**3GPP TSG-RAN WG2 Meeting #112 electronic *R2-200nnnn***

**Online, November 2 - 13, 2020**

Agenda Item: TBD

Source: MediaTek Inc. (Email Discussion Rapporteur)

**Title: [Post111-e][627][Relay] Remaining issues on L2 architecture**

Document for: Discussion and decision

# Introduction

This document is to kick off the following email discussion:

* [Post111-e][627][Relay] Remaining issues on L2 architecture (MediaTek)

Scope: Discuss the remaining issues from [AT111-e][605], including the functionality of the adaptation layer and control plane procedures.

Intended outcome: Summary to next meeting

Deadline: Long

This email discussion is a follow up discussion of “[AT111-e][605][Relay] L2 Relay Mechanism” with the aim to further discuss the needed functionality as required by L2 based Relay architecture.

# Issue list

## Uu Adaptation layer for L2 UE-to-Network Relay

It was agreed at the last RAN2 meeting to support an adaptation layer over Uu between Relay UE and gNB for L2 UE-to-Network Relay. Then it is important to clarify the required functionality for this adaptation layer.

From uplink perspective, it should be able to map ingress PC5 RLC channel for relaying into Uu RLC channel over the direct Uu path (i.e. Relay UE Uu path). The Uu adaptation layer between the Relay UE and gNB can be used to express such bearer mapping relation.

### **Question 1**

Do you agree that the Uu adaptation layer at Relay UE supports UL bearer mapping between ingress PC5 RLC channels for relaying and egress Uu RLC channels over the Relay UE Uu path?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | UL bearer mapping should be supported regardless of the support of N:1 mapping between ingress PC5 RLC channels for relaying and egress Uu RLC channels |
| OPPO | Yes |  |
| Ericsson (Min) | Yes with comments | To be more accurate, the mapping should be between Uu RB and egress Uu RLC channels. It means that it should be Uu RB ID that is carried in adaptation header on relay UE Uu connection. |
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RAN2#111e (based on email disc. 605) considered whether different traffics of the same Remote UE or different Remote UEs can be multiplexed in the same Uu RLC channel of the Relay UE (i.e. N-to-1 mapping). This issue can be discussed for uplink relaying traffic with N:1 mapping and data multiplexing.

### **Question 2**

Do you agree that the different traffics of the same Remote UE and/or different Remote UEs can be subject to N:1 mapping and data multiplexing over Uu RLC channel.

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | N:1 mapping is at least needed to support the relaying for multiple Remote UEs based traffic, since the number of e2e traffic may be larger than the max number of the Uu RLC channels |
| OPPO | Yes | It is up to network configuration on whether the N-to-1 mapping is applied to same and/or different remote UE(s). |
| Ericsson (Min) | Yes | Agree with OPPO. This is up to network configuration. In addition, it is ok to map multiple Uu RBs of remote UEs which have similar QoS requirements onto the same relay UE Uu RLC channel. |
|  |  |  |

From uplink perspective, the Relay UE always route the packets to the gNB. However, if multiple Remote UE traffic can be multiplexed, the Relay UE may need to tell the gNB the source of the traffic (i.e. comes from which Remote UE). In this case, Remote UE identification may needs be supported at Uu adaptation layer for UL packets.

### **Question 3**

Do you agree that Uu adaptation layer is used to support Remote UE identification for the UL traffic (multiplexing the data coming from multiple Remote UE)?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Ericsson (Min) | Yes |  |
|  |  |  |

From uplink perspective, the Relay UE needs to indicate the exact Remote UE Uu Radio Bearer to gNB for the gNB to resolve the data packets at Uu adaptation layer and to deliver the received data packets to the specific PDCP entity associated with the right Remote UE Uu Radio Bearer. In this case, the identity information of Remote UE Uu Radio Bearer needs be put by Relay UE at Uu adaptation layer at UL. In case of multiple Remote UE based relaying, the identity information of Remote UE needs also be put by Relay UE at Uu adaptation layer at UL.

### **Question 4**

Do you agree that the identity information of Remote UE Uu Radio Bearer needs be put into the Uu adaptation layer by Relay UE at UL in order for the gNB to correlate the received data packets with the specific PDCP entity associated with the right Remote UE Uu Radio Bearer?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes with comment | Yet “needs be put into the Uu adaptation layer **by Relay UE** at UL” is a bit misleading, since it depends on the FFS point that whether the adaptation layer is applied to the PC5 hop – in that case the remote UE Uu-bearer ID can be put into adaptation layer **by remote UE** instead of **relay UE**, so to avoid misunderstanding, maybe the “by relay UE” can be removed. |
| Ericsson (Min) | Yes | Agree with OPPO. |
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### **Question 5**

Do you agree that the identity information of Remote UE Uu Radio Bearer and the identity information of Remote UE needs be put into the Uu adaptation layer by Relay UE at UL in order for gNB to correlate the received data packets for the specific PDCP entity associated with the right Remote UE Uu Radio Bearer of a particular Remote UE in case of multiple Remote UEs based relaying?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | Similar to the response to Q4, the “by relay UE” maybe a bit misleading, and thus suggest to remove.  Furthermore, “a particular Remote UE i**n case of multiple Remote UEs based relaying**” may be not necessary since the fields of the header of adaptation layer is designed regardless of # of remote UE, so also suggest to remove. |
| Ericsson (Min) | Yes | Agree with OPPO. |
|  |  |  |

From downlink perspective, it should be able to map end-to-end Radio Bearer (SRB, DRB) of a Remote UE into one Uu RLC channel over the direct Uu path (i.e. Relay UE Uu path). The Uu adaptation layer can be used to express the bearer mapping relation.

### **Question 6**

Do you agree that the Uu adaptation layer can be used to support DL bearer mapping at gNB to map end-to-end Radio Bearer (SRB, DRB) of Remote UE into Uu RLC channel over Relay UE Uu path?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Ericsson (Min) | Yes with comments | The answer is yes for uni-directional RB. While for a bidirectional RB, it would also depend on the initial packets of the RB are uplink or downlink. If initial packets of the RB are transmitted in uplink, the bearer mapping is already determined based on UL packets. gNB can just use the same mapping for DL as in UL. If the initial packet of the RB are transmitted in DL, gNB can determine the mapping relation. in that case, remote/relay UE can apply the same mapping for UL as in DL. |
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RAN2#111e (based on email disc. 605) considered whether different traffics of the same Remote UE or different Remote UEs can be multiplexed in the same Uu RLC channel of the Relay UE (i.e. N-to-1 mapping). This issue can be discussed for downlink relaying traffic with N:1 mapping and data multiplexing.

### **Question 7**

Do you agree that the Uu adaptation layer can be used to support DL N:1 bearer mapping and data multiplexing between multiple end-to-end Radio Bearers (SRBs, DRBs) of a particular Remote UE and/or different UEs and one Uu RLC channel over the Relay UE Uu path?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | With the same reason for the answer of Question 2. |
| OPPO | Yes | As replied to Q2. |
| Ericsson (Min) | Yes |  |
|  |  |  |

From downlink perspective, the Relay UE needs to route the packets to the right Remote UE and then Uu adaptation layer needs to support Remote UE identification for Downlink traffic. Remote UE identification for relaying traffic can be seen as part of bearer mapping function or as a separate packet routing function.

### **Question 8**

Do you agree that the Uu adaptation layer needs to support Remote UE identification for Downlink traffic which can be done as part of bearer mapping function or as a separate packet routing function?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | Regardless of “bearer mapping” or “packet routing” as a terminology issue, the remote UE ID is needed for relay UE to know which remote UE to further deliver the packet to. |
| Ericsson (Min) | Yes |  |
|  |  |  |

From downlink perspective, the gNB needs to indicate the exact Remote UE Uu Radio Bearer to the Relay UE for it to resolve the data packets at Uu adaptation layer and to deliver the received data packets to the specific PC5 RLC channel associated with the right Remote UE Uu Radio Bearer. In this case, the identity information of Remote UE Uu Radio Bearer needs be put by Relay UE at Uu adaptation layer at DL. In case of multiple Remote UEs based relaying, the identity information of Remote UE needs also be put by gNB at Uu adaptation layer at DL for Remote UE identification.

### **Question 9**

Do you agree that the identity information of Remote UE Uu Radio Bearer needs be put into the Uu adaptation layer by gNB at DL in order for Relay UE to correlate the received data packets with the specific PC5 RLC channel associated with the right Remote UE Uu Radio Bearer?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Ericsson (Min) | Yes with comments | From the texts, the rapporteur hints that UE ID may be optional for adaptation layer. or? If so, it is unnecessary to make UE ID field to be optional in the header. UE ID should be always in the header. |
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### **Question 10**

Do you agree that the identity information of Remote UE Uu Radio Bearer and the identity information of Remote UE needs be put into the Uu adaptation layer by gNB UE at DL in order for Relay UE to correlate the received data packets with the specific PC5 RLC channel associated with the right Remote UE Uu Radio Bearer for the particular Remote UE in case of multiple Remote UEs based relaying?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | It should be a straightforward result if one answer Yes to Q8/Q9. |
| Ericsson (Min) | Yes | Agree with OPPO, this question can be merged with Q8 and/or Q9. |
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### **Question 11**

What additional functions on the Uu interface would be needed from the adaptation layer?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | There may be additional functions like flow control as studied by Rel-16 IAB, which may also be supported for the Uu adaptation layer. The details can be considered at WI stage. |
| OPPO |  | if any additional functions identified to discuss, it can be left to WI-phase. |
| Ericsson (Min) | Yes | For adaptation layer, there are some issues need to be studied   1. How to reflect PDCP buffer status of remote UE in a Uu BSR. 2. How other hops are informed in case a radio link failure is detected on a hop. 3. How other hops are informed in case a congestion is detected on a hop. 4. How to protect UE ID, and avoid it to be disclosed in adaptation layer header?   For the first three issues, it would be beneficial to use adaption layer (i.e., control PDUs) to distribute the above information/address the above issues.  For the fourth issue, RAN2 may need to send LS to SA3, informing SA3 of the issue. |
|  |  |  |

## PC5 Adaptation layer for L2 UE-to-Network Relay

In practice, the end to end QoS for multiple different Radio Bearers may be met with the same SL RLC channel configuration. Then the support of N:1 mapping between Remote UE Uu Radio Bearer and PC5 RLC channel may have the benefit of better resource utilization efficiency. Such N:1 mapping from Remote UE Uu Radio Bearer to PC5 RLC channel can be supported by PC5 Adaptation layer for L2 UE-to-Network Relay. Meanwhile Uu may support more logical channels than sidelink, so the N:1 mapping from Uu Radio Bearers to SL RLC channel may be inevitable.

### **Question 12**

Do you agree to support the N:1 mapping by PC5 adaptation layer between Remote UE Uu Radio Bearer and PC5 RLC channel for relaying?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | There was a discussion on the overhead to add an adaptation layer over PC5. When we consider to support the many-to-one bearer mapping between the same Remote UE traffic to the PC5 RLC relaying channel, only the Bearer identity information is needed within the adaptation layer header (e.g. it can be assumed as four bits if we support 16 RBs as the maximum RBs over PC5 per Remote UE). The overhead to add an adaptation layer over PC5 is negligible. |
| OPPO | Yes | The LCID space for RLC channel between remote-relay UE would become a bottleneck, if always assume 1-to-1 mapping, considering the forwards compatibility for multi-hop relay, and the possibility of merging of traffic between UE-to-network and UE-to-UE. |
| Ericsson (Min) | Yes with comments | We think it is more reasonable to map N Uu bearers of different remote UEs to one PC5 RLC channel. We are also fine with a majority’s view. |
|  |  |  |

There was a discussion at the last RAN2 e-meeting on the traffic differentiation over PC5 by adaptation layer between the non-relaying traffic (i.e. traffic terminated at Relay UE) and the relaying traffic (i.e. traffic destined to gNB) for L2 UE-to-NW relay operation.

### **Question 13**

Do you agree to support traffic differentiation via PC5 adaptation layer between the non-relaying traffic and the relaying traffic for L2 UE-to-NW relay operation?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | Besides the non-relay case, furthermore, the question can be extended to support the merging of traffic for UE-to-network and UE-to-UE on the same connection via adaptation layer, which can be also enabled by a unified design of adaptation layer for UE-to-network and UE-to-UE relay. |
| Ericsson (Min) | No | We don’t think adaptation layer header is needed for non-relaying traffic. Traffic termination is clear purely based on bearer mapping. Introduce adaptation layer for non relaying traffic would increase the overhead.  Just to be clearer, adaptation layer should be only supported for relaying purposes. For normal PC5 operations there should be no adaptation layer to guarantee the backward compatibility with Rel-16. |
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### **Question 14**

What additional functions on the PC5 interface would be needed from the adaptation layer if PC5 adaptation layer is supported?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | There may be additional functions like flow control and RLF notification as studied by Rel-16 IAB, which may also be supported for the Uu adaptation layer. The details can be considered at WI stage. |
| OPPO |  | One key aspect is the identification of remote UE considering the multi-hop relay, which means the remote UE ID is also motivated to be included in the adaptation layer header on PC5 hop.  Other than it, as replied to Q11, other additional function can be put into WI-Phase. |
| Ericsson (Min) | Yes with comments | In case RAN2 has decided to adopt adaptation layer for PC5 link, see our comments for Q11. |
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## 2nd Hop PC5 Adaptation layer for L2 UE-to-UE Relay

It was agreed at the last RAN2 meeting to support an adaptation layer over second hop PC5 between Relay UE and Destination UE for L2 UE-to-UE Relay. Then it is important to clarify the required functionality for this adaptation layer.

From Relay UE perspective, it should be able to map the ingress PC5 RLC channel(s) for relaying into egress PC5 RLC channel(s) for relaying. The second hop PC5 adaptation layer between the Relay UE and Destination UE can be used to express such bearer (or RLC channel) mapping relation.

### **Question 15**

Do you agree that the second hop PC5 adaptation layer can be used to support bearer mapping between the ingress RLC channels over first PC5 hop and egress RLC channels over second PC5 hop at Relay UE?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Ericsson (Min) | Yes with comments. | To be more accurate, the mapping should be between E2E RB and egress RLC channels. It means that it should be E2E RB ID that is carried in adaptation header on relay UE egress connection. |
|  |  |  |

In draft TR38.836, there is an “Editor note” at section 5.5.1: *It is FFS on the details to support the N-to-1 mapping between the ingress RLC channels from multiple transmitting Remote UEs to egress RLC channels (going to the same Destination UE) at Relay UE.* Meanwhile, the discussion in RAN2#111e (based on email disc. 605) considered whether different traffics of the same Remote UE or different Remote UEs can be multiplexed in the second hop PC5 (i.e. N-to-1 mapping).

### **Question 16**

Do you agree that the adaptation layer over second PC5 hop can be used to support N:1 bearer mapping and data multiplexing between multiple ingress PC5 RLC channels over first PC5 hop and one egress PC5 RLC channel over second PC5 hop?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Ericsson (Min) | Yes with comments | See comments for Q15 |
|  |  |  |

In addition, the Relay UE needs to route the packets to the right Remote UE and then the second hop PC5 adaptation layer needs to support Remote UE identification for relaying traffic. Remote UE identification for relaying traffic can be seen as part of bearer mapping function or a separate packet routing function.

### **Question 17**

Do you agree that the second hop PC5 adaptation layer needs to support Remote UE identification for relaying traffic, which can be done as part of bearer mapping function or a separate packet routing function?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | Remote UE identification for relaying traffic is anyway needed regardless if it is seen as part of bearer mapping function or a separate packet routing function |
| OPPO | Yes | We assume the “remote UE” in this question includes both source and destination UE. |
| Ericsson (Min) | Yes |  |
|  |  |  |

From UE-to-UE relay perspective, the Relay UE needs to indicate the exact Source Remote UE SL Radio Bearer to Destination Remote UE for Destination Remote UE to resolve the data packets at second PC5 hop adaptation layer and to deliver the received data packets to the specific PDCP entity associated with the right end-to-end SL Radio Bearer. In this case, the identity information of Source Remote UE SL Radio Bearer needs be put by Relay UE at second PC5 hop adaptation layer. In case of multiple Source Remote UEs based relaying, the identity information of source Remote UE needs also be put by Relay UE at second PC5 hop adaptation layer.

### **Question 18**

Do you agree that the identity information of Source Remote UE SL Radio Bearer needs be put into the second PC5 hop adaptation layer by Relay UE in order for Destination Remote UE to correlate the received data packets for the specific PDCP entity associated with the right end-to-end SL Radio Bearer?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes with comment | Yet “put into the second PC5 hop adaptation layer **by Relay UE**” is a bit misleading, since it depends on the FFS point that whether the adaptation layer is applied to the first PC5 hop – in that case the source UE PC5-bearer ID can be put into adaptation layer **by source UE** instead of **relay UE**, so to avoid misunderstanding, maybe the “by relay UE” can be removed.  One small comment is on the terminology, in the current TR, we use source-UE or destination-UE instead of source-remote-UE or destination-remote-UE. |
| Ericsson (Min) | Yes with comment | From the texts, the rapporteur hints that UE ID may be optional for adaptation layer. or? If so, it is unnecessary to make UE ID field to be optional in the header. UE ID should be always in the header. |
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### **Question 19**

Do you agree that the identity information of Source Remote UE SL Radio Bearer and the identity information of Source Remote UE needs be put into the second PC5 hop adaptation layer by Relay UE in order for Destination Remote UE to correlate the received data packets for the specific PDCP entity associated with the right end-to-end SL Radio Bearer in case of multiple Source Remote UEs based relaying?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | Similar to the response to Q18, the “by relay UE” maybe a bit misleading, and thus suggest to remove.  Furthermore, “SL Radio Bearer i**n case of multiple Source Remote UEs based relaying**” may be not necessary since the fields of the header of adaptation layer is designed regardless of # of remote UE, so also suggest to remove. |
| Ericsson (Min) | Yes with comment | We think both UE ID and RB ID need to be included in adaptation layer header. The header format should be fixed. In other words, no field needs to be optional for simplifying design efforts perspective. |
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### **Question 20**

What additional functions on the second hop PC5 interface would be needed from the adaptation layer?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | There may be additional functions like flow control as studied by Rel-16 IAB, which may also be supported for the Uu adaptation layer. The details can be considered at WI stage. |
| OPPO | Yes | Besides the bearer-ID and source-UE-ID discussed in Q18/19, the ID of destination-UE is also needed, considering   * Otherwise, the first/second hop of UE-to-UE relay has to be differentiated in layers below adaptation layer, in order for adaptation layer to differentiate between the UE-ID included in the header is for source or destination UE * the forwards compatibility to multi-hop relay, i.e., the destination-UE may need to further send the packet to next hop(s), and the differentiation mentioned in the bullet above has to be in 3 types, first/intermediate/last hops.   Other than that, the additional functions can be left to WI-phase. |
| Ericsson (Min) | Yes with comment | Echoing OPPO that destination ID is also needed, especially in case a UE may operate as relay UE for both U2N and U2U.  In addition, there are some issues need to be studied   * How other hops are informed in case a radio link failure is detected on a hop. * How other hops are informed in case a congestion is detected on a hop. * How to protect UE ID, and avoid it to be disclosed in adaptation layer header?   For the first two issues, same as in IAB, it would be beneficial to use adaption layer (i.e., control PDUs) to distribute the above information/address the above issues. However, it is worth noting that IAB mechanisms can not be directly reused here. We can base on the IAB control PDU format as a baseline to introduce changes for SL relay needs.  For the third issue, RAN2 may need to send LS to SA3, informing SA3 of the issue. |
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## 1st Hop PC5 Adaptation layer for L2 UE-to-UE Relay

At first, the end to end QoS for multiple different SL Radio Bearers may be met with the same SL RLC channel configuration at the first hop PC5. Then the support of N:1 mapping between Remote UE Uu Radio Bearer and PC5 RLC channel at the first PC5 hop may have the benefit of better resource utilization efficiency.

### **Question 21**

Do you agree to support the N:1 mapping by first hop PC5 adaptation layer between Remote UE SL Radio Bearers and first hop PC5 RLC channels for relaying?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | The LCID space for RLC channel between source-relay UE would become a bottleneck, if always assume 1-to-1 mapping, considering  - the same first hop carries the data for different second hop data;  - the scenario where the first-hop is also the second hop for another UE-to-UE connection.  - the forwards compatibility for multi-hop relay. |
| Ericsson (Min) | Yes with comments | We think it is more reasonable to map N SL radio bearers of different remote UEs to one PC5 RLC channel. We are also fine with a majority’s view. |
|  |  |  |

Secondly, different from L2 UE-to-Network Relay, one Source Remote UE can establish multiple PC5 links with several Destination Remote UEs via Relay UE. In this case, the traffic transmitted by the Source Remote UE needs to identify the Destination Remote UE, in order for the Relay UE to forward the packets to the right destination. Then, the adaptation layer over first hop PC5 between Source Remote UE and Relay UE is needed to carry the necessary information (e.g. the Identity of the Destination Remote UE) for that purpose.

### **Question 22**

Do you agree to support the adaptation layer over first hop PC5 between Source Remote UE and Relay UE in order to identify the traffic destined to different Destination Remote UEs?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Ericsson (Min) | Yes |  |
|  |  |  |

RAN2 already agreed to support the adaptation layer over second hop PC5 interface. If an adaptation layer is only supported at the Destination Remote UE, a UE needs to be configured differently as a Source Remote UE or as a Destination Remote UE, which is suboptimal.

In addition, there was a discussion at the last RAN2 e-meeting on the traffic differentiation over first hop PC5 by adaptation layer between the non-relaying traffic (i.e. traffic terminated at Relay UE) and the relaying traffic (i.e. traffic destined to Destination Remote UE) for L2 UE-to-UE relay operation.

### **Question 23**

Do you agree to support traffic differentiation via first hop PC5 adaptation layer between the non-relaying traffic and the relaying traffic for L2 UE-to-UE relay operation?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | Similar to the reply for Q13, besides the non-relay traffic, furthermore, the question can be extended to support the merging of traffic for first-hop of one UE-to-UE connection and the last hop of another UE-to-UE connection via adaptation layer, which can also be enabled by a unified design of adaptation layer. |
| Ericsson | No | It is unnecessary to apply adaptation layer for non relaying traffic. This would increase the overhead. It is sufficient to distinguish non-relaying traffic from relaying traffic based on bearer mapping.  Just to be clear, adaptation layer should be only supported for relaying purposes. For normal PC5 operations there should be no adaptation layer to guarantee the backward compatibility with Rel-16. |
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### **Question 24**

What additional functions on the first hop PC5 interface would be needed from the adaptation layer if the first hop PC5 adaptation layer is supported?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | There may be additional functions like flow control and RLF notification as studied by Rel-16 IAB, which may also be supported for the Uu adaptation layer. The details can be considered at WI stage. |
| OPPO | Yes | Besides the bearer-ID and destination-UE-ID discussed in Q21/22, the ID of source-UE is also needed, considering   * Otherwise, the first/second hop of UE-to-UE relay has to be differentiated in layers below adaptation layer, in order for adaptation layer to differentiate between the UE-ID included in the header is for source or destination UE * the forwards compatibility to multi-hop relay, i.e., the packet may come from the UEs relayed by the “source” UE, and the differentiation mentioned in the bullet above has to be in 3 types, first/intermediate/last hops.   Other than that, the additional functions can be left to WI-phase. |
| Ericsson (Min) | Yes with comments | In case RAN2 has decided to adopt adaptation layer for the first hop, then RAN2 shall further study issues as we commented for Q20 |
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## QoS handling for L2 Relay

For L2-based L2 UE-to-Network Relay, the Remote UE data goes over its own PDU session, and the Remote UE can inform the network the required QoS parameters. The network can provide configuration information for both PC5 RLC channel(s) and Uu Radio Bearer(s) taking into consideration the provided QoS information [23].

[7] describes that gNB guarantees the end-to-end QoS requirement of Remote UE by dividing end-to-end QoS parameters received from CN into QoS requirement on each hop, and configuring appropriate Uu and PC5 configuration. [11] and [40] describes that gNB implementation can handle the QoS breakdown over Uu and PC5 for particular session established between Remote UE and network. It would be helpful to clarify the basic QoS handling for L2 based UE to Network relaying.

### **Question 25**

**Do you agree that gNB implementation can handle the QoS breakdown over Uu and PC5 for the end-to-end QoS enforcement of a particular session established between Remote UE and network in case of L2 based UE to Network relaying? If not, please give your alternative solution and the reason.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Ericsson (Min) | Yes |  |
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For L2-based UE-to-UE Relay, QoS parameters coordination of a particular end-to-end SLRB for both PC5 links can be managed by upper layer (SA/CT scope). The basic procedure is described by solution 31 within section 6.31 of SA2 draft TR 23.752. The detailed procedure is described in section 6.31.3 of draft TR 23.752. The principle can be summarized as below in RAN2 language:

* The QoS parameters coordination for L2-based UE-to-UE Relay is governed by upper layer.
* Source Remote UE decides the E2E QoS parameters between Source Remote UE and Destination Remote UE based on the application layer requirements. Then Source Remote UE provides the QoS parameters to Relay UE.
* Relay UE splits the E2E QoS parameters into two parts: one part is for the PC5 interface between Source Remote UE and Relay (source side PC5 QoS parameters), the other part is for the PC5 interface between Relay UE and Destination Remote UE (destination side PC5 QoS parameters). Then Relay UE provides the QoS parameters to both Source Remote UE and Destination Remote UE.
* After the PC5 QoS parameters splitting for two PC5 links, the AS layer configurations for PC5 QoS parameters in each of the PC5 links can be achieved according to legacy mechanisms in R16 V2X.

### **Question 26**

**Which alternative do you prefer to document QoS handling for L2 UE-to-UE Relay in RAN2 TR?**

**Alt1: Document the principles as listed above**

**Alt2: QoS handling for L2 UE-to-UE Relay is subject to upper layer, e.g. solution 31 within TR23.752 studied by SA2.**

|  |  |  |
| --- | --- | --- |
| Company | Alternatives | Comments |
| MediaTek | Alt1/Alt2 | Both alternatives works |
| OPPO | Alt2 is preferred (Alt1 is OK with rewording suggestion) | Alt2 is safer since it is more of SA2 scope to decide on QoS framework.  Alt1 contains some uncertainty, e.g., “Then Relay UE provides the QoS parameters to both Source Remote UE and Destination Remote UE.”, it needs SA2 confirmation first. By rewording it to “How for relay UE to exchange the split QoS parameter with source and destination UE is up to SA2 decision”, Alt1 is also fine for us to be captured in TR. |
| Ericsson (Min) | Alt 2. With update | RAN2 TR can refer to 23.752 solution#31. In addition, RAN2 can highlight RAN2 aspects, such as how relay UE splits the E2E QoS is for FFS by RAN2. |
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## Connection Establishment for L2 UE-to-Network Relay

Multiple documents submitted RAN2#111e discussed the high level procedure for L2 relay connection setup [7] [8] [15] [23]. In RAN2#111e, it was agreed that Remote UE initiates the first RRC message for its connection establishment with gNB, the PC5 L2 configuration for the transmission between the Remote UE and the UE-to-Network Relay UE can be based on the RLC/MAC configuration defined in specifications. It was also agreed that the establishment of Uu SRB1/SRB2 and DRB of the Remote UE is subject to legacy Uu configuration procedures for L2 UE-to-Network Relay.

Based on the agreement made at RAN2#111e meeting and the discussion in the relevant documents, the diagram in Figure 1 and the steps described below are to show a high-level summary of the process that needs to happen for connection establishment through the relay, which assumes the Remote UE does not first access on Uu to request a transfer to the relay link.



Figure 1: Connection Establishment for L2 UE-to-NW relay

Step 1. The Remote and Relay UE perform discovery procedure, and establish PC5-RRC connection according to the legacy Rel-16 procedure.

Step 2. The Remote UE sends the first RRC message (i.e. RRCSetupRequest) for its connection establishment with gNB via the Relay UE, using a default L2 configuration on PC5. The gNB responds with an RRCSetup message to Remote UE as legacy procedure. The RRCSetup delivery to the Remote UE uses the default configuration for L2 on PC5. If the relay UE had not started in RRC\_CONNECTED, it would need to do its own connection establishment as part of this step.

Step 3. The gNB and Relay UE perform relaying channel setup procedure over Uu. According to the configuration from gNB, the Relay UE establishes an RLC channel for relaying of SRB1 towards the Remote UE over PC5. This step prepares the relaying channel for SRB1.

Step 4. Remote UE SRB1 message (e.g. an RRCSetupComplete message) is sent to the gNB via the Relay UE using SRB1 relaying channel over PC5. Then the Remote UE enters into RRC\_Connected state.

Step 5. The Remote UE and gNB establish security following legacy procedure and the security messages are forwarded through the Relay UE.

Step 6. The gNB sets up additional RLC channels between the gNB and Relay UE for traffic relaying. According to the configuration from gNB, the Relay UE sets up additional RLC channels between the Remote UE and Relay UE for traffic relaying. This step prepares the relaying channels for SRB2/DRBs.

Step 7. The gNB sends an RRCReconfiguration to the Remote UE via the Relay UE, to set up the relaying SRB2/DRBs. The Remote UE sends an RRCReconfigurationComplete to the gNB via the Relay UE as a response.

### **Question 27**

**Do you agree to capture Figure 1 and the corresponding step description above into the TR to show the high level procedure for Connection Establishment of L2 UE-to-Network relay?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes with comment | We understand the intention of this question is to provides a high-level description of the procedure which is general enough to avoid debate on specific details, which can be left to WI phase, so we agree it would be benefit to capture this in TR.  One comment is on step6/7: since the RRCReconfiguration is on SRB1 and used for configuration of SRB2/DRB, it is suggested to merge step6/7 as one, since there may be no clear boundary between the two, e.g., it can be the RRCReconfiguration itself to perform the RLC channel configuration for relay and remote UE. |
| Ericsson (Min) | Yes with comments | General we are fine with the step description. We also agree with OPPO to merge step 6 and 7. In addition, we would like the below things to be further clarified.   1. Signalling transmission directions. Since this should be a flow diagram, better to change the “squares” with “arrows” since a procedure may involve two messages rather than only one, e.g., the security establishment. 2. In step 2, the default configuration means that the default L2 configurations for SL SRB0 3. Whether or not to use SL SRBs (even a new type of SL SRB) to carry these Uu RRC signalling? If so, what SL SRB will be used. Perhaps we can add an FFS for this issue in the TR. |
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With regard to the transmission of the first RRC message (i.e. RRCSetupRequest) from the Remote UE to the gNB for connection establishment. The transmission of the message can go through Uu adaptation layer from Relay UE to gNB, which assumes Uu adaptation layer is always available and can be even used for the transmission of the first RRC message from Remote UE. Alternatively, the transmission of the message is not carried by Uu adaptation layer, which assumes the Uu adaptation layer is not established yet for the Remote UE at this stage.

### **Question 28**

Do you agree that the Uu adaptation layer is always available and can be used to carry the first RRC message (i.e. RRCSetupRequest) for connection establishment from Remote UE to the gNB when the first RRC message is forwarded by Relay UE?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | We see that if Uu adaptation layer is always available, this will simplify the signaling transmission for the end-to-end Uu message between Remote UE and gNB. |
| OPPO | Yes | Since the relaying of remote UE happens after relay UE establishing the Uu connection with network, it is easy that network provides a configuration on the bearer and the related adaption layer configuration to relay UE, before it sending the first SRB0 message of remote UE to network, i.e., there is no need to differentiate the forwarding of SRB0 and other SRB1/2/DRB message on Uu hop. |
| Ericsson (Min) | No | Adaptation layer is not configured yet for the first RRC signaling. in this case, it is enough to transmit the message without adaptation layer header.  This will have an impact on Uu operation since it means that the gNB needs to configure the adaptation layer blindly for a relay connection that may never be established. We are totally against on this kind of unnecessary configuration/signaling/impact on Uu operations. |
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## Connection Establishment for L2 UE-to-UE Relay

The connection establishment procedure for L2 UE-to-UE relay was studied by SA2 in solution 8 and solution 9 as captured within SA2 TR23.752. Both solution 8 and solution 9 assumes implicit relay discovery procedure during connection establishment procedure for UE-to-UE Relay, which is based on PC5-S signalling (e.g. Direct Communication Request). However, if the Mode A/Mode B based relay discovery procedure is performed before connection establishment procedure for L2 UE-to-UE Relay, there should be PC5-S signaling exchange for discovery purpose. In any case, the PC5-S signaling (Communication message or Discovery message) happens before PC5-RRC signaling.

The following steps and the diagram in figure 2 is to show a high-level summary of the process that needs to happen for connection establishment from AS perspective for L2 UE-to-UE Relay.



Figure 2: Connection Establishment for L2 UE-to-UE relay

Step 1. The PC5 RRC is established for both first PC5 hop between Remote UE1 and Relay UE and second PC5 hop between Remote UE2 and Relay UE after the PC5-S signalling procedure for PC5 discovery or PC5 communication.

Step 2. Remote UE1 and Remote UE2 establish end-to-end PC5 RRC connection and activate security for the end-to-end PC5 RRC connection.

Step 3. Remote UE1 and Remote UE2 exchange separate PC5-RRC signaling with the Relay UE to set up the PC5 RLC channels for traffic relaying at both hops (i.e. Remote UE1-Relay UE hop, and Relay UE-Remote UE2 hop).

Step 4. Based on the end-to-end PC5 RRC connection, Remote UE1 and Remote UE2 establish end-to-end SLRBs (including the configuration of PDCP/SDAP) which is subject to traffic relaying via Relay UE.

### **Question 29**

**Do you agree to capture Figure 2 and the corresponding step description above into the TR to show the high level procedure for Connection Establishment of L2 UE-to-UE relay?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Comment | We understand the intention of this question is to provides a high-level description of the procedure which is general enough to avoid debate on specific details, which can be left to WI phase, so we agree it would be benefit to capture this in TR.  We assume that this procedure is for the steps except/excluding the PC5-S signaling exchange for connection establishment (i.e., step-0), which is left to SA2 decision.  Comments for clarification - it is not clear on the difference between step1/2 and step3/4: now step-1/2 is for “establishment”, while step-3/4 is for SLRB “configuration” (including configuration of RLC/MAC/adaptation layer, and configuration of PDCP/SDAP) – but if relying on the R16 framework, there is no such differentiation for PC5-RRC between establishment and configuration, since there are only two PC5-RRC procedures specified, i.e., capability transfer and AS-layer configuration. So to further generalize the description for an agreeable shape to be captured in TR at the current stage, it is suggested to merge step-1/2 and step-3/4, i.e., one step for per-hop signaling, and another step for end-to-end signaling, both include at least the capability transfer and AS-layer configuration, and leave the necessity of additional PC5-RRC procedure to WI phase.  Furthermore, for the time order of the steps, e.g., whether to do the per-hop signaling exchange first or the E2E signaling exchange first (for both PC5-S/-RRC), it may also depend on SA2 conclusion on the solution and detailed design in stage-3, which can be left as open and thus to be decided at WI-phase. |
| Ericsson (Min) | No with comments | Generally we are fine with the intention. The proposed diagram needs to be improved to make it clearer.  We agree with OPPO. In addition, we would like to clarify Step 0.  In step 0, whether or not discovery protocol will be PC5-S identical or PC5-S like, is not decided yet. Therefore, better to remove PC5-S from step 0. Enough to say discovery message.  Further, since this should be a flow diagram, better to change the “squares” with “arrows” and clearly show what is the message flow. |
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## System information delivery for Remote UE (UE-to-NW relay)

As discussed within R2-2008266[43], the system information can be forwarded to Remote UE by Relay UE for L2 UE-to-NW relay.

The in-coverage Remote UE(s) can receive system information directly (via Uu link) or indirectly (via relay UE). However, if the Remote UE is out of coverage, it relies on the Relay UE to forward the system information. It assumes that the Relay UE doesn’t need to know whether the Remote UE is in coverage or out of coverage. The Relay UE can always forward the system information to the Remote UE without considering the remote UE is in coverage or out of coverage.

In any case, the Relay UE can support the relaying of the essential system information as required by the Remote UEs. Which system information is considered as essential for Remote UEs can be discussed at normative phase.

Relay UE can forward the received system information to Remote UE(s) via broadcast or groupcast. Relay UE can also forward the system information to Remote UE via dedicated PC5-RRC signaling. The detailed mechanisms of PC5-RRC signaling design can be discussed in WI stage.

### **Question 30**

**Do you agree that Relay UE can support the relaying of the essential system information as required to the Remote UE(s) and which system information is considered as essential for Remote UEs can be discussed at normative phase?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes with comment | “as required” may lead to further discussion on whether the forwarding is on-demand from remote UE, it is suggested to remove “as required” to avoid further debate at the current stage. |
| Ericsson (Min) | Yes with comment | Perhaps we can remove “essential”, “as required”, and also  Reformulate “which system information is considered as essential for Remote UEs can be discussed at normative phase” to “what system information can be relayed to Remote UEs can be discussed at normative phase”. |
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### **Question 31**

**Do you agree that Relay UE can forward the received system information to Remote UEs via broadcast or groupcast?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | It is needed since the SI forwarding is needed before remote UE establish PC5 connection with relay UE, i.e., one cannot always rely on unicast for it.  Between broadcast and groupcast, we believe only broadcast is feasible. But also fine to keep the wording as it is and leave the decision to WI phase. |
| Ericsson (Min) | Yes | this is only valid if the remote UEs are out of coverage. |
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### **Question 32**

**Do you agree that Relay UE can forward the system information to Remote UE via dedicated PC5-RRC signaling and the detailed mechanisms of PC5-RRC signaling design can be discussed in WI stage?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes |  |
| OPPO | Yes | Since the current spec allows SI delivery via dedicated RRC, the forwarding of such dedicated RRC carrying SI to remote UE via relay UE has not difference compared to the normal DL RRC forwarding. |
| Ericsson (Min) | Yes | Agree with OPPO |
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The support of on-demand SI delivery is proposed in some of the papers [7] [14] [29] [42]. Note that for Relay UE (in RRC Idle/Inactive/Connected state), which is in coverage, the legacy on-demand SI delivery mechanism is used.

From Remote UE perspective, for idle/Inactive Remote UE, Msg1-based on-demand SI request should not be used as Relay UE cannot simply forward this type of request. For idle/Inactive Remote UE, the Msg3-based on-demand SI request (i.e. RRCSystemInfoRequest) can be sent as normal Uu SRB0 message from Remote UE to gNB via Relay UE. For connected Remote UE, the Msg3-based on-demand SI request (i.e. dedicatedSIBRequest) can be sent as normal Uu SRB1 message from Remote UE to gNB via Relay UE.

In summary, on-demand SI request is supported for Remote UE for all RRC states (Idle/Inactive/Connected state). only Msg3 based on-demand SI request is supported for Remote UE, and the legacy Uu RRC procedure is reused to support the Remote UE’s on-demand SI request, when the Remote UE is in RRC Idle/Inactive/Connected state. On-demand SI delivery is needed for the Remote UE regardless of out-of-coverage or in-coverage Remote UE(s).

### **Question 33**

**Do you agree the following on-demand SI delivery principles for Remote UE:**

**(a)** **on-demand SI request is supported for Remote UE for all RRC states (Idle/Inactive/Connected state).**

**(b)Only Msg3 based on-demand SI request is supported for Remote UE**

**(c) The legacy Uu RRC procedure is reused to support the Remote UE’s on-demand SI request.**

**(d) On-demand SI delivery is supported for the Remote UE(s) regardless of out-of-coverage or in-coverage,** **when connected with Relay UE.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No (with bullets) | Comments |
| MediaTek | Yes with a/b/c/d |  |
| OPPO | Yes with a-d |  |
| Ericsson (Min) | Yes with a, b, c and d but with comment | Regarding b), should be clarified that Msg3-based framework is only supported if the remote UE is in IDLE/INACTIVE but NOT in CONNECTED. If the remote UE is in CONNECTED the procedure is different (same principle for the relay UE). Better to clarify this aspect and align to what has been specified in Rel-15 and Rel-16. |
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After the Remote UE sends the on-demand SI request message to the gNB, the Relay UE doesn’t know that the SI request was made, since it just saw that an encrypted message went through on an SRB. If the network responds by unicast, there is no problem since the response will also go transparently through the Relay UE to the Remote UE. However, if the network responds by broadcasting the concerned SI, the Relay UE can see the new SI being transmitted but has no way to know that it should be delivered to the Remote UE. In this case, Remote UE may need to notify its requested SIB to the Relay UE via PC5-RRC message, in order to trigger the Relay UE to perform SIB forwarding.

### **Question 34**

**Do you agree that Remote UE needs to notify its requested SIB to the Relay UE via PC5-RRC message, in order to trigger the Relay UE to perform SIB forwarding.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| MediaTek | Yes | We think this mechanism is needed in case the gNB can take broadcast manner as the response to the on-demand SI request from Remote UE |
| OPPO | No | This is more like an optimization, if considering the baseline scheme is relay UE forwarding all necessary broadcasted SIB by default, i.e., RAN2 define a set of SIBs that needs to be forwarded by relay UE, and relay UE would simply forward it to PC5 hop as long as it is broadcasted by network, regardless whether it is triggered by a specific remote UE or not. |
| Ericsson (Min) | No | Agree with OPPO. |
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## Access Control for L2 UE-to-Network Relay

Remote UE may perform access control. The Relay UE may provide UAC parameters to Remote UE during or after SL unicast connection is established. For example, it can be transmitted via the SL RRC message as dedicated parameters or included in forwarded SIB1 [7].

As studied by feD2D, upon reception of the UAC parameters, the access control check is performed at Remote UE using the parameters of the cell it intends to access. The UE-to-Network Relay UE does not perform access control check for the Remote UE's data. If the access is allowed, the Remote UE can trigger RRC Setup procedure towards the gNB via Relay UE.

### **Question 35**

**Do you agree the following access control check principles for L2 UE-to-Network Relay operation?**

**(a)The Relay UE may provide UAC parameters to Remote UE**

**(b)The access control check is performed at Remote UE using the parameters of the cell it intends to access.**

**(c)The UE-to-Network Relay UE does not perform access control check for the Remote UE's data.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No (with bullets) | Comments |
| MediaTek | Yes with a/b/c |  |
| OPPO | Yes with a-c |  |
| Ericsson (Min) | Yes with a, b, and c with comments | We are wondering whether different UAC parameters may be applied to the relay UE and remote UE. This could be particularly useful in certain use case.  We propose to have an FFS on this and further study this. |
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## Other issues

There may be additional issues that need to be discussed to describe the L2 relaying.

### **Question 36**

**Please give the explanation of any additional issues to describe the L2 relaying, which needs to be studied in SI phase.**

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson (Min) | 1. **Exchanging of capability** In situations when the remote UE is out-of-coverage, the remote UE may not be able to exchange its capability with the gNB/UE.   In this case, the relay UE should do it.   1. **RRC states of the relay UE and remote UE**   Our assumption is that the relay UE and remote UE may have different RRC states, but we should limit the combination of those because some of them may not be practical. In the following table to explain what our idea of the supported RRC state combinations is:   |  |  |  | | --- | --- | --- | | **RL UE state** | **RM UE state** | **Validity** | | CONNECTED | CONNECTED | Valid | | CONNECTED | INACTIVE | Valid | | CONNECTED | IDLE | Valid | | INACTIVE | CONNECTED | Invalid | | INACTIVE | INACTIVE | Valid | | INACTIVE | IDLE | Valid | | IDLE | CONNECTED | Invalid | | IDLE | INACTIVE | Valid | | IDLE | IDLE | Valid | |
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# Rapporteur’s summary and Proposal

TBD

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