**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. |
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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. |
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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. |
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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. |
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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)**

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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.. |
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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).**

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| **Companies** | **Option** | **Comments** |
| Xiaomi | Option 2 |  |
| Qualcomm | Option 2 | Aligned with agreement made in relay (re)selection |
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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. |
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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. |
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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.” |
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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.” |
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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

# References

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