**3GPP TSG RAN WG2 Meeting #117-e R2-220xxxx  
Electronic, 21th Feb - 3rd Mar, 2022**

**Agenda item: 8.7.2.2**

**Source: CATT**

**Title: Summary of [Pre117-e][603][Relay] Open issues on relay service continuity (CATT)**

**Document for: Discussion and Decision**

# Introduction

This email discussion is for the below offline discussion:

* [Pre117-e][603][Relay] Open issues on relay service continuity (CATT)

The intention of this pre email discussion is to collect companies’s view on the open issues on relay service continuity. The above email discussion is divided in two phases:

* **Phase I:** Companies are invited to provide feedback on the questions by 14th Feb 23:59 UTC.
* **Phase II:** Rapporteur submits a summary and proposals based on the feedback, and companies can comment on the summary by 17th Feb 12:00 UTC.

# Contact information

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# Identified open issues on relay service continuity

## Confirm the working assumptions of supporting IDLE/INACTIVE relay UE in path switch

During the RAN2#116bis-e, RAN2 reached the below working assumption [1].

WA: The gNB can select a relay UE in any RRC state i.e., RRC\_IDLE/INACTIVE/CONNECTED as a target Relay UE when triggering the direct to indirect path switch procedure for the Remote UE by the Remote UE oriented solution, i.e. after receiving the path switch command, Remote UE establishes PC5 link with the Relay UE and sends HO complete message via the Relay UE which will trigger the Relay UE to enter CONNECTED state.

According to the information of RAN2#116bis-e’s online and offline discussions, the majority’s view is to support that the gNB can select a relay UE in any RRC state as a target Relay UE when triggering the direct to indirect path switch procedure for the Remote UE by the Remote UE oriented solution. The intention of current discussion is to confirm this working assumption firstly.

**Question 3.1-1:** **Do you agree that RAN2 can confirm the above working assumption? Please give your comments.**

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| **Companies** | **Yes/No** | **Comments** |
| Xiaomi | Yes | As preferred by majority, the IDLE/INACTVE relay UE shoulde be supported. Otherwise, relay UE may have to stay CONNECTED even if there is no service to support remote UE mobility. |
| Qualcomm | Yes, if the WA on capablity is agreed | Although we think there are some followed remaining issues (e.g. whether to use default PC5 RLC channel for SRB1, new failure handling when relay UE reselects to another cell after MR reporting before path switchm, how remote UE local ID is assigned), we can compromise to confirm WA and try to resolve these remaining issues as much as possible.  However, because we have quite limited time to close these issues and it is a new thing that target relay can be in IDLE/INACTIVE, we are not sure whether any issue will be raised in remote UE implementation. It may cause IODT issues and slow down the time to market. Thus, we need this UE capablity, to avoid possible IODT issues. Thus, we can confirm this WA only if the capability of remote UE is agreed. |
| Apple | Yes | We have the same understandng that the WA to support IDLE & INACTIVE target relay UE can be confirmed amd the remaining isuse needs to be resolved. |
| OPPO | Yes | After futher observing, we do not see many issue left for allowing IDLE/INACTIVE relay UE as targer relay UE in direct-to-indirect path switch. |
| Huawei, HiSicon | Yes |  |
| vivo |  | Can be confimed with the prerequisite of miminizing the Spec impact and pursuing not any optimization in this release. |
| MediaTek | Yes | Agree with Qualcomm |
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If Yes is selected for Question 3.1-1, it should further define how to configure the PC5 RLC bearer of remote UE used for sending RRCReconfigurationcomplete message in HO procedure of direct to indirect path switch. Based on the above working assumption, gNB cannot configure PC5 RLC channel for Remote UE to send RRCReconfigurationcomplete message if Relay UE in RRC\_IDLE/INACTIVE is chosen as target Relay UE. Currently, we have defined SL-RLC0 to carry Remote UE’s SRB0 messages and SL-RLC1 for SRB1 messages. Next, we need to solve the issue that whether a new default or fixed PC5 RLC bearer is to be defined for the Remote UE to send the RRCReconfigurationcomplete message. In [2], one Recommendation based on majority companies’s view was as below:

**Recommendation based on majority (18/23)#3:** For the delivery of RRCReconfigurationComplete message by the Remote UE, default configuration which can be reconfigured by the network same as SL-RLC1 is used for PC5 RLC channel configuration to support RRC\_IDLE/INACTIVE target Relay UE for direct to indirect path switch procedure.

**Question 3.1-2:** **Do you agree that for the delivery of RRCReconfigurationComplete message by the Remote UE, default configuration which can be reconfigured by the network same as SL-RLC1 is used for PC5 RLC channel configuration to support RRC\_IDLE/INACTIVE target Relay UE for direct to indirect path switch procedure? Please give your comments.**

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| **Companies** | **Yes/No** | | **Comments** |
| Xiaomi | Yes | |  |
| Qualcomm | Yes | | In our understanding, only default PC5 RLC channel can be used in this case (i.e. dedicated PC5 RLC from NW can’t work). That is because PC5 RLC channel are required to be configured in both TX (remote UE) and RX (relay UE) (Note that in Rel-16, it was agreed some RLC paramters are TX only, some are RX only and some are common to TX and RX). Because target relay UE is in IDLE/INACTIVE, gNB can’t configure RX-only and TX-RX common parameters to relay UE to receive *RRCReconfigurationComplete* message. |
| Apple | Yes: with “default”,  No for “reconfigured by the network” | | We agree on the “default” configruaiton is to be used. But if NW reconfigures the remote UE to use a different dedicated configuraiton in HO message to be used for the transmisison of “RRCRreconfiguraitonComplete” message, but the relay UE is not reconfogired correspondinly, the reconfiguration will not succeed. Hence, we think it is simple to just use “defaullt configuraiton” for IDLE/INACTIVE case. |
| OPPO | Yes | | We tend to believe this SL-RLC1 can be either default or be reconfigured by gNB but the reconfiguration can only happen when IDLE/INACTIVE relay UE enter RRC\_CONNECTED state (i.e., anyway not applicable to the transmisison of HO-confirm message itself). |
| Huawei, HiSlicon | Yes | | Considering the target relay UE is in idle/inactive, it can only use default or specified PC5 RLC channel to receive the path switch complete message from remote UE so that this message can trigger the relay UE’s RRC connection setup/resume procedure. After relaly UE enter RRC\_CONNECTED state, the network configuration is donable.  For clarification, we understand the called “reconfigured by network” is refering to the RLC bearer of SRB1, not to the configuration specific to this path switch complete message. Because assuming the same default PC5 RLC bearer as RRCResume/RRCReestablishment, i.e. SL-RLC1, is used, then dedicated configuration should be allowed. Because it is SRB1, also carries other RRC messages afterwards. |
| vivo | | Yes | Only if the WA is confirmed. |
| MediaTek | Yes | |  |
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There is another working assumption as below:

WA: UE capability for support by the remote UE of handover to idle/inactive UE.

If Yes is selected for Question 3.1-1, it is nature to further confirm the above working assumption:

**Question 3.1-3:** **Do you agree that RAN2 can confirm the above working assumption? Please give your comments.**

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| **Companies** | **Yes/No** | **Comments** |
| Xiaomi | Comments | We understand the need of this capability depends whether a solution as discussed in 3.4.  If no solution is agreed, from remote UE perspective, there is no difference between handover to IDLE/INACTEVE or CONNECTED relay UE. No capability bit is needed.  If some solution is agreed, the capability may be needed to indicate the support of the agreed solution. |
| Qualcomm | Yes | We believe there are some new remtoe UE behaviors to support target relay UE in IDLE/INACTIVE. For example:   1. Use default PC5 RLC channel to send SRB1 (*RRCReconfigurationComplete)* 2. New procedure to get remote UE local ID in SRAP header (Note that the relay UE can’t obtain it from gNB in RRC message as was agreed in RRC establishment procedure because it is IDLE/INACTIVE) 3. Face some new HO failure scenarios (e.g. the relay UE reselects to another cell different from the one in HO command, relay UE failed to enter CONNECTED state, relay UE’s L2 ID is changed)   These new UE behaviors need different UE implementations.  Meanwhile, as we replied in Q1, because we have quite limited time to close these issues and it is a new thing that target relay can be in IDLE/INACTIVE, we have concern that it will cause IODT issues and slow down the time to market. Thus, we need this UE capablity, to avoid possible IODT issues. |
| Apple | See comment | If remtoe UE is unable to support IDLE/INACTIVE target relay UE, the more elegant way is to not report any such candidstes in measurement report. So, instead of introducing the new capability for remote UE, we can include RRC state information in disovery message so that remote UE can avoid the relay candidates in IDLE/INACTIVE state. |
| OPPO | Yes | We think the capability information is necessary while the RRC state bit is not needed in discovery message. Since gNB can differentiate whether a relay UE is in RRC\_CONNECTED state and it can determine whether the relay UE is suitable for the remote UE after remote UE reporting its capability info towards network. |
| Huawei, HiSilcon | Yes with comments | Although we do not see much difficulty to support this case in remote UE side, we can accept a optional UE capablity of remote UE.  For the comments from Qualcomm, share our views as below:  1) To clarify, the configuration of remote UE SRB1 can be still provided in HO commend, e.g. absent of dedicated configuration means defalut configuration applied. This aligns with the connected relay case.  2) for the remote UE local ID, it seems the same as other configuration? i.e.:   * in remote UE side, it can be configured in HO command; * in relay UE side, it will get the configuration from network after entering RRC\_CONNECTED state.   3) for the failure handling, it depends on the discussion in 3.2, and we see posibility to have a unified solution for both connected relay case and idle/inactive relay case (i.e. option4 to Q3.2-1). Or we can have notification message to trigger remote UE RRCReestablishment, seems not complicated. |
| vivo | Yes | As the path switch is likely to be an essential UE feature for L2 relay, one cannot require every UE supporting L2 relay to support also path switch towards an IDLE/INACTIVE Relay. |
| MediaTek | Yes |  |
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## Stopping condition of T304-like new timer for direct-to-indirect switching

In RAN2#116-e meeting, for the stop condition of the new T304-like timer in Remote UE, the below four options were listed as potential solutions:

* Option1: Upon successfully sending RRCReconfigurationComplete (i.e., lower layer acknowledge is received from target relay);
* Option2: Upon the PC5 unicast link is successfully established with the target Relay UE;
* Option3: Upon reception of RRCReconfigurationCompleteSidelink message from target Relay UE;
* Option4: Upon reception of an explicit indication from the target Relay UE.

This issue had been discussed during the at-meeting email discussion in RAN2#116-e. In [3], 17/22 companies support (or can accept) option1. 5/22 companies support option2 including 4 companies supporting both option2/3. It is obvious that the majority view is to support Option 1. Hence, rapporteur intends to confirm whether Option 1 can be agreed.

**Question 3.2-1: Do you agree that** **the stop condition of the new T304-like timer in Remote UE is upon successfully sending RRCReconfigurationComplete message (i.e., lower layer acknowledge is received from target relay)? Please give your comments.**

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| **Companies** | **Yes/No** | **Comments** |
| Xiaomi | Yes |  |
| Qualcomm | Yes | * Issue of Option 2:   + According to TS 38.331, the PC5 unicast link establishment is completed upon reception of upper layer indication on completion of PC5-S procedure. Thus, it is not an AS procedure and can’t be tested. Then, it is not suitable to specify as stop condition of one AS timer.  5.8.9.1a.4 Sidelink SRB addition The UE shall:  1> if transmission of PC5-S message for a specific destination is requested by upper layers for sidelink SRB:  2> establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-S message, as specified in sub-clause 9.1.1.4;  1> if a PC5-RRC connection establishment for a specific destination is indicated by upper layers:  2> establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-RRC message of the specific destination, as specified in sub-clause 9.1.1.4;  2> consider the PC5-RRC connection is established for the destination.   * Issue of Option 3:   + *RRCReconfigurationCompleteSidelink* message is not always required because RAN2 has agreed gNB directly configure relay UE and remote UE for PC5 QoS configuration via Uu RRC signaling in QoS management session. * Issue of Option 4:   + We think the explicit indication from relay UE is unnecessary spec impact. Such indication can be implicit via lower layer acknowledge in Option 1.   For Option 1, the main concerns are the following aspects. We provide our considerations for each of them.   1. It may cause extra HO latency to wait for the completion of HO-confirm delivery to send UP data   We think it is a misunderstanding. Option 1 will not incur extra HO latency because the new stop condition only impacts when HO failure happens.   1. The acknowledgement should be from gNB rather than from relay UE   This alternative also works. However, as it is up to gNB implementation whether / when to send PDCP status report during HO, we can’t ensure that remote UE can always get PDCP status report to stop the timer.   1. Lower layer acknowledgement may not always be available (e.g., if SL HARQ is disable)   RLC acknowledgement is always available because *RRCReconfigurationComplete* message is specified to use RLC AM in TS 38.33. |
| Apple | No | We think Option 2 is still a better choice and align with Uu behavior for T304. For the Qualcomm’s concern about PC5-S indication, we think the PC5-S procedure is intergrated with PC5-RRC establishement. And the time point can be tested as the completion of link estalbishmnet needs to be indicated in both upper layer and AS layer. |
| OPPO | Yes with comment | Besides option 1, we think both option 3 and option 4 can also work well. For option 3, after relay UE enter RRC\_CONNECTED state, it can send out the RRCReconfigurationCompleteSidelink message. For option 4, after relay UE enter RRC\_CONNECTED state, it can send out the explicit indication. However, we can also be compromised to option 1 if there is majority view. |
| Huawei, HiSilicon | See comments | Our perference is option4, because it is easy/clean, and can also address the issue that remote UE stops the T304-like timer but expriences a subsequent path switch failure due to relay UE connection failure as in Question 3.2-2. In legacy, there is only one HO faiure trigger, i.e. T304 expiry, in that sense, option4 is the most aligned one.  But if mojority insist to have a different handling for the case target relay is idle/inactive, we can compermise on majority view of option1 and discuss the further issue in Question 3.2-2. |
| vivo | Comments | Who wants option 1 should clarify what such “lower layer” acknowledgement actually is. A vague description of “lower layer” like in the current Option 1 is not sufficient to justify its feasibility.  If Option 1 is agreed, RAN2 needs to further decide whether any specified UE behavour is needed on how the UE judges the successful transmission of the RRCReconfigComplete msg., or this can be simply left to UE implementation with, e.g. informative texts captured in the Spec.  If the above things cannot be completed in this meeting, option 2 needs to be adopted instead. |
| MediaTek | Yes |  |
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Furthermore, during the discussion of open issue list for RAN2#117-e, one company raised [4] that when the new T304-like timer in Remote UE stops, the direct-to-indirect path switch may still fail because the IDLE/INACTIVE relay UE may still fail to establish the connection on Uu hop of indirect path (e.g., due to cell reselection).

**Question 3.2-2: Which option do you prefer regarding to the issue that when the new T304-like timer is stopped in remote UE but the direct to indirect path switch fails due to IDLE/INACTIVE relay UE fails to establish the connection on Uu hop of indirect path? Please give your comment.**

* **Option 1: Leave it to remote UE implemetation;**
* **Option 2: Relay UE sends notification message including connection reject indication**
* **Option 3: Others (if any, please give the detailed description). Upon reception of notification of failure to enter CONNECTED state from relay UE, remote UE regards path switch failure and triggers RRC reestablishment as legacy (added by QC)**
* **Option 4: Others (if any, please give the detailed description). RAN2 discuss mechanism that how relay UE can detect HOF after connected to a different gNB (not the gNB which sends HO command to remote UE) (added by Apple)**
* **Option 5: Relay UE only send “lower layer acknowledge”(or other confirmation message as to be concluded from Q3.2-1) after entering into CONNECTED state successfully**
* **Option 6: a similar handling as relay UE’s HO/Uu RLF, i.e.: (added by Huawei)**
  + **Upon relay UE receives RRCReject or experiences other connection establishment/resume failure, it either triggers PC5-S release or sends notification message indicating Uu RRC connection failure to remote UE.**
  + **PC5-S release or notification message shall trigger remote UE’s RRC reestablishment. But in case of notification, remote UE can choose to keep the current PC5 connection with this target relay, or release the PC5 connection and reselect to other relay.**

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| **Companies** | **Option** | **Comments** |
| Xiaomi | Option 2 | We think the issue is valid if relay UE is reject by NW. Relay UE can’t establish connection during wait time. Remote UE should be informed in this case.  Notification message has been introduce to indicate relay UE’s RLF or HO. This mechanism can be reused. If relay UE fails to establish the connection due to receiving connection rejection, relay UE should indicate connection reject to remote UE via notification message. Remote UE could choose whether to trigger relay reselection. |
| Qualcomm | Option 2 and 3 | This is a valid new HO failure scenario. So, the remote UE behavior should be specified. We are not sure how to understand Option 1.. |
| Apple | Option 2/3 for fail to enter connected state  Option 4 for the success connect to a wrong gNB case | I think the question is two-fold:  if gNB rejects relay UE’s access, then relay UE will need inform remote UE about fail to establish Uu path.  If gNB accept relay UE’s request, but due to cell-reselection, this will be a different gNB and the indirect path from the remote UE to the soruce gNB cannot be established at this point. We think relay UE also need to inform remote UE about the HO failure. But RAN2 has to disucss how to detect this failure. |
| OPPO | Option 5 | We think this issue is closly related to Q3.2-1, i.e., when discussing the stop condition of T304-like timer, the case that relay UE failed to enter RRC\_CONNECTED can be considered jointly, which means if T304-like timer is stopped, it means relay UE has already entered RRC\_CONNECTED state. While if T304-like timer is expiry, i.e., due to relay UE did not repond in time since it fails to enter into CONNECTED state, remote UE should trigger RRC restablishment. In the caseremote UE can just follow the legacy behiavour when T304 is expiry. |
| Huawei, HiSlicon | Option6 which is a update on top of option2/3 | Similar view as OPPO that this issue is highly related to Q3.2-1. And as commented to Q3.2-1, if the stop condition of T304-like timer only considers PC5 connection setup success but not considers relay Uu connection, the issue here exists, that is why we prefer to have an indication via PC5-RRC to indicate the remote UE that the path switch complete message is transmitte to network successfully as the stop condition.  Otherwise we think the similar handling of relay UE’s HO/Uu RLF can be used here, i.e. either PC5 release intiated by relay UE or notification send by relay UE could be used, and remote UE should perform RRCReestablishment as for other failure cases. |
| vivo | / | If Option 1 is adopted in Q3.2-1, we don’t think such a case happens, since T304-like timer is stopped only when the E2E connection is established and the RRCReconfigComplete msg has been sent succesfully (assuming the question is not asking about timer expiry case).  If the question is asking what if the relay UE’s connection fails *after* the path switch has already finished completely, this is not an issue for service continuity or path switch, but related to a general failure handling case being handled in CP procedure.  In a word, we don’t think any extra Spec impact is needed to handle this case (as the worst case for the Remote would be just going IDLE and then operating from the very begining). |
| MediaTek | Option 6 |  |
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## FFS on how to configure the threshold and use of SD-RSRP

Based on the agreements from RAN2#115-e meeting, it is clear that for the serving relay, SL-RSRP is the measurement quantity, and for the neighbor relays to be measured as candidate target relay, the SD-RSRP is the measurement quantity.

Proposal-11 (modified): As a baseline, SL-RSRP of the serving relay is used as the SL measurement quantity for the case of path switch from indirect to direct path.

Proposal-12: SD-RSRP is used as the SL measurement quantity for the case of path switch from direct to indirect path.

In RAN2#116-e meeting, RAN2 further concluded that SD-RSRP as SL measurement quantity of serving relay in case of the SL-RSRP of serving relay is unavailable. And one FFS was raised on how to measure SD-RSRP and if there would be a separate threshold for this case.

Agreement:

Proposal 4 (modified): When SL-RSRP of the serving relay is not available, SD-RSRP is used as the SL measurement quantity. FFS how to measure SD-RSRP and if there would be a separate threshold for this case.

Similarly, when discussing criteria for relay reselection, RAN2 had reached an agreement that is leave to UE implementation whether to use SL-RSRP or SD-RSRP for relay reselection trigger evaluation in case of no data transmission from relay to remote UE in RAN2#114-e:

Agreements:

Leave to UE implementation whether to use SL-RSRP or SD-RSRP for relay reselection trigger evaluation in case of no data transmission from relay to remote.

In order to solve the FFS of RAN2#116-e, the below two issues will be discussed:

**Issue 1: How to measure SD-RSRP?**

There are two options on how to measure SD-RSRP:

* Option 1: SD-RSRP measurement is based on gNB configuration.

In this option, beside basic configuration on relay specific SL measurements (e.g. SL-RSRP), additional SL measurement can also be configured by gNB (e.g. SD-RSRP). With this solution, the remote UE can report SD-RSRP depending on measurement configuration.

* Option 2: SD-RSRP measurement is left to UE implementation.

In this option, if there is no SL-RSRP, UE can measure SD-RSRP. Similar to relay (re)selection, we leave to UE implementation that which SL measurement will report to gNB, that’s to say, if the SL-RSRP is not available, the smart remote UE can use SD-RSRP for triggering estimation.

**Question 3.3-1: Which option do you prefer on how to measure SD-RSRP? Please give your comments.**

* **Option 1: SD-RSRP measurement is based on gNB configuration;**
* **Option 2: SD-RSRP measurement is left to UE implementation;**
* **Option 3: Others (if any, please give your detailed description). If there is no relay discovery message received from the serving relay, the remote UE can use model-B relay discovery procedure to trigger the transmission of relay discovery by relay UE and measure SD-RSRP (Added by Apple).**

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| **Companies** | **Option** | **Comments** |
| Xiaomi | Option 2 |  |
| Qualcomm | Option 2 | Aligned with agreement made in relay (re)selection |
| Apple | Option 3 | “How to measure SD-RSRP” means how remtoe UE can get relay UE to transmit the signal so SD-RSRP can be measurened? So, we think Option 3 |
| OPPO | Option 2 |  |
| Huawei, HiSilicon | Option 2 |  |
| vivo | Option 1 | For an RRC CONNECTED UE, SL-RSRP would be a measurement metric used for measurment reporting. It is thus inappropriate to leave whether to measure SD-RSRP to UE implementation, becasue if the UE decides not to measure it, it may report nothing to the gNB which then cannot tell what happened in SL with the expected measurment reporting being absent. |
| MediaTek | Option 2 |  |
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**Issue 2: Whether a separate threshold for SD-RSRP is needed or not?**

In the previous section, we talk about how to measure SD-RSRP. For the next step, let’s further discuss whether a separate threshold for SD-RSRP is needed or not. If Option1 in Question 3.3-1 is adopted, SD-RSRP will be configured by gNB, and the corresponding threshold will also be configured together; If Option2 in Question 3.3-1 is adopted, whether separate threshold is needed or not depends on how to handle the power imbalance issue. In relay re-selection scenario, the smart remote UE can handle the power imbalance issue by implementation.

**Question 3.3-2: For indirect to direct path switch, do you think a separate threshold should be used for SD-RSRP measurement? Please give your comments.**

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| **Companies** | **Yes/No** | **Comments** |
| Xiaomi | Yes | Dedicated discovery resource pool is agreed. The transmission power of discovery and communication may be different, due to different CBR measured on dedicated discovery resource pool and shared resource pool. So, even if the discovery and communication is sent by the same relay UE, remote UE may have different measurement of SD-RSRP and SL-RSRP. Therefore, separate thresholds are necessary.  SD-RSRP threshold is only used for evaluation of SD-RSRP. |
| Qualcomm | No | We prefer not to complicate system, and it is up to gNB implementation to ensure that the same threshold can be applied to SD-RSRP and SL-RSRP. Meanwhile, please note that RAN4 has agreed to use a unified measurement accuracy requirement for SL-RSRP and SD-RSRP. Therefore, we don’t see the need to introduce separate thresholds for SL-RSRP and SD-RSRP. |
| Apple | Yes | I think the questoin is a bit misleading, measurements can always be done by rremote UE, but the thresholds are needed to triggerd the measurement report. So, a separate threshold is needed for SD-RSRP to trigger the report, as this is different from SL-RSRP. |
| OPPO | No | Since the RS design is the same for discovery message and sidelink data, we do not see any motivation to have different thresholds. Also regarding to Xiaomi’s comment, we think it is not reasonable to set different thresholds due to different CBR measurement. According to rel-16 CBR priority configuration, even the sidelink data with different priority will transmit in different transmission power, but obviously there was no need to configure different SL-RSRP threshold for sidelink data with different priority. So the same logic holds here as well. |
| Huawei, HiSilicon | No | Share same view as Qualcomm and OPPO. |
| vivo | Yes |  |
| MediaTek | No | Agree with Qualcomm and OPPO. |
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## How does the remote UE handle the case that relay UE reselects to another cell after reporting and before path switch

During the discussion of open issue list for RAN2#117-e, one company [4] raised that how does the remote UE handle the case that the target relay UE reselects to another cell after reporting and before path switch. In [5], it stated that “Based on received measurement result from remote UE, NW could send handover command to remote UE, which includes the target relay UE’s ID. However, the handover command would be transmitted via relay UE. The transmission delay via indirect connection may be large, due to congestion on sidelink or SL/UL prioritization. Furthermore, gNB may not immediately send the handover command after receiving the measurement from remote UE. Before handover execution, target relay UE may change its serving cell due to cell reselection, handover or reestablishment. The reported relay UE’s new serving cell may not be prepared, so this relay UE would not be applicable for handover any more. In this case, the remote UE would suffer from handover failure if target relay UE changes its serving cell to other gNB.”

**Question 3.4-1: Whether it is necessary to handle the issue that the candidate relay UE reselects to another cell after remote UE’s measurement reporting and before remote UE received the handover command? Please give your comments.**

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| **Companies** | **Yes/No** | **Comments** |
| Xiaomi | Yes | Source gNB would prepare the cell according to relay UE’s serving cell ID included in the measurement report. However, if IDLE/INACTIVE relay UE reselects to another cell, the reselected cell may not be prepared. Although relay UE can establish RRC connection. The reselected cell doesn’t have remote UE’s context, the handover failure would occur for remote UE. |
| Qualcomm | Yes | We think this is a valid new failure scenario:   * The duration between MR report and HO execution is not short, because serveral pairs of inter-gNB signaling are needed to exchange target cell configuration and prepare HO command (HO preparation, HO request/ACK). * Becasue relay UE is in IDLE/INACTIVE state, it can’t inform gNB its leave.   The remote UE behavior should be specifeid anyways. |
| Apple | Yes | The remote UE shall specify the behavior for this failiure case. At least a failure report needs to be initiated from thet remote UE once it detects the indirect path is not feasible. |
| OPPO | Yes | We agree this issue exists but it widely exists in the case that relay UE in any RRC state. |
| Huawei, HiSilicon | No | We feel this is a corner case, the reasons are:  1. According to network implementation, measurement is configured when the UE is at coverage edge, and the measurement reporting will trigger NWs to send HO command very soon.  2. In case of relay UE’s cell reselection/HO/reestablishment to other cell, relay UE needs either release all the connected remote UE, or send notification message to the remote UE, which trigger remote RRC reestablishment.  Then the descripted issue is due to the relay UE changes cell after network see the measurement results/send HO but before remote UE setup unicast with the relay, we think the time window should be quite small. |
| vivo | No | We see this being related to some forms of optimization, and don’t regard it as essential for this release. Even if this case really happens, we don’t think the path switch will finally succeed, as this release of Spec does not provide enough mechinism to support an inter-gNB path switch. |
| MediaTek | Yes |  |
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If the answer to Question 3.4-1 is Yes, we should further discuss how to solve this issue, in [5], it proposed that:

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| **R2-2110220** | Proposal 7: Remote UE reports relay UE’s new serving cell upon relay UE changing serving cell, if remote UE had reported this relay UE’s serving cell. |

Besides the above potential solution, rapporteur thinks another solution is that we don’t introduce any spec impacts and leave it to remote UE implementation.

**Question 3.4-2: If the answer to Question 3.4-1 is Yes, which option do you prefer to handle the case that the candidate relay UE reselects to another cell after reporting and before receiving handover command?**

* **Option 1: Remote UE triggers measurement reports, including relay UE’s new serving cell, upon relay UE changing serving cell, if remote UE had reported this relay UE’s serving cell in measurement reoport;**
* **Option 2: Leave it to remote UE implemetation;**
* **Option 3: Others (if any, please give the detailed description). If remote UE identifies the target relay UE has reselected to another cell, remote UE regards path switch failure and triggers RRC reestablishment as legacy (added by QC)**

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| **Companies** | **Option** | **Comments** |
| Xiaomi | Option 1 | Proponent.  gNB can prepare the reselected cell of relay UE to avoid handover failure. |
| Qualcomm | Option 3 | We think Option 1 will require to introduce new reporting trigger conditon, which is unncessary spec work at this stage. And it may cause more issues because the HO command includes target cell’s conifiguration. Then, if relay UE reselects to another cell, HO command (including old target cell’s config) may not work for remote UE anymore.  For Option 2, we are not sure how it works.  For Option 3, we think it is the simplest way to close this issue, although some enhancement can be considered  [Xiaomi] Regarding option 3, our question is the remote UE doesn’t know whether relay UE is in CONNECTED or IDLE/INACTIVE. The issue doesn’t exist if relay UE is in CONNECTED, since gNB is aware of relay UE’s HO. Option 3 would result in false path switch failure if relay UE is in CONNECTED.  [QC] Thanks for question on option 3. Our understanding is that remote UE has to know target relay UE’s RRC state because it needs to determine whether to use default PC5 RLC channel or dedicated PC5 RLC channel configured by gNB to send RRCReconfigurationComplete (as **Question 3.1-2 discussed)**. And we actually don’t need any sgnaling change for relay UE’s RRC state because if target relay UE is IDLE/INACTIVE, gNB will not include dedicated PC5 RLC configuration in HO command towards to remote UE (i.e. it is implicit way from HO command).  Meanwhile, Option 3 doesn’t incldue CONNECTED relay UE because we have used the terminology “reselected to another cell.”  [Xiaomi] According to my observation, option 3 requires following changes to be feasible,   1. Remote UE needs to know the relay UE’s RRC state. 2. If relay UE is in CONNECTED, gNB has to provide dedicated PC5 RLC channel.   With above changes, Option 3 is not preferred in such late stage.  Furthermore, option 3 would definitely result in path switch failure in relay UE reslects to another cell. However, option 1 can allow gNB to prepare the new cell and lead to successful path switch. |
| Apple | Option 3 with comment | For Xiaomi’ s concern about remote UE does not know the RRC state of target relay UE, we assume the HO command need indicated this information explicitly or implicitly.  But option 3 just descirbe remote UE behavior, depending on relay UE sending cell information to remote UE, but RAN2 also need to discuss how relay UE can detect the failure upon the forwarding of RRCReconfigComplete message to the wrong gNB, as gNB will discard this message and not configure relay UE properly. So, some new mechanism in relay UE side is needed to correct this mistake more promptly.    [Xiaomi] According to my observation, option 3 requires following changes to be feasible,   1. Remote UE needs to know the relay UE’s RRC state. 2. If relay UE is in CONNECTED, gNB has to provide dedicated PC5 RLC channel.   With above changes, Option 3 is not preferred in such late stage.  Furthermore, option 3 would definitely result in path switch failure in relay UE reslects to another cell. However, option 1 can allow gNB to prepare the new cell and lead to successful path switch. |
| OPPO | Option 3 | For Xiaomi’ s concern about remote UE does not know the RRC state of target relay UE, **we do not think this is an issue for IDLE/INACTIVE case only but also for CONNCTED relay UE as well** so no additional change needed at all. |
| Huwei, HiSilicon | Option 2/3 | We understand option3 is one way of remote UE implementation, i.e. if remote UE is willing to check it can, and trigger RRC reestablishment if needed. Otherwise, if anything wrong is seen from network side, at least RRC release and RRC setup can be used to handle the remote UE. |
| MediaTek | Option 3 |  |
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However, due to transmission delay, network may not receive the new relay UE’s serving cell indication before handover command is sent from network to remote UE. Regarding to this case, in [5], it also suggested that in order to avoid handover failure, in addition to the relay UE ID, relay UE’s serving cell shall also be considered upon handover execution. If target relay UE’s serving cell belongs to the same gNB as remote UE, remote UE performs handover to the target relay UE. Otherwise, remote UE doesn’t perform handover to target relay, since the handover would fail. The target relay UE’s serving cell could be included in handover command or configured to remote UE in advance.

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| **R2-2110220** | Proposal 8: If target relay UE’s serving cell belongs to the same gNB as remote UE, remote UE performs handover to the target relay UE. Otherwise, remote UE doesn’t perform handover to target relay.  Proposal 9: The target relay UE’s serving cell could be included in handover command or configured to remote UE in advance.  Proposal 10: RAN2 to discuss remote UE’s behavior if handover is not performed due to target UE’s serving cell change,  Option 1: remote UE keeps connected with source cell and informs NW,  Option 2: remote UE triggers RRC re-establishment. |

**Question 3.4-3: If handover command is received from network, but the target relay UE has changed the serving cell, how does the remote UE handle it to avoid handover failure? Which option do you prefer? Please give your comment.**

* **Option 1: If target relay UE’s serving cell belongs to the same gNB as remote UE, remote UE performs handover to the target relay UE. Otherwise, remote UE doesn’t perform handover to target relay.** **The target relay UE’s serving cell could be included in handover command or configured to remote UE in advance;**
* **Option 2: Leave it to remote UE implemetation;**
* **Option 3: Others (if any, please give the detailed description). If remote UE identifies the target relay UE has changed its serving cell, remote UE regards path switch failure and triggers RRC reestablishment as legacy (added by QC)**

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| **Companies** | **Option** | **Comments** |
| Xiaomi | Option 1 | Proponent.  In addition, the cell ID is optional in handover command. If the target relay UE is in CONNECTED, gNB can choose not to include cell ID. Remote UE doesn’t consider relay UE’s serving cell during handover execution. |
| Qualcomm | Option 3 | For option 1, we are not sure how remote UE can decide new serving cell of relay UE belongs to the same gNB..  Again, Option 3 is simplest way to close this issue, although some enhancement can be considerered  [Xiaomi] Regarding option 3, our question is the remote UE doesn’t know whether relay UE is in CONNECTED or IDLE/INACTIVE. The issue doesn’t exist if relay UE is in CONNECTED, since gNB is aware of relay UE’s HO. Option 3 would result in false path switch failure if relay UE is in CONNECTED.  [QC] Thanks for question on option 3. Our understanding is that remote UE has to know target relay UE’s RRC state because it needs to determine whether to use default PC5 RLC channel or dedicated PC5 RLC channel configured by gNB to send RRCReconfigurationComplete (as **Question 3.1-2 discussed)**. And we actually don’t need any sgnaling change for relay UE’s RRC state because if target relay UE is IDLE/INACTIVE, gNB will not include dedicated PC5 RLC configuration in HO command towards to remote UE (i.e. it is implicit way from HO command).  Meanwhile, Option 3 doesn’t incldue CONNECTED relay UE because we have used the terminology “reselected to another cell.”  [Xiaomi] According to my observation, option 3 requires following changes to be feasible,   1. Remote UE needs to know the relay UE’s RRC state. 2. If relay UE is in CONNECTED, gNB has to provide dedicated PC5 RLC channel.   With above changes, Option 3 is not preferred in such late stage.  Furthermore, option 3 would definitely result in path switch failure in relay UE reslects to another cell. However, option 1 can allow gNB to prepare the new cell and lead to successful path switch. |
| Apple | Option 3 with comment | Option 3 works with the assumption that relay UE broadcast new cell information after remote UE receiveing HO command but not yet sending RRCReconfigComplete message to the relay UE..  We are not sure remote UE can always detect cell change of relay UE so quickly. We think some mechanism in relay UE is also needed to make sure this mistake can be rectified as soon as possbile.  [Xiaomi] According to my observation, option 3 requires following changes to be feasible,   1. Remote UE needs to know the relay UE’s RRC state. 2. If relay UE is in CONNECTED, gNB has to provide dedicated PC5 RLC channel.   With above changes, Option 3 is not preferred in such late stage.  Furthermore, option 3 would definitely result in path switch failure in relay UE reslects to another cell. However, option 1 can allow gNB to prepare the new cell and lead to successful path switch. |
| OPPO | Option 3 | For Xiaomi’ s concern about remote UE does not know the RRC state of target relay UE, **we do not think this is an issue for IDLE/INACTIVE case only but also for CONNCTED relay UE as well** so no additional change needed at all. |
| Huawei, HiSilicon | Option 2/3 | The relay UE’s HO is following NW decision. NW can avoid HO the relay UE to aother cell before the remote UE connects to the target relay UE.  But if remote UE wants to check the relay UE’cell ID, nothing prevents this. |
| vivo | 3 | We see this being related to some forms of optimization, and don’t regard it as essential for this release. It is just not optimal, if we just let handover/path switch failure happen and let remote UE recover with the corresponding failure handling procedure. |
| MediaTek | Option 3 |  |
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If Option1 is selected in Question 3.4-3, we should further discuss the remote UE’s behavior if handover is not performed due to target UE’s serving cell change.

**Question 3.4-4: If Option1 is selected in Question 3.4-3, which option do you prefer on remote UE’s behavior if hadover is not performed due to target UE’s serving cell change? Please give your comment.**

* **Option 1: Remote UE keeps connected with source cell and informs NW;**
* **Option 2: Remote UE triggers RRC re-establishment;**
* **Option 3: Others (if any, please give the detailed description).**

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| **Companies** | **Option** | **Comments** |
| Xiaomi | Option 1 | gNB could choose to prepare the reselected cell of relay UE or choose another relay UE to tirgger handover. |
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# Conclusion

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