3GPP TSG-RAN WG2 Meeting #116-e R2-210xxxx

Electronic Meeting, November 1 – 12, 2021

Agenda: 8.7.2.1

Source: InterDigital

Title: [Post115-e][610][Relay] Control plane procedures (InterDigital)

Document for: Discussion, Decision

# 1 Introduction

The following email discussion was triggered at RAN2#115-e[1]:

* [Post115-e][610][Relay] Control plane procedures (InterDigital)

 Scope: Discuss open issues on the relay control plane:

* Paging
	+ Parameters shared with relay UE for monitoring remote UE’s PO
	+ PC5-RRC signalling to forward paging to relay without CSS
	+ Forwarding of short message
* RNAU/TAU
	+ Confirm if the remote UE performs TAU/RNAU based on relay UE’s serving cell (for IC or OOC remote UE, when PC5-RRC connected to the relay UE)
	+ Determine if the relay UE can perform TAU/RNAU for the remote UE
* Control of access procedure
	+ Whether relay UE indicates to the remote UE if an access attempt is rejected or fails (e.g. connection reject, UAC check failure)
	+ Whether relay UE sends wait time to the remote UE, and if so how the remote UE handles it
	+ Handling of T300 for remote UE, considering different RRC states of the relay UE

 Intended outcome: Report to next meeting

 Deadline: Long

# 2 Discussion

## 2.1 Paging

It has been agreed that a relay UE can monitor the POs of a remote UE and forward any received paging message to the relay UE. One issue discussed in RAN2#115 [1] was whether a relay UE in RRC\_CONNECTED is still required to monitor the POs of the remote UE, or whether it can receive the remote UE paging message in a dedicated RRC message from the network. Based on that discussion, the following were agreed for the L2 relay UE in RRC\_CONNECTED and the L2 remote UE(s) in RRC\_IDLE/RRC\_INACTIVE.

Agreements:

When L2 Relay UE in RRC CONNECTED and L2 Remote UE(s) in RRC\_IDLE/RRC\_INACTIVE, the Relay UE can monitor PO of its PC5-RRC connected Remote UE(s) if the active DL BWP of Relay UE is configured with common CORESET and common search space.

For L2 relay UE in RRC\_CONNECTED and L2 remote UE(s) in RRC\_IDLE/RRC\_INACTIVE, we specify signalling for delivery of the remote UE’s paging through dedicated RRC message. Network implementation decision whether to use it (or keep the relay UE on BWP with CSS). Can be revisited if a problem is found with network knowledge of which paging to forward.

These agreements seem to imply that, for a relay UE in RRC\_CONNECTED and remote UE in RRC\_IDLE/RRC\_INACTIVE, the relay UE is only required to monitor PO of the remote UE(s) when the DL BWP of the relay UE is configured with common CORESET and common search space. Otherwise, the relay UE simply relies on dedicated signalling from the network. Rapporteur believes it would be useful to first confirm this understanding.

**Q1.1) Can RAN2 confirm the understanding that, when the relay UE is in RRC\_CONNECTED and the remote UE is in RRC\_IDLE/RRC\_INACTIVE, the relay UE has the following behaviour:**

* **When configured with common CORESET and common search space in the active BWP, the relay UE monitors the paging occasions of the connected remote UE(s)**
* **When not configured with common CORESET and common search space in the active BWP, the relay UE does not monitor the paging occasions of the connected remote UE (i.e., it relies only on dedicated RRC signaling from the gNB to receive paging for the remote UE)**

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| Company | Response (Y/N) | Comments |
| Qualcomm | Y | It has been agreed in RAN2-115-e, and captured in running 38.300 CR. We don’t see any confusion for this agreement.  |
| OPPO | No need to re-discuss this issue | Same view as Qualcomm, no need to discuss this issue. |
| InterDigital | Y |  |
| Ericsson | Yes with comment | No issue with reconfirming what has been already agreed. Probably something that is to worth to clarify is that “common search space” should be in reality “paging search space”. Otherwise things would not work. |
| Xiaomi | Y |  |

For the case of the relay in RRC\_CONNECTED and the remote UE in RRC\_CONNECTED, the remote UE need only be paged for SI change indication and/or PWS notifications. Since SI change indication and/or PWS notifications relevant to the remote UE can be received by the relay UE in any PO (including its own), there seems no need for the relay UE to monitor POs of the remote UE in this case.

Proposal 19： [17/18][Easy]When Relay UE in RRC CONNECTED and Remote UE in RRC CONNECTED, the Relay UE may monitor for SI change indication and/or PWS notifications in any PO as legacy.

**Q1.2a) Do you agree that the relay UE is not required to monitor POs of the RRC\_CONNECTED remote UE(s)?**

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| Company | Response (Y/N) | Comments |
| Qualcomm  | See comments | We are not sure what is the intention of this question. The current behavior when both relay and remote UE in CONNECTED state is well captured in Proposal 19 as quoted by Rapporteur. We don’t fully understand why a rewording of this agreement (Proposal 19) need to be confirmed. And this rewording seems to cause more misunderstandings:1. It should be “RRC\_CONNECTED relay UE”
2. When remote UE is in CONNECTED state, it is ambiguous what is “**POs of the RRC\_CONNECTED remote UE(s)”.** In current spec, CONENCTED UE can monitor any PO for SIB update and PWS, i.e. CONNECTED relay can also monitor POs of CONNECTED remote UE but it is just for SIB update/PWS (not for MT-data).
 |
| OPPO | See comments | Agree with QC that no need for this question since we already agreed proposal 19. |
| InterDigital | Yes | The relay UE is aware of the POs of the remote UE. However, it is not necessary to monitor these when the remote UE is in RRC\_CONNECTED state. |
| Ericsson | See comments | Agree with Qualcomm |
| Xiaomi | Y |  |

**Q1.2b) If the answer to Q1.2a is yes, how should the relay UE determine the RRC state of the remote UE?**

* **A) PC5-RRC signaling from the remote UE**
* **B) Dedicated Uu RRC signaling from the network**
* **C) Other (please specify)**

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| Company | Response  | Comments |
| Qualcomm  | A | First, we agree that RRC state of remote UE should be notified to relay because relay UE paging monitor behavior is different depending on whether remote UE is in CONNECTED or IDLE/INACTIVE. Then, between A and B, we prefer A because B may cause signaling latency from the timing that remote UE’s RRC state transition. The issue scenario of B is when remote UE autonomous transition from CONNECTED to IDLE/INACTIVE (e.g., PC5 RLF detected or expiry of inactivity timer), gNB will not be aligned with remote UE’s RRC state for a while. It will cause some relay UE paging miss detection for remote UE.  |
| OPPO | PC5-RRC is preferred, but simply to configure/deconfigure the paging forwarding to relay UE instead of conveying RRC state,  | Firstly, we understand the key issue is to discuss who determines the need of paging forwarding for remote UE. And for the issue, we think it should be remote UE that determine when the paging forwarding is need and when is not needed. In this case, PC5-RRC signaling from remote UE to relay UE as a trigger of starting paging monitoring/stopping paging monitoring is reasonable. Then, we do not see a need for remote UE to notify the RRC state to relay UE, but can just notify the need of paging forwarding to relay via configure/de-configure the paging forwarding request should be further discussed.Therefore, we suggest to revise this question as: **If the answer to Q1.2a is yes, how should the relay UE determine whether to do paging monitoring for remote UE or not?** |
| InterDigital | A | Agree with Quaclomm. |
| Ericsson | See comments | Not sure any of this is needed. The basic rule should be that when the relay UE receive a short message, it forwards it to the remote UE. We also agreed that the relay UE does not forwards by default of the SIB to the remote UE, but only if those are requested “on-demand” by the remote UE.Therefore, we think that the only proposal that should be formulated is the following:**When a relay UE in connected receive a short message, it informs the relay UE. FFS whether the whole short message is forwarded or only the necessary indications.** |
| Xiaomi | None | For RRC\_IDLE and RRC\_INACTIVE remote UE, remote UE would provide paging information to relay UE, such as DRX cycle, UE\_ID, which were agreed in last meeting. But for RRC CONNECTED remote UE, only short message forwarding is needed. Remote UE doesn’t provide paging information to relay UE. Therefore the RRC state of remote UE could be implicitly indicated by the presence of paging information. We don’t see the necessity of explicit indication. |

In legacy Uu, the paging occasions for a UE are determined based on the following formula in the 38.304:

*SFN for the PF is determined by:*

*(SFN + PF\_offset) mod T = (T div N)\*(UE\_ID mod N)*

*Index (i\_s), indicating the index of the PO is determined by:*

*i\_s = floor (UE\_ID/N) mod Ns*

If the same formula for computation of POs for the remote UE is maintained, the majority of the information needed by the relay UE to determine PF/PO for a remote UE can be found in SIB1 (e.g. *Ns*, *nAndPagingFrameOffset, etc.*). When computing the paging occasions for the remote UE, the relay can acquire these parameters from its own acquisition of SIB1. The only parameters which may not be configured in SIB1 are the UE ID and the UE specific DRX cycle of the remote UE.

**Q1.3) Do you agree that the remote UE paging occasions can be derived by the relay UE from the formula in 38.304 (for PF/PO calculation) and that the relay UE determines all parameters, except for the UE specific DRX cycle and UE ID or the remote UE, from the relay’s own SIB1 acquisition?**

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| Company | Response (Y/N) | Comments |
| Qualcomm  | See comments | We agree: * The remote UE paging occasions can be derived by the relay UE from the formula in 38.304 (for PF/PO calculation)
* Parameters except UE-ID and T in formula of 38.304 are obtained from SIB1
* UE-ID and T are provided by remote UE

We don’t agree that UE dedicated DRX cycle is explicitly from remote UE. It will imply that relay UE needs to obtain default DRX cycle from SIB1 and perform min operation. It unnecessarily makes relay UE complicated and will cause INACTIVE remote UE need to share both dedicated DRX cycle and RAN paging cycle. Thus, to make relay UE easier, we prefer that remote UE directly shares with relay UE on T:* T=min(Default DRX cycle, UE dedicated DRX cycle) for IDLE remote UE
* T= min(Default DRX cycle, UE dedicated DRX cycle, RAN paging cycle) for INACTIVE remote UE
 |
| OPPO | Y | Agree with rapp that the relay UE determines all parameters, except for the UE specific DRX cycle and UE ID or the remote UE.And for the issue that whether remote UE or relay UE do the min operation, we think relay UE do option is better, it is more flexible since the relay UE can calculate T and PO by itself instead of relying remote UE. For example, when remote and relay UE move together into another cell, the relay UE can calculate the PO by itself instead of requiring another round of PC5 signalling exchange (if relying remote UE to calculate T). |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Xiaomi | Y | We share similar view as QC, which is for remote UE to share its DRX cycle T to relay UE. It adds unnecessary complexity on both remote and relay UE to only share UE dedicated DRX cycle, considering it’s already mandatory for DRX capable UE to calculate DRX cycle T. |

The 5G-S-TMSI used in the UE ID calculation can be sent by the remote UE to the relay UE, as per the following agreement:

[Easy]Proposal 4: RRC\_IDLE/RRC\_INACTIVE remote UE provides 5G-S-TMSI/I-RNTI to RRC\_IDLE/RRC\_INACTIVE relay UE. (17/20)

For the DRX cycle, in legacy Uu it is computed as the shortest of:

* Value configured by upper layers, value configured by RRC, and default DRX cycle for RRC\_INACTIVE UE
* Value configured by upper layers and default DRX cycle for RRC\_IDLE UE

Since the remote UE can be in RRC\_INACTIVE and receive RAN paging, there seems to be no need to deviate from legacy behaviour for the remote UE.

**Q1.4) Can the DRX cycle of the remote UE be derived using the same mechanism as legacy Uu (i.e. the shortest of the UE specific DRX value(s), if configured by RRC and/or upper layers, and a default DRX value broadcast in SIB)?**

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| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm | See comments | Similar to Q1.5, we prefer that remote UE directly shares T= min(Default DRX cycle, UE dedicated DRX cycle, RAN paging cycle) with remote UE. |
| OPPO | See comments | Please see our reply to Q1.3. |
| InterDigital | Y | Effectively, the same minimum formula should be used to determine the DRX configuration of the remote UE. |
| Ericsson | Y |  |
| Xiaomi | Y |  |

Similar to the 5G-S-TMSI which is configured by upper layers and is sent to the relay UE from the remote UE, the upper layer configured DRX cycle may also be sent by the remote UE to the relay UE. How the remote UE shares this information with the relay UE may depend on whether the relay UE or the remote UE computes the shortest DRX cycle (assuming the legacy mechanism is used for DRX cycle determination).

**Q1.5) Which of the following is provided to the relay UE by the remote UE for determination of the DRX cycle of the remote UE?**

1. **DRX Cycle of the remote UE configured by upper layers**
2. **DRX cycle of the remote UE configured by RRC**
3. **The default DRX cycle**
4. **The minimum of A and B**
5. **The minimum of A, B, and C**
6. **The minimum of A and C**
7. **1-bit indication whether to use the same index of the PO as for RRC\_IDLE**
8. **Other (Please specify)**

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| Company | Response  | Comments |
| Qualcomm | F) for IDLE remote UEE)+G) for INACTIVE remote UE | (We added options F and G)For IDLE remote UE, it is easier to directly share T=min(A, C)For INACTIVE remote UE, besides to share T=min(A,B,C), we think it is necessary that it can also provide 1-bit indication whether to use the same index of the PO as for RRC\_IDLE. Please note that this is one important spec issue identified for non-overlapping paging monitoring of INACTIVE UE, and it was agreed to fix it from Rel-17 in RAN2-115e:* We introduce a solution, from R17, where the following is the baseline:
	+ - R2-2109077 Solution 2 (i.e. UE in RRC \_INACTIVE should use the same i\_s to determine PO as for RRC \_IDLE) is supported to address the RAN and CN paging PO non-overlap problem.
		- UE capability should be introduced to indicate support for using the same i\_s in PO determination in RRC \_INACTIVE state as in RRC \_IDLE state.

  |
| OPPO | A and B | Remote UE only need to send the UE specific information to relay UE, and relay UE calculates PF/PO of remote UE as legacy.For G, suggest to pend the discussion till RAN2 concludes on the solution in main session, since the solution has not been fully decided in R2#115, and different solutions (as provided in R2-2109077) may cause different impact to SL relay design. |
| InterDigital | D | We agree with OPPO that only the UE specific information needs to be sent. However, we think the UE can perform the minimum operation to avoid having to send multiple DRX cycles to the relay UE. |
| Ericsson | E with comment | We think minimum operation can be used in this case, but we also think that G should be taken into account once that this is agreed in the main room. |
| Xiaomi | E | We prefer remote UE to share its DRX cycle T to relay UE. It adds unnecessary complexity on both remote and relay UE to only share UE dedicated DRX cycle, considering it’s already mandatory for DRX capable UE to calculate DRX cycle T.G is out of this question’s scope, since it’s used to determine PO index, not DRX cycle. |

Similar to the UE ID, it would seem natural for the remote UE to provide any of the information indicated in the previous question via PC5-RRC signalling.

**Q1.6) Do you agree that the information in Q1.5 is provided via PC5-RRC signalling by the remote UE?**

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| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm | Y | We think it is straight forward to use PC5-RRC signaling  |
| OPPO | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Xiaomi | Y |  |

The discussion about what should be forwarded to the remote UE by the relay UE when the relay UE receives a paging message that is relevant to the remote UE can be split in two cases (which are discussed separately in the subsequent subsections): 1) paging for arrival of DL data intended to the remote UE and 2) SI modification and PWS notification

### 2.1.1 Paging from DL Data Arrival

A relay UE can receive paging message intended for a remote UE either from dedicated RRC message from the gNB, or from PCH reception during the PO of the remote UE. For dedicated RRC message design, it may be preferrable to keep this similar to the paging record and include one or more UE IDs in the message. One possible issue is whether to assume the network pages only a single UE at a time, or whether it can page multiple UEs associated to a relay UE with the same RRC message.

**Q1.7) For paging due to the arrival of remote UE DL data at the gNB, what information should be included in the dedicated Uu RRC message to the relay UE (for the case of the relay UE receiving remote UE paging in dedicated Uu RRC message)?**

1. **A single UE ID (5G-S-TMSI or I-RNTI) being paged**
2. **One or more UE ID (5G-S-TMSI or I-RNTI) being paged**
3. **Other? (please specify)**

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| --- | --- | --- |
| Company | Response  | Comments |
| Qualcomm | B) | If more than 1 remote UE have MT traffic, we don’t see reason to restrict to include only single UE’s paging record in one dedicated RRC message. Although it is stage 2, our understanding is that legacy IE *PagingRecordList* can be included in *RRCReconfiguration* message as a container (like SIB in dedicated RRC message: *dedicatedSIB1-Delivery, dedicatedSystemInformationDelivery*)PagingRecordList ::= SEQUENCE (SIZE(1..maxNrofPageRec)) OF PagingRecordPagingRecord ::= SEQUENCE { ue-Identity PagingUE-Identity, accessType ENUMERATED {non3GPP} OPTIONAL, -- Need N ...} |
| OPPO | B |  |
| InterDigital | B |  |
| Ericsson | B |  |
| Xiaomi | B |  |

**Q1.8) What Uu RRC message can be used?**

1. **Use an existing RRC message (please specify)**
2. **Use a new RRC message**

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| --- | --- | --- |
| Company | Response  | Comments |
| Qualcomm | A): *RRCReconfiguration* message | As we commented in Q1.7, legacy IE *PagingRecordList* can be included in *RRCReconfiguration* message as a container (like SIB in existing *RRCReconfigraution* message with the container *dedicatedSIB1-Delivery, dedicatedSystemInformationDelivery*) |
| OPPO | A |  |
| InterDigital | A | We think including paging in RRCReconfiguration message is sufficient. |
| Ericsson | B | Using the RRCReconfiguration message is not efficient because this is a message that is acknowledged and sending the paging is not sending a configuration.Further, the paging message as such is not an acknowledged message and using the RRCReconfiguration message is just an overkill. A new message can be used for forwarding the paging. |
| Xiaomi | A |  |

It has been agreed that unicast can be used for the paging forwarding via PC5-RRC. The paging record or the list of UEs being paged can be forwarded by the relay as is. Alternatively, since RAN2 has agreed that the relay UE decodes the paging message for the UE ID of the remote UE, and that the paging is sent via unicast to the specific UE, there seems to be no need to send all/any UE IDs to the remote UE. Instead, the relay can send only the UE ID of the paged UE, or it can simply send a paging indication (without the UE ID). In the later case, the relay can indicate only whether the paging is RAN paging or CN paging to allow the remote UE to distinguish between them.

**Q1.9) For paging due to the arrival of remote UE DL data at the gNB, what information should be included in the PC5-RRC message from the relay UE to the remote UE?**

1. **Entire paging record or list of UE IDs received in the dedicated Uu paging RRC message**
2. **UE ID of the remote UE only (5G-S-TMSI or I-RNTI)**
3. **Type of paging only (RAN paging or CN paging)**
4. **Other? (please specify)**

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| --- | --- | --- |
| Company | Response  | Comments |
| Qualcomm  | No strong view | We agree with Rapporteur that C) seems to be sufficient. It can reduce the signaling payload size. So, we slightly prefer C).A) and B) can also work. Maybe benefit of A) is that relay UE can simply forward the original paging record list without re-generating the message for remote UE. So, we don’t have strong opinion, and can follow majority view.  |
| OPPO | B and C |  |
| InterDigital | C (B may be ok) | We should try for a design that minimizes the overhead of the PC5-RRC message given that the relay UE already has the UE ID of the remote UE. |
| Ericsson | A | As Qualcomm pointed out, is much simpler for the relay UE to forward the original paging record without regenerating the message for the remote UE. |
| Xiaomi | A | We also feel it’s much easier to just forward the received paging message than generate a new message. It’s also more robustness to forward the original paging message, considering there may be error mapping between UE ID and remote UE in relay UE. |

### 2.1.2 SI Modification and PWS Notification

Short message (in paging DCI) is used to send SI modification and PWS notification to a UE. RAN2 agreed that for the relaying case, short message forwarding in SCI is not supported but forwarding in PC5-RRC is to be discussed.

Based on online discussion in RAN2#115[2], there seem to be two options for the remote UE to acquire SI/PWS following the transmission of a short message by the gNB. The advantage of each option (based on the views brought up by companies supporting each option) are as follows:

* Option 1: the relay UE receives the short message from the gNB, acquires the SI/PWS and sends it to the remote UE (no forwarding of short message)
	+ Bi-directional signaling (for subsequent request of SI) over PC5 can be avoided by just sending the modified SI
* Option 2: the relay UE receives the short message and forwards it to the remote UE so the remote UE can acquire the SI.
	+ The relay UE cannot know which SI to forward, since this is based on the remote UE’s own interest, so the request should be made after forwarding the short message

Since SI acquisition by the remote UE (particularly following an SI request) will depend on the RRC state of the remote UE, which option is preferrable may depend on the remote UE RRC state.

For a remote UE in RRC\_CONNECTED

* In option 1, the relay UE first acquires the SI (e.g., by its own dedicatedSIBRequest) and then forward the acquired SI over PC5-RRC. If the SI is not relevant to the relay, the relay still needs to acquire the SI on behalf of the remote UE. Furthermore, if the relay UE does not know which SI is of interest to the remote UE, it needs to acquire and send all the changed SI.
* In option 2, the relay UE only forwards the short message and the remote UE performs dedicatedSIBRequest only for the interested SIBs. The SI acquisition is transparent to the relay UE and can be sent along with normal data via the relay.

Option 2 avoids unnecessary SI acquisition by the relay UE. It also reduces overhead on Uu. Additional signaling on PC5 may not be an issue as the relay UE is actively relaying data when the remote UE is in RRC\_CONNECTED. Finally, option 2 is also closer to the agreed behavior of remote UE of using legacy dedicatedSIBRequest to acquire SI in RRC\_CONNECTED. Therefore, rapporteur sees a clear advantage of option 2 in this case.

**Q1.10) For a remote UE in RRC\_CONNECTED, do you agree that the relay UE forwards short message in PC5-RRC to the remote UE?**

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| Company | Response (Y/N) | Comments |
| Qualcomm  | Y | We agree with Rapporteur’s analysis  |
| OPPO | N | We fail to understand the logic of “For a remote UE in RRC\_CONNECTED, in option 1, the relay UE first acquires the SI (e.g., by its own dedicatedSIBRequest) and then forward the acquired SI over PC5-RRC.” and believe short message forwarding in PC5 is not needed since:1. We have already agreed an RRC\_CONNECTED remote UE acquire SI via dedicatedSIBRequest as legacy, and this agreement is not related to whether short message should be forwarded to remote or not.
2. By receiving dedicatedSIBRequest from remote UE, NW is aware of the interested SI of remote, and NW can send the related SI to remote UE upon SI updating.
3. The necessity of short message on Uu interface comes from the design of modification-period (MP) based SI delivery, yet the MP concept is not used at PC5 interface, so that the short message is not useful either. I.e., when there is a SI change, the network/relay can directly send the updated SI to the remote UE. Otherwise, there would be further specification effort in order for remote UE to understand the MP boundary, which leads to the option-2 solution unnecessarily complicated.
 |
| InterDigital | Y | We think it would be best to avoid that the network needs to send dedicated signaling to each remote UE when SI is changed when it can simply use the legacy behavior of sending SI modification indication in paging.As for modification period, we think this is introduced in legacy in order to provide a correct timing reference for when broadcast SI is changed, and does not preclude using short message for relay even if modification period does not apply. |
| Ericsson | Y | We agree with the Rapporteur |
| Xiaomi | Y | Short message forwarding could avoid the case Relay UE has to forward every changed SI to remote UE. |

For a remote UE in RRC\_IDLE/RRC\_INACTIVE

* In option 1, the same procedure is used as for the case of remote UE in RRC\_CONNECTED.
* In option 2, after forwarding the short message, the remote UE then needs to request SI to the relay UE, leading to an additional exchange on PC5-RRC that is not transparent to the relay UE.

In this case, while option 2 may reduce the delivered SI to only what is requested by the remote UE, it results in an additional exchange on PC5-RRC. Avoiding this exchange, as noted by companies at the last meeting, may outweigh potential benefit of reducing the amount of SI forwarded over PC5.

**Q1.11) For a remote UE in RRC\_IDLE/RRC\_INACTIVE, should short message be forwarded to the remote UE?**

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| Company | Response (Y/N) | Comments |
| Qualcomm | Y | We prefer to have a unified behavior for remote UE in CONNECTED and IDLE/INACTIVE. We agree with Rapporteur that Option 2 will increase PC5 signaling overhead, but its increased overhead should be marginal (in our understanding, it is just ***systemInfoModification*=1 and/or *etwsAndCmasIndication*=1)**. And if we introduce the new signaling for CONNECTED remote UE, why the same signaling can’t be used for IDLE/INACTIVE remote UE? |
| OPPO | N | The necessity of short message on Uu interface comes from the design of modification-period (MP) based SI delivery, yet the MP concept is not used at PC5 interface, so that the short message is not useful either. I.e., when there is a SI change, the relay can directly send the updated SI to the remote UE. |
| InterDigital | N | For this scenario, we think sending the modified SI itself is more efficient overall. |
| Ericsson | Y but no strong view | We think that is pointed out by Qualcomm it makes sense. |
| Xiaomi | Y | Without short message forwarding, relay UE has to forward every changed SI to remote UE regardless whether remote UE is interested, which may result in much signaling overhead. We share the same view as Qualcomm. It’s easy to reuse the same mechanism for remote UE in all RRC states. |

If/when we decide to use option 1, what SI is forwarded to the remote UE should be discussed. For PWS, it should be clear that the relay UE should forward all PWS SIBs being broadcasted. For the SI modification, the relay UE may forward all modified SI, or may have some knowledge of the SI that the remote UE is interested (e.g., from previous signaling from the remote UE).

**Q1.12) If/when short message forwarding is not performed by the relay UE, which SI is forwarded to the remote UE after the relay UE receives SI modification or PWS notification?**

1. **PWS SIBs being broadcasted (for PWS notification only)**
2. **All SI that the relay UE determines as changed**
3. **Only SI that has changed and is relevant to the remote UE**
4. **Other (please specify**

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| --- | --- | --- |
| Company | Response  | Comments |
| Qualcomm | A), B) | For C), we are not sure whether remote UE may change interested SIB type. Because no signaling to notify relay UE the change, it will cause some misalignment. So, if we go to option 1, we think B) is a safer choice. |
| OPPO | A) and C) | When remote UE changes interested SIB type, it can update the on-demand request to relay UE so that relay UE can always know the relevant SIB to the remote UE.  |
| InterDigital | A and C | We should avoid having to send all SIBs as some may be irrelevant to the remote UE. |
| Ericsson | A and B | The relay UE can simply inform the remote UE about all the SI that have been changed. It will be then the remote UE to ask for those ones that are of interest. |
| Xiaomi | A, B | Relay UE may not be able to acknowledge remote UE’s interest in current design. When remote UE moves from direct to indirect, remote UE may have acquired the demanded SI directly, so would not send SI request to relay UE if the SI is not changed. Therefore, Relay UE is not able to acknowledge remote UE’s interest from previous signaling from the remote UE. |

## 2.2 RNAU/TAU

The follow agreements have been made by RAN2 related to RNAU/TAU:

Proposal 5: [23/23] [Cross group] [Easy] The remote UE should perform TAU/RNAU procedure while in RRC\_INACTIVE and RRC\_IDLE. No LS to be sent from this meeting to SA2/ CT1/RAN3 on the remote UE’s TAU/RNAU procedure.

Proposal 8： [18/18][Easy]Confirm that for the OOC case, Remote UE with the RRC state of IDLE or INACTIVE should perform TAU/RNAU procedure

Proposal 9： [18/18][Easy]For IC Remote UE case, Remote UE performs TAU/RNAU based on its own serving cell information (i.e., as legacy) if it is NOT PC5-connected with Relay UE.

When a remote UE in RRC\_INACTIVE is PC5-RRC connected to a relay UE, it should still perform TAU/RNAU. As discussed in [2], which serving cell the remote UE considers when it is PC5-RRC connected to the remote UE needs to be confirmed.

In legacy, RNAU/TAU procedure can be triggered based on IDLE/INACTIVE mobility of a UE. The UE is configured with a RNA or TA (e.g. a list of cells) and the UE triggers the procedure when it reselects to a cell that is outside the RNA or TA. The purpose of the RNA/TA procedure is to allow the network to identify a set of network nodes that can be used to reach the UE via paging.

For the relaying case, since paging of a remote UE is done via a relay UE, it seems natural for the remote UE to use the serving cell of the relay UE for the procedure.

**Q2.1) Can RAN2 confirm that the remote UE performs TAU/RNAU based on the relay UE serving cell (for IC or OOC remote UE, when PC5-RRC connected to the relay UE)?**

|  |  |  |
| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm | Y | We agree with Rapporteur’s analysis.  |
| OPPO | Y |  |
| InterDigital | Y |  |
| Ericsson | Y |  |
| Xiaomi | Y |  |

Assuming the relay UE’s cell ID is used by the remote UE, another discussion point is what happens when this cell ID changes. Specifically, the relay UE’s cell may change due to a mobility procedure (HO or cell reselection of the relay UE), and the new cell ID may be outside of the remote UE’s configured RNA/TA. On the one hand, if the cell changes and is no longer inside the UE’s configured RNA/TA, it may be necessary to trigger a RNAU/TAU procedure to keep the UE behaviour consistent and to update the remote UE’s RNA configuration. On the other hand, since the network is aware of the mobility of the relay and the attached remote UEs, it can still locate the remote UE for paging, in which case the RNAU/TAU may not be necessary.

**Q2.2) If the answer to Q2.1 is yes, what should the remote UE in RRC\_IDLE/RRC\_INACTIVE do if the serving cell of the relay UE changes (due to HO or reselection of the relay UE) and is out of the remote UE’s configured RNA/TA?**

1. **Initiate a RNAU/TAU procedure**
2. **Not trigger any RNAU/TAU procedure**
3. **Others (please specify)**

|  |  |  |
| --- | --- | --- |
| Company | Response  | Comments |
| Qualcomm | A) | If we agree that the remote UE performs TAU/RNAU based on the relay UE serving cell, it implies that remote UE should have the same TA/RNA as its connected relay. So, when serving cell of relay UE changes, we think it keeps the legacy procedure that remote UE performs RNAU/TAU to align the same TA/RNA with relay UE. For option B), we agree that NW can be aware of this case, but it may have some spec impact on NW behavior on RNAU/TAU. Since this issue can be resolved in RAN2, we don’t think it is necessary to involve SA2/CT1. |
| OPPO | A | Agree with Qualcomm. |
| InterDigital | A | Agree with Qualcomm |
| Ericsson | A |  |
| Xiaomi | A | Option B would result in impact on CN paging and UE behavior. It’s easier to follow legacy procedure. |

In some circumstances, it may be beneficial to have the relay perform RNAU/TAU procedure on behalf of its attached remote UE. This can reduce the overhead of separate RNAU/TAU made by each remote UE connected to a relay. For example, if mobility of the relay UE requires each remote UE to trigger RNAU/TAU (e.g., to obtain a new RAN area configuration via a RAN area update as discussed in Q2.2). If so, a single RAN area update procedure by the remote UE on behalf of the attached relays may be beneficial. Another use may be in periodic RNAU. Rather than configuring independent periodic RAN area update procedures to each remote UE, a single periodic RAN area update performed by the relay on behalf of the remote UEs would significantly reduce signalling overhead.

**Q2.3) Should the relay UE perform RNAU/TAU on behalf of the PC5-RRC connected remote UE in some cases?**

|  |  |  |
| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm | N | We have discussed this solution multiple times. It is a group mobility like optimization solution, which is out for scoping of this release. We can revisit it in next release. |
| OPPO | N | Agree with Qualcomm. |
| InterDigital | Y | We think group mobility was discussed in the context of HO. In this case, we think some enhancements of RNAU may be beneficial. |
| Ericsson | Y | We agree with the Rapporteur. |
| Xiaomi | N | As responded in Q2.2, remote UE would trigger TAU/RANU in this case. |

If the relay UE performs RNAU/TAU on behalf of the remote UE, the information to be sent by the relay UE, and how (for the RNAU procedure) the remote UE receives a new RNA configuration needs to be discussed.

**Q2.4) If the answer to Q2.3 is yes, what should the relay UE include in the RNAU/TAU for this case?**

1. **The list of PC5-RRC connected remote UEs?**
2. **Other (Please specify)**

|  |  |  |
| --- | --- | --- |
| Company | Response  | Comments |
| InterDigital | A | We think this is sufficient. |
| Ericsson | A |  |
|  |  |  |

**Q2.5) If the answer to Q2.3 is yes, how should the gNB provide the updated RAN configuration to the remote UEs?**

1. **Dedicated RRC message to the relay UE?**
2. **gNB paging message to trigger access by the remote UE**
3. **Other (Please specify)**

|  |  |  |
| --- | --- | --- |
| Company | Response  | Comments |
| InterDigital | A |  |
| Ericsson | A |  |
|  |  |  |

## 2.3 Control Plane Access Procedure

In [2], it was suggested to discuss the case where a relay UE’s access fails due to a reject message from the gNB, or UAC check fails at the relay UE. Since the remote performs its own UAC procedure based on legacy procedure, it is suggested to handle these two cases separately to determine 1) whether the relay should inform the remote UE of the situation, and 2) what the remote UE does if it receives such indication.

**Q3.1) Should the relay UE inform the PC5-RRC connected remote UE when the relay UE’s RRC connection establishment/resume is rejected?**

|  |  |  |
| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm  | No strong view  | We see some benefit if relay can notify remote UE on its rejected establishment/resume, so that remote UE can take some action (e.g. perform relay reselection and followed RRC reestablishment). However, we think it will complicate remote UE’s RRC establishment behavior, and may bring extra spec wort (e.g. whether wait time in RRC reject message needs to be notified to remote UE?) In our understanding, this is a corner case. Thus, we can follow majority view on below 2 options:1. No need for the notification
2. Relay can inform remote UE on its rejected establishment/resume, but no further assistance info is needed and no remote UE behavior is specified upon reception of the indication
 |
| OPPO | N | The legacy access procedure can work well for remote UE, i.e. serval timers (e.g. T300) are defined to help UE determine the situation.The indication is just an optimization for some corner cases and brings complex spec impact. |
| InterDigital | N | We think legacy procedure is sufficient and there is little benefit in introducing such optimization. |
| Ericsson | Y | We think that there is some benefits in informing the remote UE that the connection has been rejected. It will make life much easier and also will speed up the procedure without waiting for timers to expire. |
| Xiaomi | Y | We understand this is a natural consequence. If remote UE sends RRC establishment/resume request via a relay UE rejected by gNB, relay UE is not able to forward remote UE’s RRC message. Then relay UE also need to indicate this failure to remote UE. We prefer relay UE to indicate the reject to remote UE as early as possible, so that remote UE could choose to reselect to other relay if necessary. |

**Q3.2) If the answer to Q3.1 is yes, what should the remote UE’s behaviour be after the reception of the indication?**

|  |  |
| --- | --- |
| Company | Comments |
| Qualcomm | We think it is up to remote UE implementation what to do (e.g., keep waiting the RRC setup re-attempt of relay UE, or performing relay reselection and RRC re-establishment). We disagree to specify remote UE behavior if notification is agreed.  |
| Ericsson | Agree with Qualcomm |
| Xiaomi | If Remote UE should not send RRC establishment/resume request via a relay UE, which is rejected by gNB. |

**Q3.3) Should the relay UE inform the PC5-RRC connected remote UE when the relay UE’s UAC check fails?**

|  |  |  |
| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm  | No strong view | Similar to Q3.1, we can follow majority view on below 2 options:1. No need for the notification
2. Relay can inform remote UE on its UAC check fail, but no further assistance info is needed and no remote UE behavior is specified upon reception of the indication
 |
| OPPO | See comments | We think this question can be removed since according to the ongoing reply LS from CT1, relay UE doesn’t perform UAC for remote UE’s data.  |
| InterDigital | N |  |
| Ericsson | No strong view |  |
| Xiaomi | N | Agree with OPPO. |

**Q3.4) If the answer to Q3.3 is yes, what should the remote UE’s behaviour be after reception of the indication?**

|  |  |
| --- | --- |
| Company | Comments |
| Qualcomm | Similar to Q3.2, we disagree to specify remote UE behavior if notification is agreed. |
| Ericsson | Up to UE implementation |
|  |  |

Another issue discussed in [2] is the access timer handling for the remote UE. For simplicity, we can limit the discussion to the connection establishment timer (T300) for the time being.

In legacy, a UE receives the value of T300 in SIB. The UE starts T300 upon transmission of the RRCSetupRequest, and if the timer expires prior to a response from the network, the UE aborts the establishment procedure and informs upper layers. The value of T300 can be configured according to the expected maximum network delay.

For connection establishment via a relay UE, the maximum expected delay may increase due to the delay introduced at the relay UE. While the network could configure a longer T300 to account for relayed connections, this may affect the performance of the legacy UEs. Instead, a longer access time could be configured to be used specifically for connection via a relay.

**Q3.5) Do you agree that the remote UE can be configured with an access timer (i.e., T300-like) specific for connection establishment via a relay UE that is different than legacy T300?**

|  |  |  |
| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm | Y | We agree with Rapporteur’s analysis. And maybe we can go a step further for RRC resume and RRC re-establishment:* The following new timers are added in SIB, which are expected to set value larger than legacy corresponding ones:
	+ A new timer for RRC establishment via relay (T300-like)
	+ A new timer for RRC resume via relay (T319-like)
	+ Two new timers for RRC re-establishment via relay (T301-like and T311-like)
 |
| OPPO | See comments | We agree with that a longer T300 timer value is needed for remote UE, and we think a separate value configured for remote UE is sufficient, no need for defining a new timer.  |
| InterDigital | Y | We agree with the extensions proposed by Qualcomm. |
| Ericsson | Yes with comments | We agree with OPPO that we can reuse the timer T300 but with different values for remote and relay UEs. No need of new timers. |
| Xiaomi | Comments | We think the legacy T300 could be reused with larger value. |

As pointed out in [2], the delay at the relay UE may depend predominantly on the RRC state of the relay UE. If the relay UE is in RRC\_CONNECTED at the time of the remote UE access attempt, the delay is limited to the forwarding delay of the RRC messages by the relay. On the other hand, if the relay UE is in RRC\_IDLE, or RRC\_INACTIVE, this delay would need to account for the latency associated with the relay UEs own access. One option would be to configure a single timer for the worst case (i.e. relay UE in RRC\_IDLE) and the remote UE may always use that value. However, this may result in a remote UE waiting longer than needed to detect a failed access (e.g. due to message loss) when the relay UE is in RRC\_CONNECTED. Another option would be to use different timers for the different RRC states of the relay UE.

**Q3.6) If the answer to Q3.5 is yes, should the access timer used by the remote UE (T300-like) be based on the RRC state of the relay UE?**

|  |  |  |
| --- | --- | --- |
| Company | Response (Y/N) | Comments |
| Qualcomm | N | We agree that different access timer for different RRC state should have better performance. However, we think it may bring some extra spec work to define various state transition handlings. To make system simple, we prefer to configure a single timer for the worst case in this release. |
| OPPO | N | Agree with Qualcomm |
| InterDigital | Y | We think this should be quite simple to implement and can be beneficial because the difference in access times between the RRC states of the relay can be quite large. |
| Ericsson | N | Agree with Qualcomm |
| Xiaomi | N |  |

## 2.4 Other related issues

**Q4.1) Are there any other issues related to paging, RNAU/TAU, or control plane access procedure that should be discussed in the scope of this email discussion?**

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |

# 4 Relevant Agreements

RAN2#113bis-e

Proposal 5: [23/23] [Cross group] [Easy] The remote UE should perform TAU/RNAU procedure while in RRC\_INACTIVE and RRC\_IDLE. No LS to be sent from this meeting to SA2/ CT1/RAN3 on the remote UE’s TAU/RNAU procedure.

Proposal 6-1: [20/23] [Easy] For the delivery of remote UE’s SRB0 RRC message, specified (fixed) configuration is used for the configuration of PC5 RLC channel. FFS for the Uu RLC channel.

Proposal 6-2: [21/23, 22/23] [Easy] For the delivery of remote UE’s SRB1 RRC message other than RRCResume and RRCReestablishment message, network configuration via dedicated signalling is used for the configuration of PC5 RLC channel and Uu RLC channel.

Proposal 6-3: [23/23] [Easy] For the delivery of remote UE’s SRB1 RRC message such as RRCResume and RRCReestablishment message, default configuration is used for the configuration of PC5 RLC channel which can be reconfigured by network. FFS for Uu RLC channel.

Proposal 6-4: [21/23, 22/23] [Easy] For the delivery of remote UE’s SRB2 RRC message, network configuration via dedicated signalling is used for the configuration of PC5 RLC channel and Uu RLC channel.

Proposal 6-5: [23/23, 23/23] [Easy] For the delivery of remote UE’s Uu DRB packet, network configuration via dedicated signalling is used for the configuration of PC5 RLC channel and Uu RLC channel.

Proposal 6-6: [22/23] [Easy] For the PC5 RLC channel configuration, only the RLC/LCH configuration is provided to the relay UE and remote UE.

Proposal 6-7: [22/23] [Easy] For the Uu RLC channel configuration, only the RLC/LCH configuration is provided to the relay UE.

Proposal 6-8: [23/23] [Easy] For the remote UE’s SRB1/SRB2 configuration, only the Uu PDCP configuration is provided to the remote UE.

Proposal 6-9: [23/23] [Easy] For the remote UE’s DRB configuration, only the Uu PDCP/SDAP configuration is provided to the remote UE.

Proposal 9-1: [23/23] [Easy] For RRC\_Connected remote UE, RAN2 confirm that DedicatedSIBRequest procedure is re-used for the Remote UE to request the SI via relay UE.

Proposal 9-2: [22/23] [Easy] For RRC\_Idle/INACTIVE remote UE, remote UE informs relay UE on requested SIB type(s) via PC5 RRC message. Then, relay UE triggers legacy on-demand SI acquisition procedure according to its own RRC state (if needed) and sends the acquired SIB to remote UE.

Proposal 10-2: [23/23] [Easy] PC5-RRC message can be used to carry the system information forwarding via PC5.

Proposal 12: [19/23] [Easy] Suppose a relay UE needs to monitor paging for a remote UE, the relay UE should monitor all POs for the remote UE as a baseline.

Proposal 13: [23/23] [Easy] Unicast can be used for the paging forwarding via PC5.

WA: Proposal 15: [23/23] [Easy] Remote UE can reuse legacy access control and no need to enhance the access control procedure of Remote UE. FFS whether the relay UE performs UAC for itself.

RAN2#114

Agreements:

Proposal 5： [18/18][Easy]The Uu RLF indication from Relay UE may trigger the Remote UE connection re-establishment

Proposal 6： [18/18][Easy] The Remote UE may trigger the Remote UE connection re-establishment upon detecting PC5 RLF.

Proposal 8： [18/18][Easy]Confirm that for the OOC case, Remote UE with the RRC state of IDLE or INACTIVE should perform TAU/RNAU procedure

Proposal 9： [18/18][Easy]For IC Remote UE case, Remote UE performs TAU/RNAU based on its own serving cell information (i.e., as legacy) if it is NOT PC5-connected with Relay UE.

Proposal 13： [18/18][Easy] the Remote UE can receive the system information via PC5 after PC5 connection establishment with Relay UE.

Proposal 1： [14/18[Easy] RRC state combination of Relay UE in RRC\_IDLE and Remote UE in RRC\_INACTIVE is supported.

Proposal 7 (modified)： [16/17][Easy] The Remote UE may perform RRC re-establishment procedure as follows:

‒ If only suitable cell(s) are available, the Remote UE initiates RRC re-establishment procedure towards a suitable cell;

‒ If only suitable relay(s) are available, the Remote UE initiates RRC re-establishment procedure towards a suitable relay UE’s serving cell;

‒ If both a suitable cell and a suitable relay are available, the remote UE can select either one to initiate RRC re-establishment procedure based on implementation.

Proposal 11： [15/18][Easy]In case of Remote UE RRC resume to a new gNB, legacy Retrieve UE Context procedure is performed, i.e., the new gNB retrieves the Remote UE context for Remote UE.

Proposal 17： [17/18][Easy]When Relay UE in RRC IDLE/RRC INACTVE and Remote UE in RRC IDLE/RRC INACTIVE, the Relay UE monitors paging occasions of its PC5-RRC connected Remote UE(s)

Proposal 19： [17/18][Easy]When Relay UE in RRC CONNECTED and Remote UE in RRC CONNECTED, the Relay UE may monitor for SI change indication and/or PWS notifications in any PO as legacy.

Proposal 22： [15/18][Easy] A new PC5-RRC message is needed to relay the paging information from Relay UE to Remote UE for unicast.

Proposal 2： [16/18[Cross WG] RAN2 to send a LS to SA2/CT1 to ask their view on whether a new or existing establishment/resume cause value is used for Relay UE when Relay UE enters RRC\_CONNECTED only for relaying purpose.

Proposal 23： [17/18][Cross WG] Confirm the WA that Remote UE performs UAC based on legacy procedure and send a LS to SA2/CT1 to inform about RAN2 decision.

RAN2#115

Agreement:

For any SIB that the remote UE requests in on-demand manner, the relay UE can forward the response (i.e. the relay UE does not filter). FFS which SIBs the remote UE could request.

FFS whether relay UE can voluntarily forward the SIBs/posSIBs to remote UE without a request.

Short message forwarding via introducing a short message field in SCI is not supported.

FFS if short message can be indicated by PC5-RRC.

Agreements:

When L2 Relay UE in RRC CONNECTED and L2 Remote UE(s) in RRC\_IDLE/RRC\_INACTIVE, the Relay UE can monitor PO of its PC5-RRC connected Remote UE(s) if the active DL BWP of Relay UE is configured with common CORESET and common search space.

For L2 relay UE in RRC\_CONNECTED and L2 remote UE(s) in RRC\_IDLE/RRC\_INACTIVE, we specify signalling for delivery of the remote UE’s paging through dedicated RRC message. Network implementation decision whether to use it (or keep the relay UE on BWP with CSS). Can be revisited if a problem is found with network knowledge of which paging to forward.

RLC configurations:

[Easy]Proposal 1: Uu RLC configuration for remote UE’s SRB0 message could be (re)configured by NW. FFS whether default configuration is supported. (17/20)

 [Easy]Proposal 3 (modified): Dedicated signalling from gNB to relay UE is used for the PC5 RLC and Uu RLC configuration of remote UE SRB1 for RRCReconfigurationComplete in path switch to indirect path for RRC\_CONNECTED relay UE. FFS for RRC\_IDLE/RRC\_INACTIVE relay UE, if agreed to support. (20/20)

Paging:

[Easy]Proposal 4: RRC\_IDLE/RRC\_INACTIVE remote UE provides 5G-S-TMSI/I-RNTI to RRC\_IDLE/RRC\_INACTIVE relay UE. (17/20)

[Easy]Proposal 5: RRC\_IDLE/RRC\_INACTIVE Relay UE decodes received paging message to derive the 5G-S-TSMI/I-RNTI and forward the paging message accordingly. (17/20)

[Easy]Proposal 6: RRC\_IDLE/RRC\_INACTIVE remote UE provide its Uu DRX cycle information to RRC\_IDLE/RRC\_INACTIVE relay UE. FFS what is Uu DRX cycle information and how to provide. (18/20)

Connection establishment procedures:

[Easy]Proposal 7: As baseline, Remote UE and relay UE performs connection establishment/resume independently, i.e. relay UE shall enter CONNECTED to be able to forward remote UE’s initial RRC messages. (20/20)

# 5 References

1. RAN2#115-e chairman notes – RAN2 chairman
2. R2-2108824 – Summary of 8.7.2.1 on control plane procedures Xiaomi