3GPP TSG-RAN WG2 Meeting #110-e R2-‎2005962‎

Electronic, June 1 – June 12 2020‎

Source: CATT (rapporteur)

Title: Summary of [706][V2X] PDCP remaining issues (CATT)

Agenda Item: 6.4.3.2

Document for: Discussion and Decision

# Introduction

This document is to kick off the offline discussion #706 to discuss the PDCP remaining issues which include the issues and proposals in the V2X PDCP summary document [1]. The scope of this offline discussion in the chairman notes is as following.

* [AT110-e][706][V2X] PDCP issues (CATT)

Discuss and conclude PDCP issues in R2-2005724 (in R2-2005962).

Deadline is 6/8 10:00am (UTC).

# Discussion

## Issues on PDCP PDU format

### Issue 1: MAC-I for SL SRB

In SA3 TS 33.536 [2], it is mentioned the PC5 unicast link shall support activation or deactivation of security based on the security policy similar to Uu‎. The security policy indicates the following:‎

* ‎Signalling integrity protection: REQUIRED/PREFERRED/NOT NEEDED
* ‎Signalling confidentiality protection: REQUIRED/PREFERRED/NOT NEEDED
* ‎User plane integrity protection: REQUIRED/PREFERRED/NOT NEEDED
* ‎User plane confidentiality protection: REQUIRED/PREFERRED/NOT NEEDED

According to SA3 TS 33.536, except for SL SRB0, the integrity and confidentiality protection for SL SRBs can be activated or deactivated.

In current PDCP spec, the MAC-I field is always present for SL SRB1, SRB2 and SRB3. Thus, it’s necessary to discuss how to handle the MAC-I field when the integrity protection for SL SRBs is deactivated. There are two options as following:

* Option 1: To follow Uu SRBs, if integrity protection is not configured for SL SRB1, SRB2 and SRB3, the MAC-I field is still present but should be padded with padding bits set to 0.
* Option 2: To follow SL DRBs, the MAC-I field is present only when the DRB is configured with integrity protection.

Thus, rapporteur‎ encourage companies to provide the views on this issue, i.e., if integrity protection is not configured for SL SRB1, SRB2 and SRB3, whether the MAC-I field is still present or absent based on the above two options.

**Question 1: If integrity protection is not configured for SL SRB1, SRB2 and SRB3, ‎which following option does company prefer for MAC-I field?**

* **Option 1: To follow Uu SRBs, if integrity protection is not configured for SL SRB1, SRB2 and SRB3, the MAC-I field is still present but should be padded with padding bits set to 0.**
* **Option 2: To follow SL DRBs, the MAC-I field is present only when the DRB is configured with integrity protection.**

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| **Company** | **Preferred option(s)** | **Comments if any**  |
| Samsung | Option 2 | BTW, integrity protection is always applied to Uu SRBs except SRB0 so MAC-I field is always present. |
| Ericsson | Option 2 |  |
| OPPO | Option 2 |  |
| ZTE | Option 1 | Keep previous agreement for SL SRBs for MAC-I field and follow Uu SRBs handling. |
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### Issue 2: PDCP SN size in SL groupcast and ‎broadcast ‎

In [4], the issue of PDCP SN size in SL groupcast and ‎broadcast was discussed. There are several observations mentioned in [4] as following:

* Observation 1: All the given date rates under different NR V2X scenarios in TS 22.186 could be ‎satisfied when PDCP SN size is 12bits, and having PDCP SN size as 18 bit seems an over design. ‎
* Observation 2: The 6-bit RLC SN length was agreed for NR SL groupcast and broadcast in RAN2 ‎‎#107, based on the companies’ views that the NR SL groupcast and broadcast are not expected to ‎be with ultra-high data requirements. Thus PDCP SN with 18 bits does not match the RLC SN with ‎‎6 bits. ‎
* Observation 3: The motivation to use 18 bit PDCP SN size for the support of security related ‎mechanism (i.e. COUNTER operation) for NR SL groupcast and broadcast is invalid as well, as ‎SA3 concluded that no security mechanism is supported for NR SL groupcast and broadcast.‎

Thus, the previous agreement on a specified 18 bit PDCP SN size in SL groupcast and broadcast was proposed to be revised in [4] based on following options:

* ‎‎Option 1: Change PDCP SN size in SL groupcast and broadcast from 18bits to 12bits.‎
* ‎Option 2: Introduce a PDCP PDU format with 12 bit SN in SL groupcast and broadcast, and ‎use a bit in PDCP header to indicate whether the PDCP SN size is 18 bits or 12 bits.‎

Rapporteur‎ thinks we can first discuss whether 12 bit SN is necessary to be introduced for SL groupcast and broadcast based on the observations in [4]. If majority view is yes, we can further discuss the solutions. If majority view is no, we keep the current PDCP PDU formats for NR SL groupcast and broadcast.

**Question 2: Does company agree to introduce 12 bit SN for SL groupcast and broadcast?**

* **Yes;**
* **No, i.e., keep 18bits PDCP SN size for SL groupcast and broadcast as current PDCP spec.**

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| **Company** | **Preferred option(s)****(Yes/No)** | **Comments if any**  |
| Samsung | Yes |  |
| Ericsson | No with comment | We don’t see this as critical issue, so no strong need to revert our previous agreement. We are fine to follow majority view.  |
| OPPO | No | Agree with Ericsson |
| Huawei, HiSilicon | Yes | As elaborated in [4], we justify that the 18 bit PDCP SN length for Gcast and Bcast is an over-design, with the specific reason that the high data rate is not usually required for Gcast and Bcast, and more importantly cannot be really achieved with the restriction of 6-bit RLC SN length. More importantly, from a UE vendor point of view, 18-bit PDCP SN can lead to big complication of UE implementation, especially for the memory consumption needed for PDCP reordering during Bcast/Gcast reception.The problem comes from the “multi-point to point” nature of SL Gcast/Bcast, since a UE has to receive all UEs in proximity for their Gcast/Bcast services, and in typical cases of V2X, the number of the UEs in proximity can be several hundreds. For example, in urban area (e.g. Beijing, Shanghai, etc.) several hundreds of vehicles nearby may need to be received in the communication range of V2X (e.g. radius of about several hundred meters).We think to change 18 bit to 12 bit is just a minor spec change, which may need nearly no difficulty for CR implementation and no more time for further discussion. Especially in the case that there is UE vendor has strong concern on it, it seems necessary to agree on this change.  |
| ZTE | No | 18 bits PDCP SN is workable, no need to revert previous agreement. |
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**Question 3: If the answer of Q2 is yes, ‎which following option does company prefer to introduce the 12 bit SN for SL groupcast and broadcast?**

* **Option 1: Change PDCP SN size in SL groupcast and broadcast from 18bits to 12bits.‎**
* **‎Option 2: Introduce a PDCP PDU format with 12 bit SN in SL groupcast and broadcast, and ‎use a bit in PDCP header to indicate whether the PDCP SN size is 18 bits or 12 bits.‎**
* **Option 3: Others.**

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| **Company** | **Preferred option(s)** | **Comments if any**  |
| Samsung | Option 1 | We prefer to define one PDCP PDU format for SL groupcast and broadcast. |
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## Issues on security policy related aspects

### Issue 1: ‎Activation/deactivation of the security per SL unicast link

In SA3 TS 33.536 [2], the confidentiality and integrity protection is activated/deactivated per PC5 unicast link for both sidelink SRBs and DRBs‎. The activation/deactivation of signalling and user plane security policy procedures are defined in SA3 TS 33.536 using PC5-S signalings. During the online discussion on RRC during this meeting, it’s agreed as a working assumption that all security configurations on whether to enable/configure ciphering and integrity protection are exchanged in the upper layers via PC5-S signalling and then instructed to the AS, for SL-SRB carrying PC5 RRC signalling and for SL-DRBs.

Thus, how to capture activation/deactivation of the security for PC5 unicast link in AS layer is necessary to be discussed. There are two options.

* Option 1: Capture the activation/deactivation of the security for PC5 unicast link in 38.331;
* Option 2: Capture the activation/deactivation of the security for PC5 unicast link in 38.323.

For Option 1, upon RRC layer receives the security activation indication for a PC5 unicast link from V2X layer, the RRC layer should indicate the security activation to the PDCP layer for each SLRB which belongs to the PC5 unicast link. Then PDCP layer should apply the security function to all PDCP PDUs for SL-SRB and for SL-DRBs.

For Option 2, the V2X layer can directly indicate PDCP layer the security activation for a PC5 unicast link associated with the source and destination ID pair. Then the PDCP layer should apply the security function to all PDCP PDUs for SL-SRB and for SL-DRBs which belong to the source and destination ID pair.

Rapporteur‎ thinks we can firstly discuss which spec is preferred to capture the activation/deactivation of the security. Then we can further discuss the detail text which should be captured in the spec.

**Question 4: Which following option does company prefer to capture activation/deactivation of the security for PC5 unicast link in AS layer‎?**

* **Option 1: Capture the activation/deactivation of the security for PC5 unicast link in 38.331.**
* **Option 2: Capture the activation/deactivation of the security for PC5 unicast link in 38.323.**

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| **Company** | **Preferred option(s)** | **Comments if any**  |
| Samsung | Option 1 | According to TS 33.536, PC5-RRC message is used to configure AS security for DRB.“When establishing or re-configuring the user plane bearer, the initiating UEs shall ensure the configuration of confidentiality and integrity protection in the PC5-RRC message matches the agreed UP security policies for traffic that will be sent on the bearer. The confidentiality and/or integrity protection algorithms are same as those selected for protecting the signalling bearers if confidentiality and/or integrity protection are required for both signalling and user plane.”We think that the security activation/deactivation for SRB can be known to RRC by V2X layer. |
| Ericsson | Option 1 | To keep a clean function split between protocol layers, it should be the RRC entity which configures other protocol layers e.g. PDCP.  |
| OPPO | Option 2 | The activation/deactivation is done via V2X layer instead of RRC layer and both integrity and confidential protection is done in PDCP layer for both SRB and DRB. So the modelling is different from Uu by nature. We think capture security related aspects in PDCP layer is sufficient |
| ZTE | Option 1 | AS security for PC5 unicast link shall be captured in RRC specification. |
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**Question 5: If the answer of Q4 is Option 1, companies are invited to provide the detail text in RRC spec and maybe also involved PDCP spec for the security activation/deactivation.**

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| **Company** | **Provided the detail context in RRC (and maybe PDCP) spec** |
| Samsung | In RRC specification, under subclause 5.8.9.1 some texts similar to 5.3.1.2 AS security and 4.2.2 Signalling radio bearers can be specified. For example: 5.8.9.1.X AS SecurityAS security comprises of the integrity protection and ciphering of PC5 signaling (SL-SRB2, SL-SRB3) and user data (DRBs).Once AS security is activated by upper layers, all PC5-S messages on SL-SRB2 and PC5-RRC messages on SL-SRB3 are integrity protected and ciphered by PDCP.PC5-RRC handles the configuration of the AS security parameters which are same as those selected for the signaling bearers, if integrity protection and/or ciphering is activated by upper layers.For PDCP specification, in the section 5.8 Ciphering and deciphering:*The ciphering function is activated for SL SRBs and SL DRBs for a PC5 unicast link by upper layers TS 38.331. When security is activated, the ciphering function shall be applied to all PDCP PDUs in the SL SRBs and SL DRBs which belong to the PC5 unicast link.*For PDCP specification, in the section 5.9 Integrity protection and verification:*The integrity function is activated for SL SRBs and SL DRBs for a PC5 unicast link by upper layers TS 38.331. When security is activated, the integrity protection function shall be applied to all PDUs including and subsequent to the PDU in the SL SRBs and SL DRBs which belong to the PC5 unicast link.* |
| ZTE | In RRC specification, under subclause 5.3.1.2 some texts similar to AS security for Uu can be specified, for example:For unicast of NR sidelink communication, AS security comprises of the integrity protection and ciphering of PC5 RRC signalling (SL-SRBs) and user data (SL-DRBs). The ciphering and integrity protection algorithms and the key (KNPR-sess ID) for a PC5 unicast link are exchanged by PC5-S messages (i.e. Direct Security Mode Command and Direct Security Mode Complete) as specified in TS 33.536 [xx]. NOTE 2: All SL-DRBs related to the same PC5 unicast link have the same enable/disable setting for ciphering and the same enable/disable setting for integrity protection. |
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**Question 6: If the answer of Q4 is Option 2, does company agree to capture the following text in the PDCP spec for the security activation/deactivation?**

In the section 5.8 Ciphering and deciphering:

*For NR sidelink communication, the ciphering function is activated for SL SRBs and SL DRBs, separately, for a PC5 unicast link by upper layers TS 33.536 [14]. When the ciphering function is activated for SL SRBs or SL DRBs for a PC5 unicast link, the ciphering function shall be applied to all PDCP PDUs in the SL SRBs or SL DRBs which belong to the PC5 unicast link.*

In the section 5.9 Integrity protection and verification:

*For NR sidelink communication, the integrity protection function is activated for SL SRBs and SL DRBs, separately, for a PC5 unicast link by upper layers TS 33.536 [14]. When the integrity protection function is activated for SL SRBs or SL DRBs for a PC5 unicast link, the integrity protection function shall be applied to all PDUs including and subsequent to the PDU in the SL SRBs or SL DRBs which belong to the PC5 unicast link.*

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| **Company** | **Agree or updates the above text, if any**  |
| OPPO | The intention is correct. But both ciphering and integrity protection are not applied to all PDCP PDU. At the beginning of section 5.8 and 5.9 there is some limitation on which kind of PDCP PDU is applied and should be reflected here also e.g. both are not applied for PDCP control PDU. |
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### Issue 2: ‎‎PDCP re-establishment trigger

Whether the PDCP re-establishment trigger is captured in RRC or V2X layer has been discussed during the last meeting. ‎Over Uu interface, the trigger of PDCP re-establishment is captured in RRC spec. While over PC5 ‎interface, PDCP re-establishment is only triggered by re-keying procedure which is in V2X layer but not ‎RRC layer. In current SA3 and CT1 spec, there is no PDCP re-establishment trigger condition due to ‎re-keying operation. Thus, according to the companies contribution [3][7], Rapporteur suggests to send LS to SA3 and CT1 to capture the PDCP re-establishment trigger due to ‎re-keying operation in V2X layer.‎

**Question 7: Does company agree PDCP re-establishment trigger should be captured in V2X layer?**

* **Yes;**
* **No, please give how to capture the PDCP re-establishment trigger.**

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| **Company** | **Preferred option(s)****(Yes/No)** | **Comments if any**  |
| Samsung | No | As for AS security, re-keying can be informed to PC5-RRC by V2X layer. Then PDCP re-establishment can be triggered by PC5-RRC. |
| Ericsson | No | To keep a clean function split between protocol layers, it should be the RRC entity which configures other protocol layers e.g. PDCP. Thus, it should be V2X layer indicates PC5-RRC and PC5-RRC triggers PDCP re-establishment.  |
| OPPO | Yes | Although it looks like a matter of taste, we don’t understand why RRC layer should be broker here. And even RRC could be broker here, V2X layer still need trigger lower layer which is RRC i.e. nothing is saved in V2X layer. |
| ZTE | No | Agree with Samsung and Ericsson |
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**Question 8: If the answer of Q7 is yes, does company agree to send LS to SA3 and CT1 to ask them to capture the PDCP re-establishment trigger due to ‎re-keying operation in V2X layer‎?**

* **Yes;**
* **No.**

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| **Company** | **Preferred option(s)****(Yes/No)** | **Comments if any**  |
| OPPO | Yes |  |
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In SA3 reply LS [8], ‎ the re-keying procedure is per PC5 unicast link‎, which means PDCP re-establishment trigger is per PC5 unicast link‎. For the issue how to capture PDCP re-establishment trigger for PC5 unicast link in AS layer, which is similar as discussed in above issue 1 in Section 2.2, there are also following two options.

* Option 1: Capture the PDCP re-establishment trigger for PC5 unicast link in 38.331;
* Option 2: Capture the PDCP re-establishment trigger for PC5 unicast link in 38.323.

This issue has also been discussed during the email discussion#959. Some companies also prefer Option 2. Thus, the current PDCP running CR already capture a NOTE as follows to clarify the PDCP re-establishment trigger operation.

*Upper layers request reestablishment of transmitting or receiving PDCP entity for PC5 interface as specified in TS 33.536 [14] and TS 24.587‎ [xx].*

However, some companies still have some concerns on Option 2. Thus, Rapporteur‎ thinks we can firstly discuss which spec is preferred to capture the PDCP re-establishment trigger for PC5 unicast link. Then we can further discuss the detail text which should be captured in the spec.

**Question 9: Which following option does company prefer to capture the PDCP re-establishment trigger for PC5 unicast link in AS layer‎?**

* **Option 1: Capture the PDCP re-establishment trigger for PC5 unicast link in 38.331.**
* **Option 2: Capture the PDCP re-establishment trigger‎ for PC5 unicast link in 38.323.**

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| **Company** | **Preferred option(s)** | **Comments if any**  |
| Samsung | Option 1 | We prefer to the same modeling for issue 1 and issue 2 of 2.2. So PC5 RRC can trigger PDCP reestablishment. |
| Ericsson | Option 1 |  |
| OPPO | Option 2 |  |
| ZTE | Option 1 | Some related text specified in RRC specification may be better |
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**Question 10: If the answer of Q9 is Option 1, companies are invited to provide the detail text in RRC spec and maybe also involved PDCP spec for the PDCP re-establishment trigger.**

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| **Company** | **Provided the detail context in RRC (and maybe PDCP) spec** |
| Samsung | In RRC specification, under subclause 5.8.9.1 a new subclause AS security can be specified as an example:5.8.9.1.X AS SecurityThe UE shall reestablish PDCP for PC5 unicast link if re-keying is informed by upper layers as specified in TS 33.536 and TS 24.587.  |
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**Question 11: If the answer of Q9 is Option 2, does company agree to capture the following text in the PDCP spec for the PDCP re-establishment trigger?**

In the section ‎5.1.2‎ PDCP entity re-establishment:

*NOTE: Upper layers request reestablishment of transmitting or receiving PDCP entity for PC5 interface as specified in TS 33.536 [14] and TS 24.587‎ [xx].*

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| **Company** | **Agree or updates the above text, if any**  |
| OPPO | Yes except for the wording “or” between transmitting and receiving PDCP entity. We think re-establishment of TX and RX PDCP entity should be done at same time hence it should be replaced by “and” |
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## Issue on PDCP status report

In the last RAN2 meeting, it’s agreed that status report for SL AM DRB is supported for SL unicast. In Uu, for AM DRBs, whether to send a PDCP status report in the uplink‎ is configured per DRB by network. Thus, the PDCP status report is optional supported in Uu interface. We suggest RAN2 to discuss whether the PDCP status report is also optional supported in PC5 interface and if yes, how to configure the status report for SL DRB.

To follow the Uu princple is preferred in [3], i.e., the PDCP status report is also optional supported per SL DRB in PC5 interface. It’s proposed whether the status report is required can be configured by NW or pre-configured to Tx UE, then the Tx UE configures whether the status report is required to Rx UE.

However, always triggering PDCP status report is preferred in [9] and selective retransmission will have better performance. Thus, it’s proposed for SL AM DRBs, a PDCP status report can be triggered without *statusReportRequired* ‎configuration.‎

Rapporteur suggests to discuss whether the PDCP status report is triggered by *statusReportRequired* configuration.

**Question 12: Does company agree the PDCP status report is triggered by *statusReportRequired* ‎configuration?**

* **Yes;**
* **No, i.e., PDCP status report is always enabled for SL AM DRBs.**

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| **Company** | **Preferred option(s)****(Yes/No)** | **Comments if any**  |
| Samsung | No | Unlike Uu, the PDCP status report can be always triggered upon PDCP re-establishment.  |
| Ericsson | No with comment | It seems a cleaner solution to trigger PDCP status report once re-establishing PDCP. On the other hand, it depends on whether UE is always capable of selective retransmission.  |
| OPPO | Yes | Not sure why do we deviate from principle over Uu |
| ZTE | No | It is straightforward that PDCP SR is triggered when re-establishing PDCP, otherwise UE may be required for some other capability. |
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**Question 13: If the answer of Q12 is yes, does company agree the following procedure for PDCP status report triggerring by *statusReportRequired* ‎configuration?**

* **For CONNECTED UE, whether the status report is required can be configured per SL DRB by RRC dedicated signaling to the Tx UE, then the Tx ‎UE configures whether the status report is required per SL DRB to the Rx UE using PC5 RRC signaling.‎**
* **For IDLE/INACTIVE or OOC UE, whether the status report is required can be configured per SL DRB by SIB or pre-configuration to the Tx UE, then the Tx ‎UE configures whether the status report is required per SL DRB to the Rx UE using PC5 RRC signaling.‎**

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| **Company** | **Preferred option(s)****(Agree or not)** | **Comments if any**  |
| OPPO | Yes |  |
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## Discard timer

The issue on discard timer was discussed in [9]. In current 38.331, there are separate IEs, *discardTimer*/*discardTimerExt* and *sl-DiscardTimer* to be ‎configured for Uu DRB and SL DRB, respectively. So it’s proposed to add some clarifications in subclause 7.3 in 38.323. ‎There are two following options are proposed to address this issue in [9].

* Option 1: the proposed text in subclause 7.3 in TS 38.323 is as follows.‎

*a) discardTimer*

This timer is configured only for DRBs. The duration of the timer is configured by upper layers TS 38.331[3] with *discardTimer/discardTimerExt* for Uu interface and *sl-DiscardTimer* for PC5 interface. In the transmitter, a new timer is started upon reception of an SDU from upper layer.

* Option 2: to modify the description *sl-DiscardTimer* in 6.3.5 in TS 38.331 as follows.‎

*sl-DiscardTimer*

Value in ms of *~~sl-~~discardTimer* specified in TS 38.323 [5]. Value ms50 corresponds to 50 ms, value ms100 corresponds to 100 ms and so on.

Rapporteur thinks this issue is valid and can be further discussed.

**Question 14: Does company agree the above issue on discard timer is valid?**

* **Yes;**
* **No, i.e., keep the current RRC and PDCP specs as they are.**

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| **Company** | **Preferred option(s)****(Yes/No)** | **Comments if any**  |
| Samsung | Yes | The IE should be aligned in both specifications. At least there is no *sl-discardTimer* in 38.323. |
| Ericsson | Yes |  |
| OPPO | Yes |  |
| ZTE | Yes |  |
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**Question 15: If the answer of Q14 is yes, which following option does company prefer to address the above issue on discard timer‎?**

* **Option 1: add some clarifications in subclause 7.3 of TS 38.323.**

*a) discardTimer*

This timer is configured only for DRBs. The duration of the timer is configured by upper layers TS 38.331[3] with *discardTimer/discardTimerExt* for Uu interface and *sl-DiscardTimer* for PC5 interface. In the transmitter, a new timer is started upon reception of an SDU from upper layer.

* **Option 2: to modify the description *sl-DiscardTimer* in subclause 6.3.5 of TS 38.331.**

*sl-DiscardTimer*

Value in ms of *~~sl-~~discardTimer* specified in TS 38.323 [5]. Value ms50 corresponds to 50 ms, value ms100 corresponds to 100 ms and so on.

* **Option 3: Others.**

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| **Company** | **Preferred option(s)** | **Comments if any**  |
| Samsung | Option 2 | This change may be simpler. |
| Ericsson | Option 1 |  |
| OPPO | Option 1 |  |
| ZTE | Option 2 | Both are OK, option 2 may be more clearer. |
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## Other Issues

Regarding to other issues mentioned in [1], e.g., order of PDCP SN and Key ID and Key ID size, are already covered in PDCP running CR [6]. Here, companies are invited to provide other technical remaining issues related V2X PDCP, if any.

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| **Company** | **Issues** | **Comments if any**  |
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# Conclusion

This contribution summarizes the offline discussion for open issues on V2X PDCP.

Based on companies’ input, the proposals achieved by this offline discussion are shown as follows.

# Reference

1. R2-2005724‎, Summary of PDCP remaining issues on NR V2X, CATT
2. S3-201338 TS 33.536 v1.2.0, Security aspects of 3GPP support for advanced Vehicle-to-Everything (V2X) services
3. R2-2004747, Remaining Issues on PDCP, CATT
4. R2-2005464, Discussion on PDCP SN size for SL groupcast and broadcast in NR V2X Huawei, MediaTek Inc.,HiSilicon
5. R2-2005343, Remaining issues for NR SL PDCP header format, Qualcomm Finland RFFE Oy
6. R2-2004888, 38.323 CR for NR V2X, CATT, CR, 0048
7. R2-2004881, Draft LS on trigger of PDCP reestablishment, OPPO
8. R2-2005727‎, LS reply to RAN WG2 LS on the security related issues for NR SL, SA3, S3-201483
9. R2-2005548, Clarification of SL PDCP Operation, Samsung Electronics Co., Ltd
10. R2-2005045, Discussion on counter check procedure for NR sidelink, Spreadtrum Communications
11. R2-2005055, Remaining issues in PDCP for NR sidelink Nokia, Nokia Shanghai Bell
12. R2-2004577‎ , Discussion on remaining issue related to RRC in NR V2X, ZTE Corporation, Sanechips