**3GPP TSG-RAN WG2 #119bis-e *R2-221xxxx***

**E-meeting, October 2022**

Agenda Item: 8.9.4

Source: OPPO

Title: Summary of  [AT119bis-e][426][Relay] Control plane aspects for multi-path (OPPO)

Document for: Discussion, Decision

# Introduction

This is for the following offline discussion.

* [AT119bis-e][426][Relay] Control plane aspects for multi-path (OPPO)

Scope: Discuss P11/P12/P18/P19/P20 of R2-2209375, considering applicability to both scenarios 1 and 2.

Intended outcome: Report to CB session

Deadline: Monday 2022-10-17 1700 UTC

# Discussion

## Scenario

For Scenario, two proposals are provided in 09375

*Proposal 11 For scenario-1 of multi-path relay, R2 does not pursue applying multi-path relay to the procedures of SIB delivery, paging delivery, RRC setup/resume and re-establishment.*

*Proposal 12 For scenario-1 of multi-path Relay, R2 focus on the application of multi-path relay to RRC\_CONNCTED UEs only, i.e., after RRC setup/resume / re-establishment procedure.*

Firstly, to check companies view on the applicability of MP-relay for RRC states.

**Q1-1: Do you think multi-path Relay is applicable to RRC\_CONNECTED remote-UE or not?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | Yes | Yes |  |
| Xiaomi | Yes | Yes |  |
| CATT | Yes | Yes |  |
| Huawei, HiSilicon | Yes | Yes |  |
| vivo | Yes | Yes |  |
| ZTE | Yes | Yes |  |
| Ericsson | Yes | Yes |  |
| Apple | Yes | Yes |  |
| Qualcomm | Yes | Yes |  |
| Lenovo | Yes | Yes |  |
| LG Electronics | Yes | Yes |  |
| China Telecom | Yes | Yes |  |
| Futurewei | Yes | Yes |  |
| Spreadtrum | Yes | Yes |  |
| Intel | Yes | Yes |  |
| CMCC | Yes | Yes |  |
| Samsung | Yes | Yes |  |
| Sharp | Yes | Yes |  |
| MediaTek | Yes | Yes |  |
| Nokia | Yes | Yes |  |

**Q1-2: Do you think multi-path Relay is applicable to RRC\_INACTIVE remote-UE or not?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | No | No |  |
| Xiaomi | No | No |  |
| CATT | No | No |  |
| Huawei, HiSilicon | No | No |  |
| vivo | No | No | In our understanding, Multi-path is a concept for Connected UE like CA and DC, which means after configuration in CONNECTED state and not related to IDLE/INACTIVE |
| ZTE | No | No |  |
| Ericsson | No | No |  |
| Apple | No | No |  |
| Qualcomm | See comment |  | We may need to discuss how to handle MP context in Inactive state, and applied RAN paging area. |
| Lenovo | No | No |  |
| LG Electronics | No | No |  |
| China Telecom | No | No |  |
| Futurewei | No | No |  |
| Spreadtrum | No | No |  |
| Intel | No | No |  |
| CMCC | No | No |  |
| Samsung | No | No |  |
| Sharp | No | No |  |
| MediaTek | No | No |  |
| Nokia | No | No |  |

**Q1-3: Do you think multi-path Relay is applicable to RRC\_IDLE remote-UE or not?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | No | No |  |
| Xiaomi | NO | NO |  |
| CATT | No | No |  |
| Huawei, HiSilicon | No | No |  |
| vivo | No | No |  |
| ZTE | No | No |  |
| Ericsson | No | No |  |
| Apple | No | No |  |
| Qualcomm | No | No |  |
| Lenovo | No | No |  |
| LG Electronics | No | No |  |
| China Telecom | No | No |  |
| Futurewei | No | No |  |
| Spreadtrum | No | No |  |
| Intel | No | No |  |
| CMCC | No | No |  |
| Samsung | No | No |  |
| Sharp | No | No |  |
| MediaTek | No | No |  |
| Nokia | No | No |  |

Secondly, besides the applicability to the dimension of RRC states, to check companies view on the other dimension, i.e., related RRC procedures.

**Q2-1: Do you think R2 needs to enhance R17 mechanism of SIB-delivery for R18 MP Relay?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | No | No | We do not think MP-Relay is applicable to RRC\_IDLE/RRC\_INACTIVE UEs, where R17 procedure (where the UE can by its implementation to perform the SI reception via direct path besides the indirect path) is sufficient.  Although it is applicable to RRC\_CONNECTED remote UE, we do not think there is a need for specific optimization for it:  If the SIB is delivered via dedicated RRC signaling, then it is a just about split-SRB configuration issue; Or if the SIB is delivered via SIB directly, then UE can acquire the SIB directly if configured with CSS. |
| Xiaomi | FFS | FFS | It’s not clear to us what ‘enhancement’ mean in the question. If we found some thing broken on SIB delivery in multipath, it should be fixed. At this early SI phase, we may need futher study.  [Rapp] If any ‘some thing broken’ identified now? if yes, please clarify  Re: We understand the SIB delivery is only applicable on the path which holds the RRC connection, e.g. anchor path, not on the other path. However, it’s still FFS whether such path differentiation is supported. So, we can’t make conclusion on the SIB delivery for now. |
| CATT | No | No | Agree with OPPO. When the remote UE is configured with multi-path, it is in RRC\_CONNECTED. Therefore, it is not needed to receive SIB/paging forward from the relay UE. |
| Huawei, HiSlicon | No | No | In Rel-17, no SIB deliver for connected Remote UE. We do not foresee any new requirement to enhance this/other aspects related to SIB forwarding for multipath. |
| vivo | No | No with comments | For scenario 1, there is R17 mechanism of SIB-delivery for U2N SL relay scenario, which is reused, e.g. in case of remote UE OOC or with lower RSRP. After establishment of indirect path as legacy R17 procedure, the remote UE enters into RRC CONNECTED state and direct path can be added. In the other direction, when a remote UE enters into RRC CONNECTED state via direct path and then a indirect path is added. In these two basic procedures, the SIB-delivery related the second path is for a CONNECTED UE, i.e. via RRC dedicated signalling as legacy. Nothing new is needed.  For scenario 2, R17 mechanism of SIB-delivery for U2N SL relay scenario cannot be used.  [Rapp comment] Please clarify why ‘R17 mechanism of SIB-delivery for U2N SL relay scenario cannot be used’. Rapp understand even though UE-UE link is a blackbox in scenario-2, the PC5-RRC signaling for remote UE to request SIB from relay UE, and for relay UE to deliver SIB to remote UE still works.  However, the SIB-delivery related to the second path is also for a CONNECTED UE, i.e. via RRC dedicated signalling as legacy. For the SIB-acquisition of the first path, remote UE reads directly via direct path or acquires from its relay UE via un-specified inter-UE interface. No specification effort is needed either. |
| ZTE | No | No | As far as we know, it has been specified in Rel-17 that the in-coverage U2N Remote UE is allowed to acquire any necessary SIB(s) over Uu interface irrespective of its PC5 connection to Relay UE. Moreover, the U2N Remote UE can also receive the system information from the Relay UE after PC5 connection establishment with U2N Relay UE. When it comes to the multi-path remote UE in RRC\_Connected UE, it may receive system information from only one of the paths or both paths. Which path to choose can be based on the bearer type configuration of SRB1. |
| Ericsson | No, with question for clarification | No, with question for clarification | The question is a little unclear, are we only considering the indirect path here because the R17 mechanism is only applicable for the indirect path?  Our understanding, for MP, the two paths can be associated to same/different cells. When connected to the different cells, SIB on direct path can be obtained via legacy procedures and on indirect path can be obtained based on R17 mechanism. When connected to the same cell, the remote UE can acquire necessary SIBs on the direct path and other (relay) SIBs over the indirect path or can be left to UE implementation. |
| Apple | FFS | FFS | We think for RRC\_CONNECTED remote UE, the UE can trigger on-demand SI procedure (e.g, transmission *DedicatedSIBrequest*) from either direct path or indirect path, this is related to how SRB1 is configured in MP and whether there is a primary path concept for control plane. Similar question for the NW side, too. |
| Qualcomm | See comment | See comment | Some clarification may be needed. E.g. whether to always use dedicated signaling or remote UE is allowed to receive some SIs (mainly SIB1) from both paths in case of different cells on two paths. |
| Lenovo | No | No | We assume the MP Relay is applied to the remote UE in CONNECTED state, it is not needed to enhance R17 mechanism of SIB-delivery. The remote UE can get SI from direct path. Alternatively, the remote UE can get SI from indirect path via dedicated RRC reconfiguration message as legacy. |
| LG Electronics | No, but some clarification seems needed. | No | If CSS for SI is configured within the active BWP on the direct path on PCell, the remote UE performs direct system information acquisition on PCell as currently specified. If not, the gNB can alternatively provide system information on DCCH to the remote UE via any path as currently specified.  Note that in any case, the remote UE needs to directly acquire SFN from MIB on the direct path, if necessary. |
| China Telecom | No | No | In our understanding, the R17 SIB-delivery mechanism still works for multi-path scenarios, and no further enhancement is foreseen. |
| Futurewei | No | No |  |
| Spreadtrum | No | No |  |
| Intel | No with comment | FFS with comment | For scenario 1, considering R17 support, no further enhancement is needed.  For scenario 2, no enhancement is foreseen, but there may be some restrictions depending on how CP is defined for this case. |
| CMCC | No | No |  |
| Sharp | No | No |  |
| MediaTek | No | No |  |
| Nokia | No | No | As the remote UE is in RRC\_CONNECTED, the remote UE can receive SIB via direct path or can receive forwarded SIB in dedicated RRC message via indirect path. |

**Q2-2: Do you think R2 needs to enhance R17 mechanism of Paging-delivery for R18 MP Relay?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | No | No | Since we do not think MP-Relay is applicable to RRC\_IDLE/RRC\_INACTIVE UEs, where R17 procedure (where the UE performs the paging reception via a single path) is sufficient. |
| Xiaomi | No | No | Paging is not applicable for CONNECTED remote UE. |
| CATT | No | No | Multi-path is only applied for the remote UE in RRC\_CONNECTED. Paging forward is not needed. |
| Huawei, HiSilicon | No | No |  |
| vivo | No | No with comments | Similar as the above response in Q2-1, a remote UE with R18 multi-path configuration is always in RRC CONNECTED state. There is no need to introduce paging-delivery solution for a CONNECTED UE.  Furthermore, regarding a IDLE/INACTIVE remote UE before Multi-path establishment in scenario 1, both monitoring paging via direct path or paging-delivery via a R17 U2N relay path are all legacy mechanisms. In scenario 2, if the cases of indirect path firstly establishment or maintaining are supported, e.g. for a OOC remote UE, unspecified paging-delivery mechanism via ideal inter-UE backhaul may be needed without specification impacts. |
| ZTE | No | No |  |
| Ericsson | No | No | The question again is unclear, R17 mechanism only relates to the indirect path?  The same scenario of same/different cells is applicable here. Paging in CONN state is applicable in the case of ETWS warnings and SIB updates. ETWS warnings can be received over the direct path. For SIB updates over the indirect path (on a different cell), like in Rel-17, it is up to the network to provide the updated SIBs |
| Apple | No | No |  |
| Qualcomm | No | No |  |
| Lenovo | No | No | We assume that the MP Relay is applied to UE in CONNECTED state, it seems unnecessary to enhance R17 mechanism of Paging-delivery. |
| LG Electronics | No | No |  |
| China Telecom | No | No |  |
| Futurewei | No | No |  |
| Spreadtrum | No | No |  |
| Intel | No | No with comment | For scenario 2, in addition to the point raised by E///, for CONNECTED UEs, we assume that the direct path is not released (which is still under discussion). |
| CMCC | No | No |  |
| Samsung | No | No | The delivery over either direct or indirect can reuse the R17 mechanism. However, which path is used deserved some discussion. |
| Sharp | No | No |  |
| MediaTek | No | No |  |
| Nokia | No | No | As the MP remote UE is in RRC\_CONNECTED, we don’t see any need for enhancement in paging delivery. |

**Q2-3: Do you think R2 needs to enhance R17 mechanism of RRC setup/resume/re-establishment procedure for R18 MP Relay?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | No | No | R17 procedure (where the UE performs the RRC procedure via a single path) is sufficient. |
| Xiaomi | No for remote UE | No for remote UE | For remote UE, MP is not established during initial access.  For relay UE, we may need further study. If relay UE in IDLE/INACTIVE can be selected during MP addition as in Q4-1, we need to study how to trigger relay UE enter CONNECTED. Legacy procedure may be enhanced. |
| CATT | No for remote UE | No for remote UE | Agree with Xiaomi. Enhancement is needed on how to trigger relay UE in IDLE/INACTIVE enter CONNECTED. |
| Huawei, HiSilicon |  |  | Not so sure about the question, if the only connected UE can be configured with multiple path, the RRC setup/re-establishment/resume procedures seem not relevant.  [Rapp] Same view. The reason of this Q is that the concerned RRC procedure may not be super clear whether it is categorized as RRC\_IDLE/INACTIVE or RRC\_CONNECTED, so hard to be covered by output from Q1-x, so check companies view here in order to be crystal clear. |
| vivo | No | No | Legacy Uu and R17 SL relay procedure for L2 Remote UE on RRC setup/resume/re-establishment, can be considered as baseline in general. |
| ZTE | No | No | For the remote UE, it may perform the RRC setup/resume/re-establishment based on legacy mechanism. We see no motivation for the enhancements. |
| Ericsson | No | No | Same concern for the question. This only relates to the indirect path?  The RRC setup/resume/re-establishment procedures are the same for direct (based on legacy) and indirect path (based on R17 mechanism) |
| Apple |  |  | Same confusion as Huawei. I assume we only discuss RRC\_CONNNECTED remote UE. The procedures are not applicable except RRC-reestablishment. Why we discuss all those procedures together. It is also too early to discuss RRCReestablishment (e.g. path failure case), as this is related to CP primary path discussion. |
| Qualcomm | See comments | See comments | For RRC resume, it depends on whether the MP relay context can be suspended during Inactive state and resumed like today’s SCG context. Want to postpone this.  Agree with Apple on RRC re-establishment procedure, needs to further discuss. |
| Lenovo | No | No | Multi-path can be configured after completing legacy RRC setup/resume/re-establishment procedure. Therefore, no enhancement is needed. |
| LG Electronics | No | No |  |
| China Telecom |  |  | Agree with Apple. RRC re-establishment procedure may need further discussion. |
| Futurewei | - | - | Some clarifications on RRX re-establishment procedure may be needed. |
| Spreadtrum | No | No |  |
| Intel | No | No with comment | For scenario 1, assuming setup/resume will be already done when MP is configured, we understand that the reestab. procedure need not be enhanced as such but some restriction may be imposed (e.g. re-establishment only on one path (anchor)…)  For scenario 2, it depends on whether we will agree to configure Remote UE on indirect path and then add direct path. For reestablishment, similar to that for scenario 1, we could have some restriction. |
| CMCC | No | No |  |
| Samsung | No | No | The delivery over either direct or indirect can reuse the R17 mechanism. However, which path is used deserved some discussion. |
| Sharp | No | No |  |
| MediaTek | No | No |  |
| Nokia | No | No | For the remote UE, MP is setup only in RRC\_CONNECTED, hence, no need of enhancement. We only need to consider how to improve an RRC Connection establishment (e.g., to decrease the latency) when the relay UE is in RRC\_IDLE/INACTIVE. |

## PCell configuration

For Pcell configuration, one proposal is provided in 09375

*Proposal 18 For scenario-1 of multi-path Relay, PCell is always configured on the direct path when configured.*

**Q3: For UEs operating in MP Relay, if the two paths are for different cells, which case(s) is a valid case?**

**Case-1: The cell of direct path is PCell of the UE**

**Case-2: The cell of indirect path is PCell of the UE**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | Case-1 | Case-1 | If we put PCell on direct path, it means Uu interface is only with SCell, which did not happen before, and the problem is how to perform RACH, PUCCH reporting and RLM, which relies on the existence of PCell based on the current spec. |
| Xiaomi | Both | Both | In R17, it’s already supported the PCell is on the indirect path, since it’s the only way.  [Rapp comment] this Q is limited to ‘**For UEs operating in MP Relay**’, R17 is limited to single (indirect) path case.  In addition, direct path can be added to improve thoughput. In this case, it’s not CA between direct and indirect path. It’s more like DC structure. There should be one cell on the direct path acting as PSCell.  The motiviation of PCell on indirect path is to improve the reliability. Remote UE is expected at the cell edge, according to the Uu threshold condition. The indirect path may be more reliable at cell edge. If the associated cell of direct path and indirect path is different, it may be more reliable to put PCell on indirect path.  [Rapp comment] although might be anyway inevitable, still suggest to provide argument besides the DC-modelling / CP P/S-path thing which is a bit controversial at the current stage.. |
| CATT | Both | Case-1 | For scenario-1, in Rel-17, remote UE’s PCell is the serving cell of relay UE. For MP. For the case addition of direct path over indirect path, PCell should be the cell of indirect path. Remote UE should not change the MAC-I in path add/modification procedure. |
| Huawei, HiSilicon | Ask for clarification | Ask for clarification | We would like to better understand the question. In the original proposal 18, when it says PCell is “configured”, does it imply PCell change procedure? Because during other cases like RRC setup/re-establishment/resume, the UE takes the cell/Pcell of the connected Relay UE ( via which the RRC procedure is initated) as PCell, which is not configured by network.  [Rapp] we share the view “during other cases like RRC setup/re-establishment/resume, the UE takes the cell/Pcell of the connected Relay UE ( via which the RRC procedure is initated) as PCell, which is not configured by network”, so realize the original P18 is not accurate.. and thus why use the new wording in Q3 which would be more comprehensive / accurate |
| vivo | Case-1 | Case-1 | Regarding PUCCH configuration, random access procedure, special deactivation limitations and so on, it is a simplest way to accept PCell in Uu link as the real PCell of remote UE. Otherwise, if we choose PCell of relay UE as PCell of remote UE in multi-path scenarios, remote UE cannot work well in Uu link, e.g. lots of legacy behaviors about PCell should be re-considered. |
| ZTE | Both | See comments | For Scenario 1, if the RRC is established via direct path, the remote UE regard the serving cell of direct path as PCell. On the other hand, if the RRC is initially established via indirect path, the remote UE regard the serving cell of indirect path as PCell. Even if the direct path is added after a while, the original serving cell of indirect path can still be regarded as PCell. It is not necessary to change the PCell due to the addition of direct path.  For Scenario 2, if the UE can only establish the RRC via direct path, the serving cell of direct path should work as the PCell. However, if the UE can also establish the RRC via indirect path which is actually still FFS, the serving cell of indirect path may also work as the PCell similar to Scenario 1. |
| Ericsson | Case-1 | Case-1 | Agree with OPPO. In addition, PCell should be configured on the path where the network is capable of performing RLM, given that that is only possible on the direct path, Case-1 is sufficient. |
| Apple | Both | Case 1 | For Scenario 1, we see no reason to restrict PCell to be only in direct path. That will force a PCell change when adding direct path.  For scenario 2, the direct path is always present. So, it is fine to assume PCell is on direct path. |
| Qualcomm | Both | Both | As PCell definition, PCell is the cell in which the UE either performs the initial connection establishment procedure or initiates the connection re-establishment procedure. We already agreed the UE establishes RRC connection over indirect path, then add direct path. So case-1 does not work for this scenario.  If PCell is on indirect path, then there should be PSCell on direct path to provide the functions of companies mentioned RACH, PUCCH reporting, RLM, special deactivation limitations and so on. Actually, current specification already almost supports such configuration, we don’t see much specification change.  For scenario 2, it is also possible that the Remote UE establishes RRC connection over indirect path, with control plane message transferred between the Remote UE and Relay UE by implementation, and we don’t need to exclude them from standard. |
| Lenovo | Both | Both | Regarding scenario1, which cell can be configured as PCell depends on the gNB configuration. PCell may be configured to the first path. PCell can be changed after addition of the second path.  Regarding scenario 2, we prefer to have a common solution for both scenarios. |
| LG Electronics | Case-1 | Case-1 | We think that Case-2 is expected to require some discussion for clarification and changes. For Rel-18, we can restrict to Case 1 for simplicity. |
| China Telecom | Both | Both | For scenario 1, we think there is no need to restrict PCell only in direct path, which may lead to a PCell change when adding the direct path. And the gNB can anyway trigger a PCell change if needed. For scenario 2, we slightly prefer to have a common solution. |
| Futurewei | Both | Case-1 |  |
| Spreadtrum | Both | Case-1 |  |
| Intel | Both | Case 1 with comment | Assuming that for scenario 2, we only support direct path first and it is always present and indirect path added later. |
| CMCC | Case-1 | Case-1 |  |
| Samsung | Both cases are possible | Both cases are possible | The MP operation may be started when either direct path or indirect path is established. If the indirect path is firstly establishment, the PCell should be the one serving the relay UE, which is aligned with R17 design. If we limit to PCell over direct path only, the above case does not have PCell for the UE.  In our understanding,   * PCell is the one serving the initial path over which the UE connects to gNB |
| Sharp | Both | Case 1 | In U2N relay case, PCell can be configured on indirect path. We think MP is introduced for enhancement throughput and reliability compared than single path (i.e. direct only or indirect only). Therefore, PCell should be configured on either paths. But for scenario 2, Remote UE may not be configured on only indirect path |
| MediaTek | Both | Case 1 |  |
| Nokia | Both | Case1 with comment | For scenario 1, RAN2 decides to support cases starting with direct and indirect path. Accordingly, the PCell can be on direct and indirect path, respectively. Answering ‘Both’ here does not intend to support PCell change/reconfiguration upon addition of another path to the existing path. If RAN2 wants to support this case, the motivation and the potential impact needs to be discussed.  For scenario 2, it depends on whether RAN2 support the case B and D, which is still FFS. If stand-alone indirect path is not supported for scenario 2, case 1 would be sufficient. |

## Path Switching

R2 reached the conclusion as follows

Agreements:

Proposal 1-1A (modified): The following cases are to be supported for Scenario 1.

A. The remote UE operating only on the direct path adds the indirect path under the same gNB;

B. The remote UE operating only on the indirect path adds the direct path under the same gNB;

C. The remote UE operating in multi-path releases the indirect path;

D. The remote UE operating in multi-path releases the direct path;

G. The remote UE operating in multi-path changes to a new relay UE for the indirect path while keeping the direct path under the same gNB. FFS if this case would be supported via separate release-and-add (A+C in separate reconfigurations) or a single switch procedure (e.g. similar to i2i service continuity).

Proposal 1-1B (modified): The following case is to be not supported for Scenario 1 as a group mobility scenario.

F. The remote UE configured with multi-path keeps the serving relay UE for the indirect path and the serving cell of the remote UE for the direct path while the serving relay UE changes the serving cell of the relay UE under the same gNB;

Agreement:

The following case can be supported via separate release-and-add for scenario 1 (B+D in separate reconfigurations):

E. The remote UE operating in multi-path changes the direct path to a different cell of the same gNB while using the serving relay UE for the indirect path under the same gNB.

FFS if a single procedure for this case would be supported.

Agreements:

Proposal 1-2A: The following cases are proposed to be supported for Scenario 2.

A. The remote UE configured only on the direct path adds the indirect path under the same gNB;

C. The remote UE configured with multi-path releases the indirect path;

Proposal 1-2B: The following case is proposed to be not supported for Scenario 2.

F. The remote UE configured with multi-path keeps the serving relay UE for the indirect path and the serving cell of the remote UE for the direct path while the serving relay UE changes the serving cell of the relay UE under the same gNB;

Proposal 1-2C: Whether to support the following case can be further discussed for Scenario 2.

B. The remote UE configured only on the indirect path adds the direct path under the same gNB;

D. The remote UE configured with multi-path releases the direct path;

E. The remote UE configured with multi-path changes the serving cell of the remote UE for the direct path while keeping the serving relay UE for the indirect path under the same gNB;

G. The remote UE configured with multi-path changes to a new relay UE for the indirect path while keeping the direct path under the same gNB.

One proposal is provided in 09375

*Proposal 19 For scenario-1 of multi-path Relay, in case of path switching, a RRC\_IDLE/RRC\_INACTIVE Relay UE initiates RRC connection establishment procedure upon the message received from a Remote UE via SL-RLC, not limited to SL-RLC0/1.*

**Q4-1: For R18 MP Relay, for the supported path switching scenario (which scenarios to support is up to the specific discussion on scenarios), when there is an addition of indirect path or a change of indirect path, do you agree to support RRC\_IDLE/RRC\_INACTIVE target relay UE?**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | Yes | Yes | Same as in R17. |
| Xiaomi | Yes | Yes |  |
| CATT | Yes | Yes |  |
| Huawei, HiSilicon | Yes | No | For scenario 2, no need to consider the case relay UE is not in RRC connected, because before network configures relay UE to the remote UE, it needs to know and verify the relation between remote UE and relay UE, which means the relay UE should have been connected to the network already. |
| vivo | Yes | Yes |  |
| ZTE | Yes | Yes |  |
| Ericsson | Yes | Yes | No restriction on RRC state |
| Apple | Yes | Yes |  |
| Qualcomm | Yes | Yes | For HW’s comment on scenario 2, Remote UE will indicate the target Relay to the gNB, then gNB behaviour is same for scenario 1. |
| Lenovo | Yes | Yes | Same as legacy Rel-17. |
| LG Electronics | Yes | No | For scenario 2, we assume that UE informs gNB about semi-static UE-to-UE connection by using RAN specific ID (e.g. C-RNTI) in order to avoid impact on CN. |
| China Telecom | Yes | Yes |  |
| Futurewei | Yes | Yes |  |
| Spreadtrum | Yes | Yes |  |
| Intel | Yes | Yes |  |
| CMCC | Yes | Yes |  |
| Samsung | Yes | Yes |  |
| Sharp | Yes | Yes |  |
| MediaTek | Yes | Yes |  |
| Nokia | Yes | Yes | However, for scenario 2, it is out of 3GPP scope, how the remote UE selects/resects the relay UE over unknown interface. |

**Q4-2: If Yes to Q4-1, how to trigger the RRC\_IDLE/RRC\_INACTIVE target relay UE to initiate RRC connection establishment procedure?**

**Option-1: Upon the message received from a Remote UE via SL-RLC, not limited to SL-RLC1**

**Option-2: Other (please clarify the solution if this is selected)**

**Option-3: Upon the indication/configuration received from a remote UE, e.g. indication/configuration in *RRCReconfigurationSidelink message***

**Option-4: gNB configures *RRCReconfigurationComplete* message deliverd via indirect path, e.g. configure duplication of SRB1 or change the primary RLC entity of SRB1 to indirect RLC entity.**

**Option-5: During discovery/PC5 unicast establishment for multi-path**

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | 1 | 2 (Up to UE implementation) | For Sce-1: in R17, it is limited to SL-RLC1, yet for MP Relay, since SRB1 may not be configured at indirect path, it does not have to be limited to it.  For Sce-2: Since UE-to-UE link is a blackbox, maybe OK to leave it to UE implementation. |
| Xiaomi | 3 | Up to implementation | If relay UE is in IDLE/INACTIVE, NW can send essential multipath configuration to relay UE via remote UE during MP addition. Remote UE can forward the configuration via *RRCReconfigurationSidelink* message to relay UE. Upon reception of the configuration, relay UE can enter CONNECTED. |
| CATT | 4 or 3 | Up to implementation | Both 4 and 3 can trigger RRC\_IDLE/RRC\_INACTIVE target relay UE to initiate RRC connection establishment procedure. |
| Huawei, HiSilicon | 5 | Up to implementation | For scenario 1, according to what we learn from SA2 discussion, the relay UE needs to advertise it support multi-path via service code in discovery message, so when the remote UE establishes PC5 unicast link with the relay UE, the relay UE already knows the access is for multi-path service, then it should enter connected state.  For scenario 2, if the remote UE want to leverage multi-path, it can inform the relay UE to enter connected state on the non-3GPP interface, the detailed method is left to UE implementation. |
| vivo | 1 | 2 : Up to UE implementation | For scenario 1, in Release 17, it is limited to SL-RLC1, i.e. RRC Reconfiguration Complete message. However, in release 18 multi-path relay, the SRB1 may be configured on direct path and consequently RRC Reconfiguration Complete message may not be transmitted via indirect path, it can not rely on it. The first data via indirect path may be a DRB data or a new PC5 indication message can be introduced and so on. Details are FFS.  For scenario 2, an unspecified inter-UE indication may be a simplest way to trigger relay UE to initial RRC connection establishment procedure and details can be left to UE implementation. |
| ZTE | 4 or 5 | Up to implementation | For the Scenario 1, we think both 4 and 5 may work without introducing additional specification impact if the SRB can be configured as split bearer or indirect bearer.  For Scenario 2, it can be up to UE implementation. |
| Ericsson | 2, FFS | UE implementation | Re-use Rel-17 indication. It should be possible when adding the indirect path, to configure a split SRB for SRB1 and as a result, SL-RLC1 will be configured. |
| Apple | 3 | Up to UE implementation | We think option 4 is unnecessary. There is no need to force SRB1 duplication or reconfigure primary path just for the triggering of IDLE/INACTIVE relay UE case. We can rely on PC5-RRC. |
| Qualcomm | 1 with comment; or  Wait for SA2 on 5 | Up to implementation | FFS for “not limited to SL-RLC1”, can further discuss whether split SRB1 configured to support this scenario.  For 5, we can wait for SA2 to see whether there is special information introduced on PC5-RRC, and can reuse it. |
| Lenovo | 4 | Up to implementation | Regarding scenario1, option 4 will not impact the current specification. |
| LG Electronics | 4 | No support | If Opt 4 is not used, Opt 3 can be considered. |
| China Telecom | 3, 4, 5 | Up to implementation | For scenario 1, we think both 3 and 4 are workable. We are also fine with 5 if SA2 has related agreement. |
| Futurewei | 1, 5 | Up to implementation |  |
| Spreadtrum | 1 | Up to implementation |  |
| Intel | 1 | Option 2: Up to UE implementation | For scenario 2, we can leave it to UE implementation as the link is considered to be semi-static between the Remote UE and the Relay UE. gNB will anyway enable Multipath and perform configuration towards the Relay UE only after the Relay UE has connected to the gNB. |
| CMCC | 1 | Up to UE implementation |  |
| Samsung | FFS for now | 2 (up to UE implementation) | For scenario-1, SL-RLC1 can be one possible way, which can be used to transmit the RRCReconfigurationComplete message as response for the indirect path addition. However, another possible way is to use unicast PC5 RRC message, e.g., use RRCReconfigurationSidelink or define a new PC5 RRC message. Both options need further evaluation. Thus, we proposed to discuss this in next meeting. |
| Sharp | 3 or Wait for SA2 on 5 | Up to implementation |  |
| MediaTek | FFS for now | 2 (Up to UE implementation) |  |
| Nokia | 3 | UP to implementation | For scenario 2, we cannot introduce any specific solution because the interface between UE-to-UE is unknown, so no message can be defined in 3GPP.  For scenario 1, it is important to reduce latency. For this, the network may provide necessary information for relay UE’s RRC setup to the remote UE via RRC Reconfiguration and the remote UE can forward this to the target relay UE. In this case, we think RRCReconfigurationComplete message should be transmitted on direct path because it is a kind of confirmation that the remote UE forwards the relay UE’s RRC setup to the relay UE successfully. So, option 4 is not preferred. |

## RLM/RLF

One proposal is provided in 09375

*Proposal 20 For scenario-1 of multi-path Relay, UE performs RLM on both direct and indirect path.*

When UE operating in MP Relay, which path(s) to perform RLM?

|  |  |  |  |
| --- | --- | --- | --- |
| Company | Scenario-1 | Scenario-2 | Comment |
| OPPO | Uu + PC5 | Uu, and UE-UE link is left to UE implementation | For Scenario-1, it is clear and it is just to follow legacy procedure.  For Scenario-2, the handling of UE-UE link is a blackbox, so the key issue is whether/how to handle if there is some ‘failure’ like event at UE-UE link, yet no need to dig into the need of RLM though. |
| Xiaomi | Both | At least Uu | Although the RLM is performed on both link, the consequence of RLF on either path may be different. Note in legacy, UE would trigger RRC reestablishment if the RLF occurs on the only direct or indirect path. However, in multipath, RLF on one path may not trigger RRC reestablishment, if the path is only responsible for DRB transmission.  For scenario, whether ideal connection could fail can be clarified. |
| CATT | Both direct and indirect path | At least direct path. | For Scenario-1, reuse legacy procedure.  For Scenario-2, RLM for ideal link is up to UE implementation |
| Huawei, HiSilicon | Both | Uu | For scenario 1, the RLM on both paths are possible, but the detailed discussion also relates to the specific cases, e.g. whether the Uu Cell is PCell or not. |
| vivo | Uu + PC5 | Uu only | For scenario 1, legacy mechanisms can be reused.  For scenario 2, there is no need for RLM between two UEs. However, relationship reporting between UEs may be needed, e.g. inter-UE connection available or not available. |
| ZTE | Both | Uu | For scenario 1, we think it is necessary for the multi-path remote UE to perform RLM on both path independently. When RLF is detected on direct/indirect path, it is natural to reuse the legacy fast RLF recovery design, i.e. multi-path remote UE may send the direct/indirect path failure information to gNB via the indirect/direct path. Only if both path are not available or suspended, the remote UE may perform the RRC re-establishment via either direct path or indirect path as legacy UE.  For scenario 2, only the RLM on Uu need to be specified. The RLM for UE-UE connection can be up to implementation. |
| Ericsson | Uu | Uu | Firstly, we think there should be a differentiation between RLM and RLF. RLM is the procedure for link monitoring based on configured reference signals and this is only supported on the direct path. On the PC5 link, there is no RLM procedure i.e., configured reference signals for link monitoring.  RLF is declared based on RLM, on Uu, based on in-sync and out-of-sync indications from monitoring configured reference signals. On the PC5 interface, RLF is declared based on RLC/HARQ DTX/T400 expiry.  As a result, we believe there is no RLM on the indirect path at least on the PC5-link. |
| Apple | Both | At least Uu | It is unclear how do conduct RLM in a non-3GPP link for scenario 2 |
| Qualcomm | both | Both, for indirect path, it is left to UE implementation to detect RLF | For scenario 1, follow existing mechanism on indirect path and direct path. For direct path, existing MCG or SCG failure can be reused.  For indirect path of scenario 2, it should be left to UE implementation on how the remote UE detects ideal connection failure and how the relay UE informs the remote UE Uu failure. |
| Lenovo | Both with comments | Uu only | We agree the intention. Specifically, the remote UE should perform RLM on direct path, detect PC5 link. In addition, the remote UE may receive the notification from relay UE due to e.g RLF.  RLM in Uu means that physical layer will indicate the out-syn to MAC layer. We would like to clarify that there is no concept of RLM in PC5 link. Therefore, we suggest the following proposal:  *For scenario-1 of multi-path Relay, UE performs RLM on direct path.*  *For scenario-1 of multi-path Relay, UE detects PC5 link in indirect path and check the state of Uu link of relay UE.* |
| LG Electronics | Uu + PC5 | Uu only | For scenario 1, since the legacy specification, UE operating with SL unicast in RRC\_CONNECTED performs both Uu RLM and SL RLM. |
| China Telecom | Both | At least Uu | For scenario 1, the legacy mechanism can be used. For scenario 2, we are not sure whether the RLM can be performed in the non-3GPP link, but at least the legacy Uu RLM can be used. |
| Futurewei | Uu + PC5 | Uu | RLM on a non-3GPP link is not within RAN2 scope. |
| Spreadtrum | Both | Uu only |  |
| Intel | Uu and PC5 | Uu | For scenario 2, we share the same view as OPPO. For failure, we may need some handling, but for RLM, it is only feasible/reasonable to do so over Uu. |
| CMCC | Both path | Uu |  |
| Samsung | Uu + PC5 | Uu, and UE-UE link is left to UE implementation | This is referring to remote UE only.  In scenario 2, the UE-UE link is up to implementation. However, the failure over UE-UE link can be indicated to gNB as well. |
| Sharp | Uu+PC5 | At least direct only. (UE-UE link is up to UE | For scenario 1, Remote UE can perform Uu RLM and PC5 RLM using legacy mechanism.  For scenario 2, Remote UE can perform at least Uu RLM. For UE-UE link, it is up to UE implementation.  For both case, Remote UE can also detect indirect path RLF upon receving Uu-RLF indication from Relay UE. |
| MediaTek | Both | Uu, and UE-UE link is left to UE implementation |  |
| Nokia | Both with comments | Both with comments | The intended question would be how and for which path the remote UE detects failure.  For scenario 1,   * the remote UE detects Uu RLF based on Uu RLM as in the legacy. * the remote UE detects sidelink RLF as specified in 5.8.9.3 of TS38.331.   For scenario 2,   * the remote UE detects Uu RLF based on Uu RLM as in the legacy. * the remote UE detects failure on UE-to-UE link. However, the detailed procedure of the failure detection over the non-3GPP link and how the remote UE receives the failure information is out of scope from 3GPP perspective and can be left up to implementation. |

1. xxx.

# Conclusion

We have the following proposals:

[Proposal 1 xxx.](#_Toc116550638)

# Reference

1. xxx