**3GPP TSG-RAN WG2 #113-e *R2-20XXXXX***

**E-meeting, January 2020**

Agenda Item:

Source: LG (rapporteur)

Title: Draft summary of email discussion [702][SLe] High-level principles for SL DRX (LG)

Document for: Discussion, Decision

# Introduction

This is to kick off the following email discussion:

* [POST112-e][702][SLe] High-level principles for SL DRX (LG)

Discuss and attempt to decide high-level principles that were not concluded in the issues listed by session chair (see 8.15.2 sub-AI). Note the email discussion scopes are limited to the above high-level principles and the detailed solutions are not in the scope of this email discussion. Deadline is long email discussion until next RAN2 e-meeting.

# SL DRX configuration

## UE common DRX configuration

At the RAN2 #112-e meeting [1], there was a discussion about the necessity of a Common SL DRX configuration that can be used by multiple UEs in common, but no consensus was reached. In the discussion paper [2, 3, 4, 5, 6, and 7] and online discussion submitted at #112-e meeting, the necessity of UE common SL DRX configuration that UE can use in common regardless of cast type was pointed out. There was also an opinion that UE common SL DRX configuration may be an SL DRX configuration that can be used in common between UEs using the same SL service.

**Question 2.1-1: do you agree to support UE common SL DRX Configuration in SL DRX?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | No | According to the above description, UE common SL DRX means a common SL DRX configuration that can be used by multiple UEs in common.  In our understanding, this solutions is not feasible due to the following reasons:   1. Different UEs may have different PC5 communication peer UE(s) and different service types, if all UEs use the same SL DRX configuration, it may be less power efficiency; 2. If Uu similar DRX timers are also applied in sidelink, even if the sidelink DRX configurations amongst multiple UEs are same, the actually active time of each UE may also be different. In fact, it is still not common DRX. |
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If UE common SL DRX configuration is supported, this UE common DRX configuration should be determined whether it is a DRX configuration that can be used in common by any UEs, a DRX configuration that can be used in common by UEs classified by cast type, or an SL DRX configuration that can be used in common by UEs classified by service type.

Option 1) UE common SL DRX configuration can be configured with pre-configuration for any UEs regardless of cast types or service types

Option 2) UE common SL DRX configuration can be configured per cast type

Option 3) UE common SL DRX configuration can be configured per service type (e.g., QoS)

**Question 2.1-2: if the answer to question 2.1-1 is yes, which option do you prefer for configuring the UE common SL DRX configuration?**

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| --- | --- | --- |
| Company | Options | Comments |
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## UE specific SL DRX configuration

Among the SL DRX issue lists of RAN2 chairman note [1], discussion paper [2, 5, 6, and 8] pointed out that UE specific SL DRX should be supported in sidelink DRX operation. And there was an opinion that the SL DRX configuration considering the characteristics of sidelink service (e.g., PQI) should be considered. In this email discussion, RAN2 can discuss whether the UE specific DRX configuration is supported or not.

**Question 2.2-1: do you agree to support UE specific DRX Configuration in SL DRX?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes | See the comments as Question2.1-1, we think that the UE specific SL DRX is more suitable compared with the UE common SL DRX amongst multiple UEs. |
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In the discussion paper [2 and 8] submitted at meeting #112-e, it was pointed out that SL DRX configuration can be set per PC5 unicast connection (i.e., a pair of source ID / destination ID) or per source TX UE in SL unicast communication. In other words, if UE specific SL DRX configuration can be used in sidelink unicast communication, this SL DRX configuration can be configured per source and destination pair and the SL DRX configuration can be set taking into account QoS requirement (e.g.,PDB) of SL unicast service.

The discussion paper [3 and 6] suggested that SL DRX configuration per PQI can be set up in SL communication, which maps to sidelink QoS class. In other words, UE specific SL DRX configuration can be set per PQI representing sidelink QoS class.

Option 1) UE specific SL DRX configuration can be configured per a pair of source/destination

Option 2) UE specific SL DRX configuration can be configured per cast type (unicast or groupcast or broadcast)

Option 3) UE specific SL DRX configuration can be configured per QoS Class (e.g., PQI)

Option 4) UE specific SL DRX configuration can be configured per QoS characteristic (e.g., PDB)

**Question 2.2-2: if the answer to Question 2.2-1 is yes, which option do you prefer for configuring the UE specific SL DRX configuration.**

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| --- | --- | --- |
| Company | Options | Comments |
| CATT | Option 1) for sidelink unicast;  Option 3) for sidelink broadcast/groupcast. | At least for sidelink unicast, we think the SL DRX configurations should be based on each PC5 connection;  For sidelink broadcast/groupcast, we have no strong view since there is no interactivity between the Tx UE and Rx UE on the SL DRX configuration in AS layer. Default SL DRX configuration or SL DRX configuration per PQI are both feasible. |
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## SL DRX configuration/parameters

For DRX operation, the On/off duration must be divided within the DRX Cycle, and the UE must be able to perform active mode operation in on-duration and sleep mode operation in the outer section of on-duration (e.g., off-duration). Therefore, for SL DRX operation, the following parameters need to be provided by default.

* *sl-drx-SlotOffset*: the delay before starting the *sl-drx-onDurationTimer*
* *sl-drx-onDurationTimer*: the duration at the beginning of an SL DRX cycle
* *sl-drx-StartOffset:* the subframe where the SL DRX cycle starts
* *sl-drx-Cycle: the SL DRX cycle*

**Question 2.3-1: do you agree that at least SL DRX configuration includes sl-drx-SlotOffset, sl-drx-onDurationTimer, sl-drx-StartOffset, and sl-drx-Cycle?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes for *sl-drx-SlotOffset and sl-drx-onDurationTimer;*  See comment for *sl-drx-StartOffset* and *sl-drx-Cycle.* | In general, we agree with the above parameters.  But for *sl-drx-StartOffset* and *sl-drx-Cycle*, it should wait for the conclusion whether there are both long and short DRX cycles. If both long and short DRX cycles are supported, these parameters should be re-defined. |
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## Long DRX cycle and Short DRX cycle

At #112-e meeting, RAN2 agreed to support the long DRX cycle in SL unicast as follows.

RAN2 agreement on long DRX cycle:

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| Support of long DRX cycle for SL unicast should be assumed as a baseline. FFS on the need of short DRX cycle. |

Further discussion is needed as to whether SL unicast supports the short DRX cycle as well as the long DRX cycle. Since SL unicast service can have different QoS requirements, RAN2 needs to discuss whether it is necessary to support not only the long DRX cycle but also the short DRX cycle to satisfy various QoS requirements in SL unicast communication.

**Question 2.4-1: do you agree to support the short DRX cycle in SL unicast?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes | Long DRX is benefit for power saving, but it will introduce latency. For sidelink unicast, in order to improve the latency, it had better also support short DRX cycle. |
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**Question 2.4-2: do you agree to support the long DRX cycle for SL broadcast/groupcast like unicast?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | See comment. | Long and short DRX cycles are relative definition. For SL broadcast/groupcast, it should first discuss whether multiple DRX cycles are necessary and whether DRX cycle switching is necessary? |
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**Question 2.4-3: if the answer to Question 2.4-2 is yes, do you agree to support the short DRX cycle in SL broadcast/groupcast?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | See comment. | Same comments as Question 2.4-2. |
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## Who will decide SL DRX configuration/parameters

At the #112-e meeting, there was a discussion [9] about who decides SL DRX configuration, and no consensus was reached. Among the options discussed, the first option is for gNB to determine the SL DRX configuration and notify the UEs within the gNB's coverage of the SL DRX configuration and then, the UEs perform the SL DRX operation using the SL DRX configuration received from the gNB. The SL DRX configuration received from the gNB can be transferred to peer other UEs.The second option is for the UE performing SL TX to determine the SL DRX configuration and transmitting the determined SL DRX configuration to the UE performing SL RX. The third option is for the UE performing SL RX to determine the SL DRX configuration and transfer the determined SL DRX configuration to the UE performing SL TX. The last option is that UEs perform SL DRX operation by applying pre-configuration for SL DRX operation.

Option 1) gNB

Option 2) UE performing the SL TX

Option 3) UE performing the SL RX

Option 4) Use pre-configuration SL DRX parameters

**Question 2.5-1: which options do you prefer regarding who sets up and determines the SL DRX configuration?**

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| --- | --- | --- |
| Company | Options | Comments |
| CATT | Option 1) for IC Tx UE in RRC\_CONNECTED state;  Option 2) for other cases. | Tx UE centric SL DRX configuration is preferred (Option 1 and Option 2).   * If the Tx UE is in RRC\_CONNECTED, in order to align the Uu and SL DRX configurations, the gNB can determine the SL DRX configuration for Tx UE; * If the Tx UE is IC but in RRC\_IDLE or inactive, since there is no interactivity between UE and gNB, gNB can’t aware the SL service requirement in UE, hence it had better let Tx UE determine the SL DRX configuration by itself; * If the Tx UE is OOC, there is no need to align the SL DRX configuration between Uu and SL, hence Tx UE can determine the SL DRX configuration. |
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How the SL DRX configuration is signaled to UEs should be discussed further.

For example,

Option 1) Dedicated RRC signaling for RRC Connected

Option 2) SIB for RRC Idle/Inactive

Option 3) Pre-configuration signaling for OOC

Option 4) provided by the upper layer (e.g., the upper layer is V2X layer)

Option 5) PC5 RRC signaling

**Question 2.5-2: which option do you prefer regarding signaling the SL DRX configuration to the UEs?**

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| --- | --- | --- |
| Company | Options | Comments |
| CATT | Option 1) for RRC Connected UE. | We wonder about the relationship of this question with question 2.5-1? |
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# Coordination between Uu DRX and SL DRX

Discussion paper [2, 3, 9, and 10] pointed out the issue of coordination between Uu DRX and SL DRX. In order to maximize power saving gain of UE, DRX parameters need to be set so that the on-duration of Uu DRX and SL DRX overlap as much as possible, and for this, SL DRX information (e.g., preferred SL DRX patterns/QoS information of UE) exchange between the UE and gNB is required. And an entity that coordinates Uu DRX and SL DRX can be gNB or UE. In other words, gNB can inform the UE of the Uu DRX configuration determined by coordinating the Uu DRX and the SL DRX, or the UE can determine the SL DRX configuration by directly adjusting the SL DRX configuration based on the Uu DRX configuration received from the gNB.

Option 1) gNB should adjust Uu DRX configuration by aiming to align Uu DRX wake-up time with SL DRX wake-up time.

Option 2) UE should adjust SL DRX configuration by aiming to align SL DRX wake-up time with Uu DRX wake-up time.

**Question 3-1 which option do you prefer with respect to who adjusts the Uu DRX configuration or SL DRX configuration for the purpose of aligning the Uu DRX wake-up time and SL DRX wake-up time?**

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| --- | --- | --- |
| Company | Options | Comments |
| CATT | See comments. | For RRC\_CONNECTED UE, gNB should be responsible for aligning the SL and Uu DRX, which option is adopted depends on gNB implementation. |
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# SL Active Time

## UE behaviours in the SL active time?

At the RAN2 #112-e meeting, the following agreement was reached regarding the SL Active Time.

RAN2 agreement on SL Active time

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| --- |
| If a UE is in SL active time, UE should monitor PSCCH. FFS on PSSCH. FFS for sensing impacts. |

In other words, UE should monitor at least PSSCH at the SL active time. Also, at the #112-e meeting, the following agreement was reached as a work assumption of SL DRX operation. According to the working assumptions below, RAN2 assumes that the UE should perform SL data reception at SL active time.

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| --- |
| Working assumption: SL DRX should take PSCCH monitoring also for sensing (in addition to data reception) into account if SL DRX is used. |

**Question 4.1-1 do you agree that UE should perform SL data reception in SL active time?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
|  |  |  |

**Question 4.1-2 is there any need to receive other channel/signal at active time except PSCCH and PSSCH?**

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| --- | --- |
| Company | Comments |
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# SL DRX Timer

At the RAN2 #112-e meeting, the following agreement was reached regarding the SL DRX timer.

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| As baseline, for Sidelink DRX for SL unicast, it is proposed to inherit and use timers similar to what are used in Uu DRX. FFS for SL broadcast/groupcast. FFS on detailed timers. |

As further discussion regarding the SL DRX timer, it is necessary to discuss and determine which DRX timer can be used in SL unicast, and also discuss whether Uu DRX timer can be inherited and used in SL broadcast/groupcast.

## SL DRX timer in SL unicast

In SL unicast, like Uu DRX, SL DRX On-duration timer is basically required for active mode operation. Besides, to continuously monitor SL unicast traffic, it is necessary to support SL DRX Inactivity timer to extend the SL DRX On-duration timer. Moreover, to support the SL DRX operation related to HARQ operation in SL unicast, SL DRX HARQ RTT timer and SL DRX Retransmission timer also needs to be supported.

**Question 5.1-1 do you agree to support the On-duration timer, Inactivity timer, HARQ RTT timer, and Retransmission timer in SL DRX for SL Unicast?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes for On-duration timer, Inactivity timer;  Yes for HARQ RTT timer and Retransmission timer if HARQ feedback is enabled;  FFS for HARQ RTT timer and Retransmission timer if HARQ feedback is disabled. | For sidelink, the difference compared with Uu is that the sidelink HARQ feedback can be disabled. In case of sidelink HARQ feedback is disabled, whether the HARQ RTT timer should be started and how to maintain the retransmission timer should be further discussed. |
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In Uu DRX, the values ​​of DRX On-duration timer and DRX Inactivity timer are set as separate values ​​for each DRX group. In Sidlink DRX, as in Uu DRX, the On-duration timer and Inactivity timer values ​​can be set independently for each SL unicast service. In other words, QoS requirements of SL unicast service can be reflected in SL DRX operation.

**Question 5.1-2 if the answer to question 5.1-1 is yes, do you agree that values ​​of SL DRX on-duration timer and SL DRX inactivity timer are set to independent values ​​for each PC5 unicast link?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
|  |  |  |

In Uu DRX, the values ​​of the DRX HARQ RTT timer and DRX Retransmission timer are set to the common value regardless of the DRX group. In Sidlink DRX, as in Uu DRX, the values ​​of DRX HARQ RTT timer and DRX Retransmission timer in SL unicast service can be set to common values ​​regardless of specific PC5 Unicast connection.

**Question 5.1-3 if the answer to question 5.1-1 is yes, do you agree that values ​​of SL DRX HARQ RTT timer and SL DRX Retransmission timer are set to a common value regardless of specific PC5 unicast link?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
|  |  |  |

## SL DRX timer in SL groupcast

SL groupcast communication supports HARQ operation as in SL unicast, so HARQ RTT timer and Retransmission timer can be used in SL groupcast as in SL unicast.

**Question 5.2-1 if you agree to support SL DRX timer in groupcast, do you agree to support the On-duration timer, Inactivity timer, HARQ RTT timer, and Retransmission timer in SL DRX for SL groupcast?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes for On-duration timer;  FFS for Inactivity timer, HARQ RTT timer and Retransmission timer. | Regarding to inactivity timer, for sidelink groupcast, some Rx UE may not be able to receive the SCI, it will not start the inactivity timer. The Tx and Rx UE may have different understanding on the active time. RAN2 should further discuss whether it is necessary to maintain the inactivity timer for SL groupcast.  For HARQ RTT timer/retransmission, the same misunderstanding issue described for inactivity timer also exists. In addition, HARQ enable/disable impact should also be considered. |
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**Question 5.2-2 5.2-1 if the answer to question 5.2-1 is yes, do you agree that SL DRX On-duration timer and SL DRX Inactivity timer values ​​are set to independent values ​​for each SL groupcast service in SL DRX operation?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
|  |  |  |

**Question 5.2-3 if the answer to question 5.2-1 is yes, do you agree that values ​​of the SL DRX HARQ RTT timer and SL DRX Retransmission timer are set to a common value regardless of SL groupcast services?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
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## SL DRX timer in SL broadcast

Since HARQ operation is not supported in SL broadcast communication, HARQ RTT timer and Retransmission timer are not required. In other words, for SL DRX operation for SL broadcast communication, only an On-duration timer and Inactivity timer are needed if necessary.

**Question 5.3-1 if you agree to support SL DRX timer in broadcast, do you agree to support the On-duration timer and Inactivity timer in SL DRX for SL broadcast?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes for On-duration timer;  FFS for Inactivity timer. | For sidelink broadcast, some Rx UE may not be able to receive the SCI, it will not start the inactivity timer. The Tx and Rx UE may have different understanding on the active time. RAN2 should further discuss whether it is necessary to maintain the inactivity timer for SL broadcast. |
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**Question 5.3-2 if the answer to question 5.3-1 is yes, do you agree that the values ​​of SL DRX On-duration timer and SL DRX Inactivity timer are set to independent values ​​for each SL broadcast service?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
|  |  |  |

# SL DRX Command MAC CE

At the RAN2 #112-e meeting, a contribution [11] pointing out the necessity of the SL DRX command MAC was submitted and included in issue lists of the chairman note, but no discussion took place. Therefore, it is necessary to discuss the necessity of SL DRX command MAC CE in SL DRX operation through this email discussion.

For Uu, the gNB can send a DRX Command MAC CE or a Long DRX Command MAC CE to the UE at any time and the UE is expected to immediately stop the On-Duration Timer and the Inactivity timer and go into DRX sleep. For sidelink, a similar MAC CE might need to be defined to allow the peer UE the opportunity to potentially stop monitoring PSCCH and go into DRX sleep as well.

**Question 6-1 do you agree to support SL DRX Command MAC CE in SL DRX operation?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes | It should be supported at least for sidelink unicast. |
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# Uu DRX to monitor PDCCH for SL operation

Among the issues that have not been discussed in the SL DRX issue list of RAN2 #112-e, there is a Uu DRX impact for SL operation.

In discussion paper [2 and 12] indicated the following issues about Uu DRX impact for SL operation:

According to clause 5.7 of TS 38.321, the MAC entity may be configured by RRC with a DRX functionality that controls the UE's PDCCH monitoring activity for the MAC entity's C-RNTI, CS-RNTI, INT-RNTI, SFI-RNTI, SP-CSI-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, and TPC-SRS-RNTI. When using DRX operation, the MAC entity shall also monitor PDCCH according to requirements found in 38.321. When in RRC\_CONNECTED, if DRX is configured, for all the activated Serving Cells, the MAC entity may monitor the PDCCH discontinuously using the DRX operation.

For NR SL mode 1 and LTE SL mode 3, while served by NG-RAN, UE should monitor the PDCCH for the MAC entity's SL-RNTI and SLCS-RNTI. However, it has been not specified whether UE monitors the PDCCH for SL-RNTI and SLCS-RNTI, if DRX is configured. It seems clear that UE shall monitor the PDCCH for the MAC entity's SL-RNTI, SLCS-RNTI, and SL Semi-Persistent Scheduling V-RNTI, if DRX is configured.

**Question 7-1 do you agree that UE should monitor the PDCCH for the MAC entity's SL-RNTI, SLCS-RNTI, and SL Semi-Persistent Scheduling V-RNTI, if DRX is configured?**

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| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes | In Rel-16, it was agreed that UE does not expect DRX configuration if SL mode1 is configured.  In Rel-17, Uu DRX and SL DRX cofigurations had better be aligned. But even if the Uu DRX and SL DRX configurations are aliged, the extended active time beyond the on duration period due to inactivity timer and retransmission timer may also different. In the un-aligned active time period, we think UE still need to monitor the SL-RNTI, SLCS-RNTI and so on.  As a summary, SL related RNTI monitoring should not be restricted by Uu active time. |
|  |  |  |

# Conclusion

# Reference

[1] R2-2010708 Report from session on LTE V2X and NR V2X Samsung

[2] R2-2008943 Discussion on Sidelink LG Electronics

[3] R2-2009696 Discontinuous reception and transmission in SL Lenovo, Motorola Mobility

[4] R2-2008988 Alignment of DRX wake up times Intel Corporation

[5] R2-2009231 DRX for sidelink communications Ericsson

[6] R2-2009527 Discussion on Sidelink DRX Apple

[7] R2-2010140 Sidelink DRX Considerations Convida Wireless

[8] R2-2009289 Considerations for SL DRX Samsung Research America

[9] R2-2009413 Consideration on the sidelink DRX for unicast, groupcast and broadcast Huawei, HiSilicon

[10] R2-2008772 Discussion on DRX for sidelink OPPO

[11] R2-2008978 On general sidelink DRX design Intel Corporation

[12] R2-2009211 Discussion on Uu DRX for SL UE InterDigital