Response | Comments |
| OPPO | D | We do not see a need to deviate from legacy behavior for the case of “**Upon reception of a release message**”.  Based on the current spec, upon release message with suspend configuration  2> if the UE is capable of L2 U2N Remote UE:  3> enter RRC\_INACTIVE, and perform either cell selection as specified in TS 38.304 [20], or relay selection as specified in clause 5.8.15.3, or both;  Upon release message without suspend configuration  2> if the UE is capable of L2 U2N Remote UE:  3> enter RRC\_IDLE, and perform either cell selection as specified in TS 38.304 [20], or relay selection as specified in clause 5.8.15.3, or both;  So we think the following we reached online is sufficient  *A remote UE in multipath that is released to RRC\_IDLE/RRC\_INACTIVE can apply legacy cell/relay selection behaviour, thus moving to single-path operation on either path according to implementation.* |
| Xiaomi | E | Following legacy procedure, the behavior should be left to UE’s implementation whether to select relay or cell. |
| CATT | E | The remote UE should perform legacy release operation. The remote UE can select to camp on a cell or connect to a relay up to UE implementation. This principle is reused from Rel-17 L2 U2N relay which was agreed in RAN2#114-e meeting.  “For RRC\_IDLE/INACTIVE L2 remote UE, the legacy cell (re)selection procedure and relay (re)selection procedure could go independently and up to UE implementation to select either cell or relay.”. |
| Huawei, HiSilicon | E | Even for L2 U2N relay in Rel-17, redirection to Uu or relay is not supported. We do not see the motivation to support it for MP. |
| NEC | E | Following legacy procedures. |
| Nokia | E | We can follow the R17 principle. |
| Qualcomm |  | Currently, We had the following agreements,  *Support storing direct path configuration for potential resume as legacy operation (to single-path configuration)*  *Remote UE storing indirect path configuration (e.g., SRAP and PC5-RLC channel configurations) and resuming directly into multi-path configuration is not supported for scenario 1.*  Some questions are not clear from our side.  1) If Remote UE resume over indirect path, whether is it possible to resume direct path, as today’s DCCA resume? Or, Remote UE should discard direct path context autonomously or released by gNB?  2) If Remote UE resumes over direct path, whether the indirect type bearer configuration should be discard autonomously, or can keep them with gNB providing MCG config? |
| vivo | E | The common part between the two options is that the remote UE will enter RRC IDLE or RRC\_INACTIVE, and the difference part is that it is up to the implementation of the remote UE to either keep or release the PC5 link. It follows the similar mechanism as in Rel-17. |
| MediaTek | E |  |
| Lenovo | E | Agree with Huawei. |
| Kyocera | E |  |

# 4 Conclusion

# 5 References

1. RAN2#121bis-e Chairman Notes
2. R2-2302924