**3GPP TSG RAN WG2 Meeting #116bis R2-22XXXXX
Electronic Meeting, 17th - 25th Jan 2022**

**Agenda item: 6.2.3**

**Source: CATT**

**Title: Summary [POST116-e][710][V2X/SL] PDCP/RLC Entity Maintenance for SL-SRBs (CATT)**

**Document for: Discussion and Decision**

# Introduction

This is for the email discussion:

* [POST116-e][710][V2X/SL] PDCP/RLC Entity Maintenance for SL-SRBs (CATT)

 **Scope:** Clarify the issue and discuss solution (if the issue is confirmed).

 **Intended outcome:** Discussion summary and CR (if needed)

**Deadline:** Long email discussion. Recommend to have short intermediate phase to check if you list all options/solutions companies mind when to discuss solution.

The above email discussion is divided in three phases:

* **Phase I:** Companies are invited to check the questions and provide your option for each question if it is not included in the candidate options by 12/3, 10:00am UTC. Please pay attention, no feedback on the questions is needed in Phase I. The intention for this phase is to clarify the questions and check if all options/solutions have been listed.
* **Phase II:** Companies are invited to provide feedback on the questions of this email discussion by 12/13, 10:00am UTC.
* **Phase III:** Rapporteur submits a summary and proposals based on the feedback, and companies can comment on the summary by 12/17, 10:00pm UTC.

# Discussion

## Scenarios

According to TS 33.536, for sidelink unicast, the high-level signaling flow of connection establishment is as below:



**Figure-1 High-level signaling flow of connection establishment**

The cast type of each PC5-S message in the above Figure-1 is summarized in the following Table-1 based on the descriptions of TS 23.287 and TS 24.587.

**Table-1 Cast type of each PC5-S signalling during PC5-S connection establishment procedure**

|  |  |  |
| --- | --- | --- |
| PC5-S signaling | Cast type  | Reference |
| DIRECT LINK ESTABLISHMENT REQUEST | Unicast or broadcast | **TS23.287**UE-1 sends the Direct Communication Request message via PC5 broadcast or unicast using the source Layer-2 ID and the destination Layer-2 ID. |
| DIRECT LINK AUTHENTICATION REQUEST | Unicast | **TS24.587**After the DIRECT LINK AUTHENTICATION REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication. |
| DIRECT LINK AUTHENTICATION RESPONSE | Unicast | **TS24.587**After the DIRECT LINK AUTHENTICATION RESPONSE message is generated, the target UE shall pass this message to the lower layers for transmission along with the target UE's layer-2 ID for unicast communication and the initiating UE's layer-2 ID for unicast communication. |
| DIRECT LINK SECURITY MODE COMMAND | Unicast | **TS24.587**After the DIRECT LINK SECURITY MODE COMMAND message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication, …… |
| DIRECT LINK SECURITY MODE COMPLETE | Unicast | **TS24.587**After the DIRECT LINK SECURITY MODE COMPLETE message is generated, the target UE shall pass this message to the lower layers for transmission along with the target UE's layer-2 ID for unicast communication and the initiating UE's layer-2 ID for unicast communication, NRPIK, NRPEK if applicable, KNRP-sess ID,…… |
| DIRECT LINK ESTABLISHMENT ACCEPT  | Unicast | **TS24.587**After the DIRECT LINK ESTABLISHMENT ACCEPT message is generated, the target UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication, …... |

For the first PC5-S unicast message reception, there is the risk that the Rx UE can’t aware the Tx UE’s L2 SRC ID. In order to make it clear, we listed the detailed scenarios as below:

* Scenario 1: The first PC5-S unicast message is DCR.
* Scenario 2: The first PC5-S unicast message is DIRECT LINK AUTHENTICATION REQUEST.
	+ In this scenario, the cast type of DCR is broadcast.
* Scenario 3: The first PC5-S unicast message is DIRECT LINK SECURITY MODE COMMAND.
	+ In this scenario, the cast type of DCR is broadcast and the DIRECT LINK AUTHENTICATION REQUEST/RESPONSE procedure is omitted.

### 2.1.1 Scenario 1 (The first PC5-S unicast message is DCR)

 Scenario 1 is shown in the following figure, where the cast type of the DCR message is unicast.



**Figure-2 Scenario 1**

According to TS 24.587, the condition for UE\_1 transmitting DCR to UE\_2a by unicast is as below:

|  |
| --- |
| NOTE:      The target UE may reuse the target UE's layer-2 ID used in the transport of the DIRECT LINK ESTABLISHMENT REQUEST message provided by the lower layers in case that the target UE's layer-2 ID has been used in previous PC5 unicast link with the same peer.   |

That is to say, if UE\_1 had been setup PC5 unicast link with UE\_2a before, it may store the destination layer-2 ID of UE\_2a. If it wants to setup PC5 unicast link with UE\_2a again, it can use the stored destination layer-2 ID of UE\_2a. But in fact, UE\_2a may not store the source layer-2 ID of UE\_1 after the previous PC5 unicast link release because UE\_2a does not know whether and when the UE\_1 will re-initiate PC5 unicast link establishment procedure again. Hence, for scenario 1, it is possible that the UE\_2a does not know the L2 SRC of UE\_1 if DCR is transmitted via unicast.

**Question 1-1: For scenario 1, do companies agree that it is possible that UE\_2a does not know the source layer-2 ID of UE\_1 if DCR is transmitted via unicast?**

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| **Companies** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Huawei, HiSilicon | See comments  | We think we need to check with SA2 on this question. Based on our understanding, SA2 agreed to transmit DCR via unicast message with the assumption that the initiating UE (UE\_1 in the figure) is able to get the target UE’s (UE\_2a in the figure) layer-2 ID before setting up the PC5 unicast link. By implementation, we think the target UE should also know the initiating UE’s layer-2 ID. However, nothing is captured in SA2 specification. We think it is better to check SA2’s opinion since the scenario was introduced/agreed by them. |
| Lenovo | See comments | Our understanding is if UE\_2a release UE\_1 ID, UE\_2a will also release corresponding UE\_2a source layer-2 id of the same unicast link since when release the unicast link, all unicast link identities will be released. Since the procedure is designed by SA2, this is better to be confirmed by SA2 |
| Ericsson | Check with SA2 | We also prefer to check with SA2. Basically, same understanding as Huawei that the DCR message is sent via unicast only if there was previous PC5 connection between UE\_1 and UE\_2. Otherwise, the very first DCR message between UE\_1 and UE\_2 is always sent via broadcast. |
| Apple | Yes | We think even if UE 2a stores the prior source L2 ID, UE 1 is still allowed to use a new src L2 ID, so the problem is still there. |
| vivo | See comments | The “issue” we admit here is that there is no description *explicitly specifying* how the UE gets the L2 IDs of its target UE in Rel-16 Spec (either in RAN2 or SA2 Spec). However, we should have already been aware of this “issue”, when we were specifying Rel-16 NR SL, with the assumption that there should have been some ways of “hand-shake” procedure that enables the UEs to get the L2 IDs of the peer UEs prior to the DCR exchange. Such a “hand-shake” procedure is UE implementation specific. In this scenario, specifically, UE1 and UE2a already got each other’s L2 ID based on such implementation-based “hand-shake” procedure. In general, we believe this (i.e. implementation-specific L2 ID exchange prior to 3GPP unicast link setup procedure) should have been the basic assumption of the whole Rel-16 design, and don’t think further standard efforts is needed to explore this “issue”. |
| Qualcomm | See comments | We agree with the comments from Huawei and Ericsson that a unicast DCR should be sent if the initiating UE has prior knowledge of the target UE’s L2 ID. |
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### 2.1.2 Scenario 2 (The first PC5-S unicast message is DIRECT LINK AUTHENTICATION REQUEST unicast)

In this scenario, as shown in the following figure, the DCR message uses broadcast and the DIRECT LINK AUTHENTICATION REQUEST message uses unicast.



**Figure-3 Scenario 2**

According to the above Figure-3, for UE\_2a, after the DIRECT LINK AUTHENTICATION REQUEST message is generated, UE\_2a shall pass this message to the lower layers for transmission along with the UE\_2a's source layer-2 ID for unicast communication and the target UE's destination layer-2 ID for unicast communication.

According to the description in TS 23.287, it clearly stated that the source layer-2 ID are always self-assigned. Hence, it is obvious that UE\_1 can’t aware the source layer-2 ID used by UE\_2a.

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| 5.6.1 Identifiers for V2X communication over PC5 reference point…….Each UE has one or more Layer-2 IDs for V2X communication over PC5 reference point, consisting of:- Source Layer-2 ID(s); and- Destination Layer-2 ID(s).Source and destination Layer-2 IDs are included in layer-2 frames sent on the layer-2 link of the PC5 reference point identifying the layer-2 source and destination of these frames. Source Layer-2 IDs are always self-assigned by the UE originating the corresponding layer-2 frames. |

**Question 1-2: For scenario 2, do companies agree that UE\_1 does not know the source layer-2 ID of UE\_2a when UE\_1 sends DCR by broadcast and UE\_2a sends DIRECT LINK AUTHENTICATION REQUEST message to UE\_1 by unicast?**

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| **Companies** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Lenovo | Yes |  |
| Ericsson | Check with SA2 | Our understanding is that when the DCR message sent the UE should also send the L2 ID along with the message. However, better to check with SA2.From section 6.1.2.2.2 of TS 24.587:*After the DIRECT LINK ESTABLISHMENT REQUEST message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the destination layer-2 ID used for unicast initial signaling, and start timer T5000. The UE shall not send a new DIRECT LINK ESTABLISHMENT REQUEST message to the same target UE identified by the same application layer ID while timer T5000 is running.*And similar text we have for the reply of the DCR in section 6.1.2.2.3 of TS 24.587:*After the DIRECT LINK ESTABLISHMENT ACCEPT message is generated, the initiating UE shall pass this message to the lower layers for transmission along with the initiating UE's layer-2 ID for unicast communication and the target UE's layer-2 ID for unicast communication, NRPIK, NRPEK if applicable, KNRP-sess ID, and the selected security algorithm as specified in TS 33.536 [20], and shall start timer T5011 if the target UE has the privacy configuration as specified in clause 5.2.3.* *After sending the DIRECT LINK ESTABLISHMENT ACCEPT message, the target UE shall provide the following information along with the layer-2 IDs to the lower layer, which enables the lower layer to handle the coming PC5 signalling or traffic data:* 1. *the PC5 link identifier self-assigned for this PC5 unicast link;*
2. *PQFI(s) and its corresponding PC5 QoS parameters;*
3. *an indication of activation of the PC5 unicast signalling security protection for the PC5 unicast link, if applicable; and ETSI 3GPP TS 24.587 version 16.2.1 Release 16 22 ETSI TS 124 587 V16.2.1 (2020-10)*
4. *e) an indication of activation of the PC5 unicast user plane security protection for the PC5 unicast link, if applicable.*
 |
| Apple | Yes |  |
| vivo | See comments | See our comments for Q1-1. In this scenario, specifically, since UE1 sends the “broadcast-manner” DCR, it should take any UE responding with  **DIRECT LINK AUTHENTICATION REQUEST message** to it as a target UE it is interested to communicate with, and thus treats any source L2 ID received with **DIRECT LINK AUTHENTICATION REQUEST message** as interested for reception. This is quite straightforward, and thus should be based on reasonable UE implementation.  |
| Qualcomm | See comments | Agree with Ericsson. We are OK to check with SA2 |
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### 2.1.3 Scenario 3 (The first PC5-S unicast message is DIRECT LINK SECURITY MODE COMMAND)

In this scenario, as shown in the following figure, the DCR message uses broadcast, the DIRECT LINK AUTHENTICATION REQUEST/RESPONSE messages are absent, and the DIRECT LINK SECURITY MODE COMMAND is the first PC5-S unicast message.



**Figure-4 Scenario 3**

In this scenario, after the DIRECT LINK SECURITY MODE COMMAND message is generated, UE\_2a shall pass this message to the lower layers for transmission along with the UE\_2a’s source layer-2 ID for unicast communication and the UE\_1’s destination layer-2 ID for unicast communication.

Similar as the analysis in section 2.1.2, the source layer-2 ID of UE\_2a is self-assigned by UE\_2a, it is obvious that UE\_1 can’t aware the source layer-2 ID used by UE\_2a.

**Question 1-3: For scenario 3, do companies agree that UE\_1 does not know the source layer-2 ID of UE\_2a when UE\_1 sends DCR by broadcast and UE\_2a sends DIRECT LINK SECURITY MODE COMMAND message to UE\_1 by unicast?**

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| **Companies** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Lenovo | Yes |  |
| Ericsson | Check with SA2 | See reply to Q1-2 |
| Apple | Yes |  |
| vivo | See comments | Refer to our comments in Q1-1/1-2. |
| Qualcomm | See comments | See response to prior two Qs |
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## Issue description

### 2.2.1 MAC filtering issue for the first PC5-S unicast message during PC5-S connection setup procedure

As stated in section 2.1, when receiving the first PC5-S unicast message during PC5-S connection setup procedure, it is possible that the Rx UE can’t aware the source layer-2 ID used by the Tx UE. In this case, there may be filtering issue in MAC. The detailed issue is described as below.

According to the TS 38.321, when Rx UE receives a sidelink unicast TB from Tx UE, the corresponding behaviors are as below:

|  |
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| 5.22.2.2.2 Sidelink process……1> if the data for this TB was successfully decoded before:2> if this is the first successful decoding of the data for this TB:3> if this TB is associated to unicast, the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI, and the SRC field of the decoded MAC PDU subheader is equal to the 16 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 8 LSB are equal to the Source ID in the corresponding SCI; or3> if this TB is associated to groupcast or broadcast and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI:4> deliver the decoded MAC PDU to the disassembly and demultiplexing entity;2> consider the Sidelink process as unoccupied.… … |

From the above description, it is obvious that for sidelink unicast, before delivering the decoded MAC PDU to the disassembly and demultiplexing entity, UE should check if both of the following two conditions are met:

* The DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI;
* The SRC field of the decoded MAC PDU subheader is equal to the 16 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 8 LSB are equal to the Source ID in the corresponding SCI.

Hence, for sidelink unicast, if the Rx UE can’t aware the source layer-2 ID of the Tx UE, it can’t complete the MAC filtering. Hence, the decoded MAC PDU will not be delivered to the disassembly and demultiplexing entity.

**Question 2-1: For sidelink unicast, do companies agree that the Rx UE will not deliver the decoded MAC PDU to the disassembly and demultiplexing** **entity if it doesn’t know the source layer-2 ID used by the Tx UE?**

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| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Lenovo | Yes |  |
| Ericsson | Check issue with SA2 first | We prefer to check the issue with SA2 first and then procedure with a solution in RAN2, if needed. |
| Apple | Yes |  |
| vivo | See comments | See comments to our responses to Q1-1/1-2/1-3. In general, we think the “issue” of not clearly specifying the interested L2 ID acquisition exists in some cases (e.g. scenario 1), but think this can be solved by UE implementation.  |
| Qualcomm | See comments | Agree with vivo |
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For companies who answer “Yes” for at least one of the Question 1-1, Question 1-2 and Question 1-3 in section 2.1 are encouraged to answer the following question further:

**Question 2-2: If companies answer “Yes” for at least one of Question 1-1, Question 1-2 and Question 1-3, do companies confirm that the Rx UE will not deliver the decoded MAC PDU to the disassembly and demultiplexing entity for the scenario(s) that the Rx UE doesn’t know the source layer-2 ID used by the Tx UE?**

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| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Lenovo | Yes |  |
| Ericsson | Check issue with SA2 first | We prefer to check the issue with SA2 first and then procedure with a solution in RAN2, if needed. |
| Apple | Yes |  |
| vivo | See comments | See comments to our responses to Q1-1/1-2/1-3. In general, we think the “issue” of not clearly specifying the interested L2 ID acquisition exists in some cases, but think this can be solved by UE implementation. |
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### 2.2.2 PDCP/RLC receiving entity establishment issue

In RAN2#107 meeting, regarding to the PDCP/RLC entity establishment, the following agreements were reached:

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| For NR Sidelink unicast, the establishment and release of transmitting PDCP entity and receiving PDCP entity can be requested by upper layer. For NR SL unicast, RLC TX side and RX side establishment/release is triggered by upper layer request. FFS the case for RLC TX side re-establishment. |

Based on the above agreements, it is obvious that, for sidelink unicast, both the transmitting and the receiving PDCP/RLC entity establishment are triggered by upper layer. Here, the upper layer refers the RRC layer.

But according to the current TS38.331, for SL-SRB 0/1/2, there is only RRC triggers for establishing the transmitting PDCP/RLC entities, but there is no description on how to establish the receiving PDCP/RLC entities.

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| 5.8.9.1a.4            Sidelink SRB additionThe UE shall:1>  if transmission of PC5-S message for a specific destination is requested by upper layers for sidelink SRB:2>  establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-S message, as specified in sub-clause 9.1.1.4;1>  if a PC5-RRC connection establishment for a specific destination is indicated by upper layers:2>  establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-RRC message of the specific destination, as specified in sub-clause 9.1.1.4;2>  consider the PC5-RRC connection is established for the destination. |

Someone may argue that the PDCP entity and RLC entity marked with gray in TS38.331 as above includes both the transmitting and receiving PDCP/RLC entities. But in rapporteur’s understanding, it is not the fact. The detailed reasons are as below:

* For scenario 1 of section 2.1.1, if DCR is transmitted via unicast, UE\_2a will not establish the receiving PDCP/RLC entities based on the gray part of TS38.331 because UE\_2a may have no PC5-S message transmission requirement before DCR reception.
* For scenario 2 of section 2.1.2, if DCR is transmitted via broadcast, UE\_1 will establish the transmitting PDCP/RLC entities for SL-SRB0 using broadcast destination layer-2 ID. UE\_1 can’t establish the receiving PDCP/RLC entities for SL-SRB0 which carrying the DIRECT LINK AUTHENTICATION REQUEST message since it is transmitted via unicast and the UE\_1 does not know the source layer-2 ID used by UE\_2a.
* For scenario 3 of section 2.1.3, if DCR is transmitted via broadcast, UE\_1 will establish the transmitting PDCP/RLC entity for SL-SRB0 using broadcast destination layer-2 ID. UE\_1 can’t establish the receiving PDCP/RLC entities for SL-SRB1 which carrying the DIRECT LINK SECURITY MODE COMMAND message since it is transmitted via unicast and the UE\_1 does not know the source layer-2 ID used by UE\_2a.

**Question 2-3: Do companies agree that the description in the following table (copied from TS38.331) is only used to trigger the transmitting PDCP/RLC entities establishment for SL-SRB0/SL-SRB1/SL-SRB2, not for the receiving PDCP/RLC entities establishment for SL-SRB0/SL-SRB1/SL-SRB2?**

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| 5.8.9.1a.4            Sidelink SRB additionThe UE shall:1>  if transmission of PC5-S message for a specific destination is requested by upper layers for sidelink SRB:2>  establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-S message, as specified in sub-clause 9.1.1.4; |

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| --- | --- | --- |
| **Companies** | **Yes/No** | **Comments** |
| OPPO | No | We understand the establishment is not limited to Tx entity, but can be also applicable to Rx entity (although it is not necessary for SRB0 of the broadcast L2 address), but just the trigger (of the establishment of Tx and Rx entity (if needed)) is the transmission of PC5-S message |
| Huawei, HiSilicon | Yes | It is better to describe the establishment of PDCP/RLC for reception explicitly. |
| Lenovo | See comments | A reasonable UE implementation could establish both Tx and Rx entity for SL-SRBs of PC5-S message. But agree that current wording is not clear enough. |
| Ericsson | No with comments | We basically agree with Oppo that current description is not restricted to TX entity only. |
| Apple | Yes | We share the same view as Huawei that the current RRC text only describes TX-side behavior and TX-side trigger. |
| vivo | Yes with comments | We share the view that literally the trigger conditions for reception is not explicitly specified for the PC5-S SL-SRBs. But we think this can be handled by UE implementation as well, as a UE is not prevented from establishing an RX SL-SRB when it receives the PC5-S message with the L2 ID(s) in the AS. Note that in 36.331, there seems no such specified triggers either, with UE implementation able to handle the case. |
| Qualcomm | No | We do agree the change proposed 5.8.9.1a.4 Sidelink SRB addition can help clarify the behavior.  |
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## Candidate solutions

Based on the description in section 2.2, the problems of the current spec are summarized as below:

* Problem 1: The MAC filtering procedure for the first PC5-S unicast message described in scenario 1/2/3 has problem. The MAC can’t handle it properly. Hence, it will result that the receive MAC PDU will not be delivered to upper layer.
* Problem 2: The trigger for establishing the receiving PDCP/RLC entities at least for SL-SRB0/SL-SRB1/SL-SRB2 in TS38.331 are missing.

In order to fix the above two problems in current specs, there are two main methods:

* Alt 1: Resolve it in upper layer (SA2/CT1 scope);
* Alt 2: Resolve it in AS layer.

For Alt 1, there are mainly three methods:

* Alt 1.1: When upper layer sends the unicast PC5-S message(s) to lower layer before PC5-S connection setup, it changes the cast type from unicast to broadcast.
* Alt 1.2: Upper layer still indicates lower layer to use unicast to transmit the unicast PC5-S message, but use a source layer-2 ID that known by the reception UE.
* Alt 1.3: Send LS to SA2 and CT1 to describe the problems and how to solve it left to SA2 and CT1.

For Alt 2, there are mainly three methods:

* Alt 2.1: Add a note in section 5.8.1 of TS 38.331.

In the note, it can clarify that before PC-5 RRC connection setup, for SL-SRB0/SL-SRB1/SL-SRB2, no matter which cast type is indicated from upper layer, AS take its cast type as sidelink broadcast.

One example CR is shown in annex B.

* Alt 2.2: Modify the MAC and RRC spec.

In order to resolve the issues mentioned in section 2.2, the following modification on spec can be considered:

* + - For MAC:
			* Modify the spec to deliver the decoded MAC PDU to the disassembly and demultiplexing entity without check the SRC field of the TB if the received TB is the first unicast TB belonging to a logical channel which associated LCID is equal to 0 or 1 or 2.
			* MAC sends indicator to RRC to trigger the establishment of receiving PDCP/RLC entity for first SL-SRB0, SL-SRB1 and SL-SRB2 message reception.
		- For RRC:
			* Adding the trigger for establishing the receiving PDCP/RLC entities for SL-SRB0, SL-SRB1 and SL-SRB2 if needed.

One example CR is shown in annex A.

* Alt 2.3: Modify the MAC, RLC and PDCP spec.
	+ - For MAC:
			* Modify the spec to deliver the decoded MAC PDU to the disassembly and demultiplexing entity without check the SRC field of the TB if the received TB is the first unicast TB belonging to a logical channel which associated LCID is equal to 0 or 1.
		- For RLC:
			* Modify the spec to follow RLC RX entity establishment of NR sidelink communication broadcast/groupcast for SL-SRB0 and SL-SRB1.
		- For PDCP:
			* Add one note to describe that the receiving PDCP entity for NR sidelink communication for SL-SRB0 and SL-SRB1 is established as NR sidelink communication for groupcast and broadcast.

One example CR is shown in annex C.

**Question 3-1: If the issue in section 2.2 is confirmed, do companies prefer to resolve it in AS layer or upper layer?**

* + **Option 1: resolve it in upper layer.**
	+ **Option 2: resolve it in AS layer.**
	+ **Option 3: based on UE implementation.**

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| **Companies** | **Option** | **Comments** |
| OPPO | 2 | Do not see a feasible way-out in option-1:Alt1.1 is not feasible technically: the unicast type was used because one message is sent to a specific UE (instead for a group (groupcast) or a service type (broadcast)), so difficult for us to understand the change of U-cast => B-cast here, does it mean a change on the PC5-S procedure, i.e., none of the related PC5-S message will be sent to a specific UE but to all neighboring UEs? (but how is that feasible considering this is for unicast link establishment, i.e., I thought finally at some time point, the message should be in unicast manner?)Alt1.2 is not feasible either: if take scenario-1 as an example, the source L2 ID is used for the peer-UE late to include as destination L2 ID to send message to, how can the source L2 ID be set arbitrarily set? Wouldn’t it lead to the problem that UE fails to differentiate between unicast messages send to itself or someone else?Alt1.3 is not a solution essentially.. |
| Huawei, HiSilicon | 2 | Firstly we think the MAC filtering issue and the establishment of PDCP/RLC entity issue should be handled by AS.We also share the same view as OPPO that the proposed higher layer solution seems not feasible. |
| Lenovo | 1 | we think Alt 1.2 is workable. To address OPPO’s concern for the differentiate issue, UE\_1 could include a temp layer-2 ID generated by itself in the first message (DCR), and this temp layer-2 ID can be used by UE\_2a as source layer-2 ID to send the unicast message to UE\_1 |
| Ericsson | Check issue with SA2 first | We prefer to check the issue with SA2 first and then procedure with a solution in RAN2, if needed. |
| Apple | 1 | We think Alt 1.1 is feasible because this is how it was done in LTE ProSe for PC5-S procedures, as there is no SL unicast support in LTE ProSe. The “unciast” message is sent via broadcast, so the peer UE(s) will be able to match the address in upper layer and decide whether to trigger to establish PDCP entity from the RX side. Alt 1.2 is not feasible.Alt 1.3 is also OK for us. Anyway, such a change need SA2 to discuss it. |
| vivo | 3 | For Problem 1 in MAC, it is related to how the UE gets the interested UE’s L2 ID, and based on our replies to earlier questions, the “issue” can be addressed by UE implementation. For Problem 2 in RLC/PDCP, we think it is more related to not having explicit triggers specified for RX SL-DRB establishment. We think this can be handled by UE implementation as well, as a UE is not prevented from establishing an RX SL-DRB when it receives the data with the L2 ID(s) it is interested in. Note that in 36.331, there seems no such specified triggers either, with UE implementation able to handle the case. |
| Qualcomm | 2 | The proposed RRC change to 5.8.9.1a.4 Sidelink SRB addition is sufficient. We do not believe there is a MAC filtering issue, and do not see a compelling need to modify the MAC spec.  |
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**Question 3-2: If Option 1 is selected in Question 3-1, which of the following option(s) do companies prefer?**

* **Alt 1.1: When upper layer sends the unicast PC5-S message(s) to lower layer before PC5-S connection setup, it changes the cast type from unicast to broadcast;**
* **Alt 1.2: Upper layer still indicates lower layer to use unicast to transmit the unicast PC5-S message, but use a source layer-2 ID that known by the reception UE;**
* **Alt 1.3: Send LS to SA2 and CT1 to describe the problems and how to solve it left to SA2 and CT1;**
* **Alt 1.4: Others (if you choose this option, please give the detailed description on the solution).**

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| **Companies** | **Option** | **Comments** |
| Lenovo | Alt 1.2, or Alt 1.3 | We also fine to left the issue to SA2 and CT1 as in Alt 1.3 |
| Apple | Alt 1.1./1.3 | As explained in our answer in Q3-1 |
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**Question 3-3: If Option 2 is selected in Question 3-1, which of the following option do companies prefer?**

* **Alt 2.1：Agree to add a note in section 5.8.1 of TS 38.331(See annex B);**
* **Alt 2.2: Agree to modify MAC and RRC specs (See Annex A);**
* **Alt 2.3: Agree to modify MAC, RLC and PDCP specs (See Annex C);**
* **Alt 2.4: Others (if you choose this option, please give the detailed CR(s)).**

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| **Companies** | **Option** | **Comments** |
| OPPO | Use NOTE to capture it in MAC, RLC and PDCP spec | We do not think normative text is needed to solve this.For MAC spec: we are generally fine with the TP of annex-C for 38.321, yet prefer to capture that using NOTE instead of normative text (we are not quite strong on this though). E.g., NOTE: If this TB is associated to unicast and this TB is the first TB of a logical channel which associated LCID is equal to 0 or 1, and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI, deliver the decoded MAC PDU to the disassembly and demultiplexing entity.For RLC spec: we tend to think a TP similar to 38.323 of annex-C can be used here, i.e., NOTE: The RLC entity for NR sidelink communication for SL-SRB0 and SL-SRB1 is established as NR sidelink communication for groupcast and broadcast.For PDCP spec: we are fine with the TP of annex-C for 38.323, i.e., NOTE: The PDCP entity for NR sidelink communication for SL-SRB0 and SL-SRB1 is established as NR sidelink communication for groupcast and broadcast.We do not think the change to RRC spec is needed, since the received PDU reaches lower layer first then higher layer, so the trigger path is from PHY => MAC => RLC => PDCP, we do not see it is a must to go for the solution in Annex-A, i.e., PHY => MAC => RRC => PDCP/RLC.. |
| Huawei, HiSilicon | **Alt 2.2 with comments**  | Firstly, we wonder if Alt 2.1 (a note in section 5.8.1 of TS 38.331) is one candidate of Option 1 as the proposed change is to modify the cast type from unicast to broadcast… In this case this alternative should be deleted as the assumption to answer this question is option 2 is selected for Question 3-1…Then we tend to agree with Alt 2.2 with normative text to solve this but we don’t think the MAC layer should indicate the RRC layer to trigger the establishment of PDCP/RLC. We think when the MAC is able to deliver the packet to higher layer, upon reception of this SRB, the higher layer is able to request the establishment of the PDCP/RLC entity for reception. Therefore we propose the following change. For 38.321:3> if this TB is associated to groupcast or broadcast and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI; or3> if this TB is associated to unicast and this TB is the first TB of a logical channel which associated LCID is equals to 0 or 1 or 2, and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI:4> deliver the decoded MAC PDU to the disassembly and demultiplexing entity;For 38.331:The UE shall:1> if transmission and reception of PC5-S message for a specific destination is requested by upper layers for sidelink SRB:2> establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-S message, as specified in sub-clause 9.1.1.4;1> if a PC5-RRC connection establishment for a specific destination is indicated by upper layers:2> establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-RRC message of the specific destination, as specified in sub-clause 9.1.1.4;2> consider the PC5-RRC connection is established for the destination. |
| Apple | Alt 2.1 | If we do not want to involve SA2/CT1, then the simplest fix is Alt 2.1 in Annex.B |
| vivo | Alt 2.4 | Since UE implementation can be relied on, we prefer doing nothing. Adding NOTEs shouldn’t be regarded as an essential correction for Rel-16 at this stage, especially considering that there are too many SL specific NOTEs in the Spec. If companies can be OK to rely on UE implementation, perhaps a common understanding in Chairman Notes is sufficient. However, if really a majority of companies want to add further NOTEs in the Spec, clarifying the cases are tackled by UE implementation, we are fine to follow the majority of doing so.  |
| Qualcomm | Alt 2.2 with comments | Per our response to Q3-1, our view is the proposed change to the RRC spec is sufficient.  |
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# Conclusion

In conclusion, rapporteur proposes the following recommendations as the outcome of this email discussion.

# References

1. R2-2110610 PDCP/RLC Entity Maintenance for SL-SRBs CATT, APPLE, vivo, Huawei, HiSilicon, OPPO
2. R2-2111429 Summary [AT116-e][709][V2X/SL] PDCP/RLC Entity Maintenance for SL-SRBs (CATT)

# Annex A Text proposals

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| START OF TP |

**Start of TP for 38.321**

##### 5.22.2.2.2 Sidelink process

For each PSSCH duration where a transmission takes place for the Sidelink process, one TB and the associated HARQ information is received from the Sidelink HARQ Entity.

For each received TB and associated Sidelink transmission information, the Sidelink process shall:

1> if this is a new transmission:

2> attempt to decode the received data.

1> else if this is a retransmission:

2> if the data for this TB has not yet been successfully decoded:

3> instruct the physical layer to combine the received data with the data currently in the soft buffer for this TB and attempt to decode the combined data.

1> if the data which the MAC entity attempted to decode was successfully decoded for this TB; or

1> if the data for this TB was successfully decoded before:

2> if this is the first successful decoding of the data for this TB:

3> if this TB is associated to unicast, the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI, and the SRC field of the decoded MAC PDU subheader is equal to the 16 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 8 LSB are equal to the Source ID in the corresponding SCI; or

3> if this TB is associated to groupcast or broadcast and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI; or

3> if this TB is associated to unicast and this TB is the first TB of a logical channel which associated LCID is equals to 0 or 1 or 2, and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI:

4> deliver the decoded MAC PDU to the disassembly and demultiplexing entity;

3> if this TB is associated to unicast and this TB is the first TB of a logical channel which associated LCID is equals to 0 or 1 or 2, and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI:

4> indicate RRC layer to trigger the reception of PC5-S message for a specific Source layer-2 ID.

**End of TP for 38.321**

**Start of TP for 38.331**

##### 5.8.9.1a.4 Sidelink SRB addition

The UE shall:

1> if transmission of PC5-S message for a specific destination is requested by upper layers for sidelink SRB:

2> establish the transmitting PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-S message, as specified in sub-clause 9.1.1.4;

1> if reception of PC5-S message for a specific source is requested by lower layers for sidelink SRB:

2> establish the receiving PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-S message if needed, as specified in sub-clause 9.1.1.4;

1> if a PC5-RRC connection establishment for a specific destination is indicated by upper layers:

2> establish PDCP entity, RLC entity and the logical channel of a sidelink SRB for PC5-RRC message of the specific destination, as specified in sub-clause 9.1.1.4;

2> consider the PC5-RRC connection is established for the destination.

**End of TP for 38.331**

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| END OF TP |

# Annex B Text proposals

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| START OF TP |

**Start of TP for 38.331**

## 5.8 Sidelink

### 5.8.1 General

NR sidelink communication consists of unicast, groupcast and broadcast. For unicast, the PC5-RRC connection is a logical connection between a pair of a Source Layer-2 ID and a Destination Layer-2 ID in the AS. The PC5-RRC signalling, as specified in sub-clause 5.8.9, can be initiated after its corresponding PC5 unicast link establishment (TS 23.287 [55]). The PC5-RRC connection and the corresponding sidelink SRBs and sidelink DRB(s) are released when the PC5 unicast link is released as indicated by upper layers.

For each PC5-RRC connection of unicast, one sidelink SRB (i.e. SL-SRB0) is used to transmit the PC5-S message(s) before the PC5-S security has been established. One sidelink SRB (i.e. SL-SRB1) is used to transmit the PC5-S messages to establish the PC5-S security. One sidelink SRB (i.e. SL-SRB2) is used to transmit the PC5-S messages after the PC5-S security has been established, which is protected. One sidelink SRB (i.e. SL-SRB3) is used to transmit the PC5-RRC signalling, which is protected and only sent after the PC5-S security has been established.

For unicast of NR sidelink communication, AS security comprises of integrity protection of PC5 signalling (SL-SRB1, SL-SRB2 and SL-SRB3) and user data (SL-DRBs), and it further comprises of ciphering of PC5 signaling (SL-SRB1 only for the Direct Link Security Mode Complete message as specified in TS 24.587[57], SL-SRB2 and SL-SRB3) and user data (SL-DRBs). The ciphering and integrity protection algorithms and parameters for a PC5 unicast link are exchanged by PC5-S messages in the upper layers as specified in TS 33.536 [60], and apply to the corresponding PC5-RRC connection in the AS. Once AS security is activated for a PC5 unicast link in the upper layers as specified in TS 33.536 [60], all messages on SL-SRB2 and SL-SRB3 and/or user data on SL-DRBs of the corresponding PC5-RRC connection are integrity protected and/or ciphered by the PDCP.

For unicast of NR sidelink communication, if the change of the key is indicated by the upper layers as specified in TS 24.587 [57], UE re-establishes the PDCP entity of the SL-SRB1, SL-SRB2, SL-SRB3 and SL-DRBs on the corresponding PC5-RRC connection.

NOTE 1: In case the configurations for NR sidelink communication are acquired via the E-UTRA, the configurations for NR sidelink communication in *SIB12* and *sl-ConfigDedicatedNR* within *RRCReconfiguration* used in subclause 5.8 are provided by the configurations in *SystemInformationBlockType28* and *sl-ConfigDedicatedForNR* within *RRCConnectionReconfiguration* as specified in TS 36.331 [10], respectively.

NOTE 2: In this release, there is one-to-one correspondence between the PC5-RRC connection and the PC5 unicast link as specified in TS 38.300[2].

NOTE 3: All SL-DRBs related to the same PC5-RRC connection have the same activation/deactivation setting for ciphering and the same activation/deactivation setting for integrity protection as in TS 33.536 [60].

NOTE 4: When integrity check failure concerning SL-SRB1 for a specific destination is detected, the UE sends an indication to the upper layers [57].

NOTE X: Before PC5-RRC connection establishment for a specific destination is indicated by upper layers, for PC5-S message using unicast, modify the cast type from unicast to broadcast.

**End of TP for 38.331**

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| END OF TP |

**Annex C Text proposals**

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| START OF TP |

**Start of TP for 38.321**

**5.22.2.2.2 Sidelink process**

For each PSSCH duration where a transmission takes place for the Sidelink process, one TB and the associated HARQ information is received from the Sidelink HARQ Entity.

For each received TB and associated Sidelink transmission information, the Sidelink process shall:

1> if this is a new transmission:

2> attempt to decode the received data.

1> else if this is a retransmission:

2> if the data for this TB has not yet been successfully decoded:

3> instruct the physical layer to combine the received data with the data currently in the soft buffer for this TB and attempt to decode the combined data.

1> if the data which the MAC entity attempted to decode was successfully decoded for this TB; or

1> if the data for this TB was successfully decoded before:

2> if this is the first successful decoding of the data for this TB:

3> if this TB is associated to unicast, the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI, and the SRC field of the decoded MAC PDU subheader is equal to the 16 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 8 LSB are equal to the Source ID in the corresponding SCI; or

3> if this TB is associated to groupcast or broadcast and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Destination Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI; or

3> if this TB is associated to unicast and this TB is the first TB of a logical channel which associated LCID is equal to 0 or 1, and the DST field of the decoded MAC PDU subheader is equal to the 8 MSB of any of the Source Layer-2 ID(s) of the UE for which the 16 LSB are equal to the Destination ID in the corresponding SCI:

4> deliver the decoded MAC PDU to the disassembly and demultiplexing entity;

**End of TP for 38.321**

**Start of TP for 38.323**

5.1 PDCP entity handling

5.1.1 PDCP entity establishment

When upper layers request a PDCP entity establishment for a radio bearer for Uu or PC5 interface; or for NR sidelink communication for groupcast and broadcast, when receiving the first PDCP PDU, and there is not yet a corresponding PDCP entity, the UE shall:

- establish a PDCP entity for the radio bearer;

- set the state variables of the PDCP entity to initial values;

- follow the procedures in clause 5.2.

NOTE: The receiving PDCP entity for NR sidelink communication for SL-SRB0 and SL-SRB1 is established as NR sidelink communication for groupcast and broadcast.

**End of TP for 38.323**

**Start of TP for 38.322**

5.1 RLC entity handling

5.1.1 RLC entity establishment

When upper layers request an RLC entity establishment, the UE shall:

- establish a RLC entity;

- set the state variables of the RLC entity to initial values;

- follow the procedures in clause 5.2.

For NR sidelink groupcast and broadcast, when receiving the first UMD PDU from a Source Layer 2 ID and Destination Layer 2 ID pair for an LCID, and there is not yet a corresponding receiving RLC entity for a radio bearer, the UE shall:

- establish a receiving RLC entity;

- set the state variables of the RLC entity to initial values;

- follow the procedures in clause 5.2.

For NR sidelink unicast for SL-SRB0, when receiving the first UMD PDU from a Source Layer 2 ID and Destination Layer 2 ID pair for LCID=0 and there is not yet a corresponding receiving RLC entity for a radio bearer or for NR sidelink unicast for SL-SRB1, when receiving the first AMD PDU from a Source Layer 2 ID and Destination Layer 2 ID pair for LCID=1 and there is not yet a corresponding receiving RLC entity for a radio bearer, the UE shall:

- establish a receiving RLC entity;

- set the state variables of the RLC entity to initial values;

- follow the procedures in clause 5.2.

**End of TP for 38.322**

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| END OF TP |