**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. |
| Lenovo, MotM | Yes | The meaning of “common” needs to be clarified. We understand “common” “or default” as something known to the potential peer UEs even before starting first communication. The “common” basis allows a potential transmitter to determine when an intended recipient is receiving. In absence of such a common basis, the transmitter may need to keep transmitting for a long time, like for an entire SFN cycle, to reach the receiver. |
| OPPO | Further clarification is needed. | We do not agree with that the “common SL DRX” can be used “regardless of cast type”:   * For unicast, common SL DRX configuration is not applicable, while a per-UE (before link establishment\_) or link-specific or more accurately, direction-specific DRX configuration (after link establishment) is preferred; * For broadcast/groupcast, we are open to the common DRX configuration; |
| Xiaomi | Yes if DRX configuration is provided by SIB | This is related to the configuration method.  If the SL DRX configuration is provided by preconfiguration or dedicate signalling, i.e. Reconiguration message via Uu or PC5. There is no need to introduce this common configuration. The UE specific DRX could be configured in a way as commonly used by multiple UEs.  If the SL DRX configuration could be provided by SIB, it can be common. But the benefit of SIB control is not clear and need further discussion. |
| ASUSTeK | Yes | There are two meanings on the term ‘common’:   1. In addition to other (UE, service, cast type, etc.) specific DRX configurations, a default (or pre-defined) common DRX configuration is beneficial for basic power saving. 2. A common DRX configuration used for a specific service/cast type among all relevant UEs is also beneficial. |
| HW | See comments | For broadcast/groupcast, we think UE common SL DRX configuration is feasible, e.g., dedicated resource pool configuration for SL broadcast/groupcast DRX operation. But some clarification on “common” is needed. Based on our understanding, “common” does not mean there is only one DRX configuration but it is more like a connection-less DRX configuration.  For unicast, if the SL DRX configuration is configured by the TX UE/TX UE’s connected gNB, due to “M-to-1” nature, the RX UE may perform sidelink communication with more than one TX UEs simultaneously. In this case, UE common SL DRX configuration means all the connected TX UEs need to configure the same SL DRX configuration to the RX UE which requires signalling coordination among different TX UEs, introducing additional signalling overhead and may be not feasible.  If the SL DRX configuration is configured by the RX UE, then there may be only one DRX configuration applied commonly to all the connected TX UEs or multiple DRX configurations (i.e. different DRX configurations for different TX UEs). If there is only one DRX configuration, it seems to be a per UE level DRX configuration, but the actual configuration signalling is carried via PC5-RRC signalling which is indeed per connection level.  Therefore we think for unicast, the SL DRX configuration should be configured per unicast connection (per Source and Destination pair) as the DRX configuration requirements are various among different unicast links due to different cast types/service types being carried on different unicast links. |
| Apple | Yes | There needs to be a default common DRX configuration for UEs which are not engaged with any SL cast types traffic. This is the rendezvous point for bootstrap SL communication of any cast type with a power-saving UE. Such a common DRX configuration ensures the SL UE can still have power-saving while being reachable by other UEs as well. If we do not design this, then a SL UE has to be ACITVE all the time to monitor PSCCH, and the objective of SL-DRX will not be achieved.  For CATT’s concern that the usage of inactivityTimer will cause UE to be in different ON/OFF state depends on which traffic the UE receives in ON duraiton, we think the common DRX configuration does not ensure all UEs will always in sync in the same ON/OFF periods, but just ensure there is a common “minimum” ON period which can be used as a starting point among UEs.  For the broadcast and groupcast, UEs may be configured with additional common DRX configurations which are customized for the broadcast/groupcast service.  For unicast, even when a SL UE is PC5-conneted with one or more peer UE, it still has to remain reachable to other potential peer UEs, so it still has to follow common DRX configuration, as well as the link-specific DRX configurations with existing peer(s). |
| InterDigital | See further clarification. | We do not agree that common configuration can be used regardless of cast type. We think the notion of a “common” configuration is necessary only for broadcast/groupcast, where multiple (more than two) UEs are involved in SL communications and cannot coordinate the times in which the peer UEs are reachable. In such case, a set of resources (e.g. defined by a resource pool) can be configured for multiple related UEs.  “Common” configuration should not be limited to a single configuration but allow using multiple configurations. The minimum resources to be monitored by an RX UE can depend on QoS/service type, and so defining a single configuration would lead to inefficiency in power savings. |
| vivo | Not need for unicast  Yes for groupcast and broadcast | For unicast communication, similar to Uu, SL DRX should not be based on service level but based on connection/link level, which means the minimum granularity of SL DRX configuration can be per pair of source & destination L2 IDs.  For groupcast and broadcast communication, there is no PC5 connection/link concept as unicast. From this perspective, it is ok to further discuss the support of “common” SL DRX configuration. |

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, service type(e.g., PSID/ITS-AID) or QoS class (e.g., PQI)

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., PSID/ITS-AID)

Option 4) UE common SL DRX configuration can be configured per PQI or per set of PQIs

Option 5) UE common SL DRX configuration(s) can be configured for broadcast/groupcast

**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 |
| Lenovo, MotM | 4 or 1 (as second preference) | Option 1) By this option we understand that all UEs are having same common DRX configuration. This one common DRX configuration could be only used for “control signalling” which is then further used to adapt the final DRX configuration between UE’s according to QoS for example. Therefore, we understand Option1 as some common/ default DRX configuration.  Option 2) would mean that primarily only three DRX configurations exist; one each for UC, GC and BC. This can be used as a “common” basis and the transmitter about to make a UC/ GC/ BC transmission would know where the Active time for a potential receiver is depending on if the to be made transmission is UC/ GC or BC. This is however not practical since the granularity is rather high – leading to high congestion and half duplex issues e.g. when so many UC (or GC or BC) UEs wake up and start making a transmission at the start of *onDurationTimer* for UC. We would need some mechanism to distribute the load in the active time of the UEs once the *onDurationTimer* starts.  Option 3) The Access stratum does not have a definition of “service type”; to us it should rather translate to Option 4 i.e. to PQI(s)  Option 4) is closer to Access Stratum and can be translated to *priority* (of a logical channel) etc. It takes away the above demerits to a good extent since there are many more PQIs than just 3 (cast types). SA2 is adding 7 more as indicated in their LS (R2-2008761\_S2-2006588). If we have far too many PQIs, one can even combine a group of these to a corresponding DRX configuration. |
| OPPO | Option-2 + Option-4 with clarification | As replied to Q2.1-1, we do not think this “UE common SL DRX” is applicable to unicast.  And for broadcast and groupcast, we are open to define the DRX configuration in a way of:   * Option-2, i.e., a DRX configuration is adopted by all UEs (for a specific cast type) without further differentiation; * Or Option-4, i.e., a per-QoS DRX configuration is defined. |
| Xiaomi | Option 2 | Since there is no RRC connection in broadcast and groupcast, the service type and PQI is not known to RX UE before receiving the packet in broadcast and groupcast. Option 3 and 4 may result in UE applies inappropriate DRX configuration and misses the broadcast or groupcast packet. |
| ASUSTeK | Option 1, 2, 3 for different scenarios | Option 1 can be used for a default (or pre-defined) common DRX configuration.  Option 2 can be used for all broadcast services, while it seems not suitable for unicast or groupcast.  Option 3 can be used for unicast and groupcast services, and upper layer can provide relevant DRX parameters (e.g. DRX cycle and on-duration). FFS for broadcast. |
| HW | Option 5 | As reply to Q2.1-1, we don't think common SL DRX should be supported for unicast and is only applied to broadcast/groupcast.  Regarding to whether to support only one common DRX configuration or multiple DRX configurations (e.g., per service type/per QoS), we think this needs FFS pending on SA2 progress. Specifically, as to per service type/per QoS, we suggest to discuss the corresponding RAN impacts or mechanism. |
| Apple | 1,3,4 | Option 1 can be used for the default common DRX configuration.  Option 3,4 can be used for additional common DRX configuration for broadcast/groupcast.  We do not think there is a common DRX configuration needed for the purpose of SL unicast, although some DRX parameters may share or be common between different DRX configurations. |
| InterDigital | Option 3 or option 4;  Also support Option 5 | As discussed in Q2.1-1, common configuration is not applicable/motivated for unicast, so we think option 5 should be the assumption.  Either or both of options 3 or option 4 can be used to enable common DRX configuration to be tailored to the characteristics of the data transmissions. This avoids having to define a single DRX configuration for all types of services, which would limit the efficiency of DRX. If a UE is interested in multiple services/types, then it simply monitors according to each/all of the common DRX configurations. |
| vivo | Option 5) | For option 1) and 2), as we replied in Question 2.1-1, at least common SL DRX configuration is not applicable for unicast.  For Option 3), we think the service-level granularity is overrefined. From receiving perspective, one Rx UE may be interested in receiving many services from surrounding TX UEs. Since there is no PC5 RRC connection for broadcast and groupcast, the SL DRX configuration is not negotiable between TX and RX. By applying Option 3), the UE power saving benefit may be very limited considering many SL DRX configurations are running simultaneously, so we don’t prefer this option.  For Option 4), the QoS (e.g., PQI) is only know to Tx UE but not known to Rx UE before receiving the packet, so actually the Rx UE doesn’t know which SL DRX configuration should be applied at the first place. At least some enhancement may be needed on signaling design to deliver the per-QoS DRX configuration from Tx to RX.  We support Option 5) as baseline. One set of SL DRX configuration is simple for broadcast/groupcast. Whether more than one set of SL DRX configuration (e.g., using Option 4) can be FFS if Option 5) is not enough. |

## 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. |
| Lenovo, MotM | Yes | For Unicast PC5 connections, DRX configuration could be exchanged, e.g. using a default common DRX configuration to fine tune the DRX configuration. |
| OPPO | Further clarification is needed. | As replied to Q2.1-1, we believe that for unicast,   * Before link establishment: for unicast-based DCR message reception, a per-UE DRX configuration can be adopted; * After link establishment, a link-specific, or more accurately, direction-specific DRX is necessary, i.e., for a specific unicast link (i.e., L2 source and destination address pair), DRX can be configured for the two directions (UE1 => UE2, and UE2 => UE1) respectively. |
| Xiaomi | Yes | In unicast, different TX UE may have different traffic pattern. UE specific is more efficient. |
| ASUSTeK | Yes | At least for unicast, support UE-specific DRX configuration. |
| HW | Yes with comments | For broadcast/groupcast, common SL DRX configuration should be applied, see our reply on Q2.1-1. So based on our understanding, UE specific DRX configuration only applies to unicast. |
| Apple | Yes with comment | We think this only for SL unicast and it is more of a link-specific DRX configuration rather than UE-specific. |
| InterDigital | Yes with comments | We also think this is only for SL unicast. Whether the two UEs share the same UE-specific DRX configuration should be further discussed. |
| vivo | Yes with comments | We think the UE specific SL DRX configuration can be used for SL-DRBs after successful unicast link establishment. But for the related PC5-S and PC5-RRC messages over SL-SRB 0/1/2/3 which are transmitted in broadcast fashion, we can further discussion whether they should follow the common SL DRX configuration like groupcast and broadcast services. |

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)

Option 5) SL DRX configuration can be configured per UE;

Option 6) SL DRX configuration can be configured per direction of a pair of source/destination

**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. |
| Lenovo, MotM | 3 | 2) and 4) are also possible but 2) is not very practical as explained earlier. 4) can get complex – which QoS characteristic, which granularity and also the knowledge of PDB/ remaining PDB by the time a packet arrives in L2 buffer is somewhat ‘grey’. |
| OPPO | Option-5 and option-6 with clarification | As replied in Q2.2-1, we believe that the said “UE specific DRX configuration” (for which the term can be refined) is only applicable to unicast, with the following differentiation   * Before link establishment: for **unicast-based** DCR message reception, a per-Rx-UE DRX configuration can be adopted, i.e., each UE follows per-UE DRX configuration for the reception of **unicast-based** DCR message; * After link establishment, a link-specific, or more accurately, direction-specific DRX is necessary, i.e., for a specific unicast link (i.e., L2 source and destination address pair), DRX can be configured for the two directions (UE1 => UE2, and UE2 => UE1) respectively. |
| Xiaomi | Option 1 | The DRX configuration should be aligned with the traffic pattern of tx UE. Therefore, the UE specific DRX should be configured per TX UE. |
| ASUSTeK | Option 1 and 6 for unicast | For groupcast and broadcast, UE specific SL DRX configuration seems not suitable since a Tx UE will need to consider different active times of multiple Rx UEs. |
| HW | 1 or 6 for unicast | We think based on the Rel-16 modelling, option 1 has the same meaning as option 6, i.e., UE1 operating as source and UE2 operating as destination is one pair while UE1 operating as destination and UE2 operating as source is another pair.  Regarding to the option 5, we think even for the **unicast-based** DCR message, it can be considered as a broadcast message and signalled on the dedicated resource pool which is configured for broadcast/groupcast and in this case, a separate per UE configuration for this message is not needed |
| Apple | Option 1 for SL unicast | We do not believe there is a need to configure more than one link specific DRX configuration per unicast link, in regardless of how many different QoS flows are supported between a pair of UEs. For all the active QoS flows, the peer UEs need to negotiate a single suitable DRX configuration between them via PC5-RRC. And this configuration is only used in the PC5-link, and not per UE. |
| InterDigital | Option 1 and option 3, for unicast | For unicast, the DRX configuration should be per source/destination pair, so option 1 (or option 6 which is equivalent) should be supported.  In our understanding, even though some negotiation is performed between the peer UEs in the unicast link to derive a single DRX configuration for that link, the allowable/selected DRX configuration for a unicast link should depend on the QoS. For this reason, option 3 should be supported for the selection of the DRX configuration. |
| vivo | Option 1) | For unicast services, SL DRX should base on link level similar to Uu, which means the minimum granularity of SL DRX configuration can be per pair of source & destination L2 IDs. Whether the SL DRX configuration of two direction over one link is independent or not can be FFS. This may also be pending on other topics, e.g., coordination between TX and RX. |

## 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. |
| Lenovo, MotM | Yes | As required in Uu. |
| OPPO | Yes with comment | On the other hand, RAN2 can further discuss the selection between 2 ways to reflect the DRX configuration   * Resource pool configuration without DRX configuration, i.e., UEs are active within the resource pool, so that the DRX configuration (cycle/timer) can be saved (this is possible if a UE common DRX configuration is defined); * Resource pool configuration with DRX configuration, i.e., UE is active following the DRX parameters, i.e., the UE is active in a subset of configured resource pool. |
| Xiaomi | Yes |  |
| ASUSTeK | Yes with comment | We agree that these 4 parameters are needed for SL DRX operation. However, it is too early to decide which parameters should be included in the configuration.  In our understanding, the intention of this question is to ask whether these 4 parameters should be used for SL DRX operation. Therefore, we suggest to modify the question as follow:  **do you agree to support at least sl-drx-SlotOffset, sl-drx-onDurationTimer, sl-drx-StartOffset, and sl-drx-Cycle for SL DRX operation?** |
| HW | Partially yes | For unicast, we think we can adopt timer based mechanism and reuse these parameters, similar as in Uu.  For broadcast/groupcast, we are not sure whether timer based mechanism should be supported as PC5-RRC is not supported for groupcast and broadcast in R16 V2X, and thus DRX configuration coordination is not possible among UEs in sidelink directly. In addition, there may be some data loss for later arrived UEs which missed the previous message that wakes up the other UEs and fails to extend the active time by in-activity timer. Therefore, we think some kind of “dedicated resource pool” which requires the UE carrying out DRX will only receive on the dedicated resource pattern in the pool.  However, if RAN2 agrees to use timer based mechanism for broadcast/groupcast, we think these four parameters should be supported to wake up the UE periodically for broadcast/groupcast service, which is actually quite similar as “dedicated resource pool”. |
| Apple | Yes | Similar to Uu DRX configuration. |
| InterDigital | Yes, if applied to unicast only | We have similar concerns as Huawei on supporting these timers for groupcast/broadcast.  In addition, we don’t see any need for supporting the *sl-drx-SlotOffset* and *sl-drx-StartOffset* for groupcast/broadcast since the intent of these parameters in Uu is to distribute the on times of different UEs under the control of a single gNB. For SL groupcast/broadcast, a UE may have different active DRX configurations (associated to different group or service) and distributing the on times would increase power consumption compared to aligning them.  We agree with some of the other companies that a separate resource pool can be used to model the DRX cycle and on duration. |
| vivo | Yes | These are mandatory Uu DRX parameters. We can reuse them to SL as baseline. |

## 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. |
| Lenovo, MotM | No | The need is not clear now especially since the basis mechanism is not agreed and unlike Uu, here a UE has potentially many peer (UEs). |
| OPPO | No | For unicast, although theoretically it is feasible, we do not observe too much benefit from the usage of short DRX cycle, i.e., the performance gain can be achieved with proper configuration of long DRX + inactivity timer. |
| Xiaomi | No | We should first discuss the long DRX frame work. It’s not clear whether short DRX is beneficial for now. |
| ASUSTeK | No | We can focus on long DRX cycle (that is, one kind of DRX cycle) in Rel-17. |
| HW | Yes | It is expected that sometimes SL services arrive frequently, in which case short cycle can be inherited to ensure timely scheduling while reduce the power consumption. So we think short cycle is beneficial and can be reused for unicast. |
| Apple | No | Given that a SL UE has multiple unicast peers and the transient nature of peer-to-peer communication, there is no benefit to accommodate a transition from short to long DRX cycles. |
| InterDigital | No | We think it is too early to agree to the Uu-like long/short DRX cycle mechanism, given there does not seem to be much benefit. |
| vivo | No | In Uu short DRX cycle is an optional feature. At least it is not essential to support the short DRX cycle in SL for now. |

**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? |
| Lenovo, MotM | Yes | As a start we assume there will be a long DRX Cycle. |
| OPPO | Yes with comment | As replied in Q2.3-1, for broadcast/groupcast, we are open to both options (to configure as resource pool, or to configure as DRX configuration), to reflect the long DRX cycle; |
| Xiaomi | Yes |  |
| ASUSTeK | Yes |  |
| HW | See comments | The long cycle is quite similar as “dedicated resource pool”, both are actually a DRX pattern that requires the UE to wake up periodically for broadcast/groupcast service. From this perspective, we share the same view as OPPO and are open on either way. |
| Apple | Yes | Only need to support long (normal) cycle. |
| InterDigital | See comments | Same view as OPPO and Huawei |
| vivo | Yes | We tend to specify a unified UE behavior for SL DRX operation for all cast types. |

**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. |
| Lenovo, MotM | No | The need is not clear now especially since the basis mechanism is not agreed and unlike Uu, here a UE has potentially many peer (UEs). |
| OPPO | No | For broadcast/groupcast, since there is no stable topology, it is not possible to configure either inactivity timer or short DRX cycle. |
| Xiaomi | No | Same as Q 2.4-1 |
| ASUSTeK | No |  |
| HW | No | If short cycle is supported, then for later arrived UEs, they may not know whether the long cycle or short cycle is used and may cause some misalignment and data loss. |
| Apple | No | Only normal (long) cycle is needed. |
| InterDigital | No | Same as Q 2.4-1 |
| vivo | No | Same answer as for SL unicast. |

## 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

Option 5) Specified

Option 6) Upper layer (e.g. V2X layer)

**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. |
| Lenovo, MotM | 4) and 5)  2) for UC based later adjustments of DRX configuration only. | 1) does not work since peer UEs where one is in coverage of a gNB and the other is not (another gNB or OOC). This problem applies for already other configurations in SL and so instead of solving this, we should not make it any further critical.  2) for UC based later adjustments of DRX configuration.  5): Specified might be useful as well if the DRX patterns are to be known universally. |
| OPPO | For broadcast/groupcast, option-1/4  For unicast, option-1/2 | For broadcast and groupcast, we believe a common DRX configuration is feasible (FFS it is per-QoS or not), for which UE can rely on SIB/pre-configuration for in/out-of-coverage case.  For unicast, for the DRX after link establishment, we believe a link/direction-specific DRX configuration is necessary (as replied to Q2.2-2), for which the decision can be by TX-UE or the serving gNB of the TX-UE (depending on whether the TX-UE is in RRC\_CONNECTED or not). |
| Xiaomi | Option 2 + 1 for IC UE  Option 2+4 for OOC UE  FFS for option 3 | In Uu, the DRX is configured by gNB, since gNB is aware of the traffic pattern and in charge of resource scheduling. gNB could provide appropriate DRX configuration to fulfil the QoS without much delay.  On sidelink TX UE is aware of the traffic pattern. TX UE’s gNB and pre-configuration is in charge of sidelink resource allocation.  But I also see some benefit of RX determined DRX configuration. Maybe we could have some further discussion on how to harmony these two options. |
| ASUSTeK | See comment  Different options for different scenarios | **For In-Coverage unicast UEs:**  Option 1) gNB (e.g. UE-specific configuration to peer UEs)  Option 2) UE performing the SL TX  Option 3) UE performing the SL RX  **For in-Coverage broadcast/groupcast UEs:**  Option 1) gNB (e.g. for common SL DRX configuration per resource pool)  Option 6) Upper layer (e.g. V2X layer)  **For out-of-coverage unicast UEs:**  Option 2) UE performing the SL TX  Option 3) UE performing the SL RX  Option 4) Use pre-configuration SL DRX parameters (e.g. for common SL DRX configuration per resource pool)  **For out-of-coverage broadcast/groupcast UEs:**  Option 4) Use pre-configuration SL DRX parameters (e.g. for common SL DRX configuration per resource pool)  Option 6) Upper layer (e.g. V2X layer) |
| HW | 3 for unicast  1 or 4 for broadcast/groupcast | For unicast, we slightly prefer UE performing the SL RX determines the SL DRX configuration as this is the most power-saving mechanism and based on some coordinated information between the TX UE(s) and the RX UE, the RX UE can determine a proper DRX configuration applying to all the connected TX UEs or determine multiple DRX configurations applying to different TX UEs.  For broadcast/groupcast, we think it should be the NW (dedicated RRC signalling for connected mode and SIB for idle/inactive mode) to configure the dedicated resource pool(s) or the mapping relationship between different service/QoS profile and the corresponding dedicated resource pool for the UEs IC and for UEs that are OOC, they should use predefined dedicated resource pool configuration for SL DRX operation. |
| Apple | 3 for unicast DRX configurations  1 & 4 for common DRX configuration | We agree with Huawei that RX UE is more suitable to determine how to achieve power saving from SL-DRX. We prefer RX-driven decisions for each PC5 link.  Common DRX configurations are provided via SIB or pre-configurations. |
| InterDigital | Option 1 & 4 for groupcast/broadcast  Option 3 for unicast (with comments) | Similar to other groupcast/broadcast parameters on SL, gNB should configure DRX for in coverage, and preconfiguration should be used for OOC.  For unicast, the RX UE should select the final DRX configuration(s) to ensure efficient power savings for multiple active unicast links (with different UEs). However, since the TX UE is aware of the characteristics of the data to be transmitted, and could also be an RX UE for other unicast links, the TX UE should be involved in such decision (e.g. by sending a suggested configuration(s) or other information used by the RX UE for selection). |
| vivo | Option 1, 2, 4  see comments | For groupcast and broadcast, the UE common DRX configuration can be part of the SLRB configuration as in Rel-16 V2X, i.e., by **Option 1** for In-Coverage UEs and **Option 4** for Out-of-Coverage UEs.  For unicast, as we replied in Section 2.2**,** there may be UE common DRX Configuration before unicast link establishment and link specific DRX after unicast link establishment. Therefore:  - Before unicast link establishment, the DRX configuration can simply follow the method for groupcast and broadcast as above.  - After unicast link establishment, the link specific DRX configuration is defined by **Option 2**, i.e., the Tx UE sets up the initial DRX configuration and the Rx UE may decide whether to accept/reject/modify the initial DRX configuration from TX UE. This DRX negotiation between TX and RX can reuse similar QoS negotiation procedure defined in Rel-16 V2X. |

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

Option 6) Specification

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

|  |  |  |
| --- | --- | --- |
| Company | Options | Comments |
| CATT | Option 1) for RRC Connected UE. | We wonder about the relationship of this question with question 2.5-1? |
| Lenovo, MotM | 2), 3), 4) and 5) and 6)  1) only for UC DRX finer adjustments. | 5) will allow further negotiation of DRX configuration between two peer UEs once they have used the “common” basis and started communicating. |
| OPPO | For broadcast/groupcast, option-2/3  For unicast, option-1/5. | As replied in Q2.5-1,  For broadcast and groupcast, we believe a common DRX configuration is feasible (FFS it is per-QoS or not), for which UE can rely on SIB/pre-configuration for in/out-of-coverage case. For dedicated-RRC, considering there is no need for a UE-specific configuration, it is not motivated.  For unicast, we believe a link/direction-specific DRX configuration is necessary, for which the decision can be by TX-UE or the serving gNB of the TX-UE (depending on whether the TX-UE is in RRC\_CONNECTED or not). For SIB/Pre-configuration, considering there is no need for UE-common configuration, it is not motivated. |
| Xiaomi | Option 1, 2, 3, 5 | Upper layer is not aware of the sidelink radio resource allocation. The DRX configuration may not be appropriate. |
| ASUSTeK | Option 1, 2, 3, 4, 5 | Option 1 is for DRX configuration decided by gNB and provided to connected UEs.  Option 2 and 3 is for common SL DRX configurations (provided by gNB or pre-configured).  Option 4 if DRX configuration is determined by upper layer of UE itself.  Option 5 is for unicast UEs exchanging UE-specific parameters. |
| HW | 5 for unicast  1 or 2 or 3 for broadcast/groupcast | For unicast, after the UE performing the SL RX determining the SL DRX configuration, the RX UE should signal this SL DRX configuration to the connected TX UE(s) via PC5 RRC signalling.  For broadcast/groupcast, for connected UEs, they rely on the RRC configuration to configure the dedicated resource pool for SL DRX operation while for UEs in idle or inactive mode, SIB configuration is applied. For UEs that are OOC, they should use predefined configuration for SL DRX operation. |
| Apple | 1,2,3, 5 | 1.2,3 are for common DRX configurations.  5 is for unicast DRX configurations. |
| InterDigital | 1, 2, 3, 5 | As commented by other companies, 1, 2, 3 are for broadcast/groupcast, and 5 is for unicast. |
| vivo | Option 1, 2, 3, 5  See comments | As in R16 V2X, SL related configuration can be obtained via three methods: dedicated RRC signalling for RRC-Connected TX UE, SIB for RRC-Idle/Inactive TX UE and preconfigured signalling for OOC TX UE. SL DRX configuration is also a typical SL related configuration.  Similar to R16 V2X configuration acquisition, SL DRX parameters of TX UE comes from Option 1/2/3. Further, Option 5 is used to delivery the SL DRX configuration to RX UE. |

# 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/SL 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?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Lenovo, MotM | Both 1) and 2) | On the principle that UE seeks assistance (e.g. Uu and SL DRX alignment) when it can’t solve the problem itself (i.e. it is not possible/ easy to align the SL DRX with the peer UE(s) to the Uu DRX). |
| OPPO | Option-1 and Option-2 for different cases | For broadcast and group-cast, since UE is to follow the SIB/Preconfiguration, there is no much flexibility at UE side, so it is more of option-1, i.e., up to NW to do the coordination.  For unicast:   * In case UE is in RRC\_CONNECTED mode, it is more of option-1, i.e., when NW decide on Uu-DRX, it has to take into account of SL-DRX; * Or in case UE is not in RRC\_CONNECTED mode, it is more of option-2, i.e., it is more of UE to coordinate |
| Xiaomi | Option 1 and 2 | Option 1 is used if the UE is in connected.  If UE is not in connected, option 2 should be used. |
| ASUSTeK | Option 1 | It may be difficult for Rx UE to adjust traffic pattern from Tx UE. It’d be easier for the gNB to adjust Uu DRX or SL DRX based on sidelink UE information provided by the UE. |
| HW | 1 and 2 | We think both option 1 and option 2 can be supported.  Regarding to option 1, the basic procedure is the RX UE determines the SL DRX configuration based on some coordinated information from the connected TX UE and signals this configuration to the TX UE, then the TX UE informs the gNB the received SL DRX configuration and the gNB takes the information into account when determining the Uu DRX configuration to align the Uu DRX with the SL DRX.  Regarding to option 2, the basic procedure is the Uu DRX configuration is transmitted from the TX UE to the RX UE as the coordinated information and the RX UE takes the Uu DRX configuration into account when determining the SL DRX configuration to align the SL DRX with the Uu DRX. |
| Apple | 1, 2  with comments | At this stage, we think the exact use cases for UU/SL DRX alignment is still not clear, and the objective/benefits of such alignment is also unclear. To be safe, we can put both options at the table and then decide later once the design is more mature. |
| InterDigital | 1 and 2 | Both options are possible and should be considered at this stage. Downselection, if needed, can be discussed later. |
| vivo | Option 1), 2) | Option 1) can ne applied to RRC\_CONNECTED UEs, in which case the gNB is a more powerful node to take responsibility to align Uu DRX wake-up time with SL DRX wake-up time.  Option 2) can be applied to e.g. RRC\_IDLE/INACTIVE UEs. In this case, the UEs cannot change the Uu DRX configuration but simply follows the cell-specific DRX from SIB. However, the SL DRX configuration can still be adjusted by UE to wake up to receive SL and Uu paging within the same DRX window as far as possible. |

# 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

|  |
| --- |
| 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 PSCCH 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.

|  |
| --- |
| 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?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
| Lenovo, MotM | Yes, but | Active time is for transmission as well as reception.  This Question seems to assume that ActiveTime is only for reception. This needs to be first clarified, i.e. whether SL UE needs to have ActiveTime configuration for RX and one for Tx or one common ActiveTime (Rx +Tx). We see only one common ActiveTime (Rx +Tx) is sufficient/ plausible. |
| OPPO | No | As in Uu, monitoring control channel is enough for the definition of DRX. I.e., the Rx-UE does not need to decode PSSCH if the ID in PSCCH does not correspond with the ID of Rx-UE |
| Xiaomi | Yes |  |
| ASUSTeK | Yes, but for receiving 2nd stage SCI | Since the 2nd stage SCI carrying src/dst ID is transmitted via PSSCH, the UE should perform PSSCH reception for complete SCI in addition to PSCCH monitoring. |
| HW | See comments | We are not sure about the meaning of “performing the SL data reception”.  If it means to monitor the PSCCH for SL data reception during the active time, then we think the answer is “Yes”  If it means to decode the PSSCH for SL data reception during the active time, we think the answer is “No”. Actually in Uu DRX is defined to control the UE to monitor the PDCCH during the active time and it has nothing to do with decoding the PDSCH. So similar principle applies to SL as well. |
| Apple | Yes | My interpretation in the question is that UE “should” decode PSSCH if PSCCH contains a matching L1 ID which the UE is interested to receive.  If my understanding of the question is correct, I support that UE should do SL reception in this case. |
| InterDigital | See comments | We think the intent of the question is to indicate that the UE “can” (not should) receive SL data during the active time. The UE receiving SL data should be conditioned on whether a matching L1 ID is decoded in SCI, which has nothing to do with active time. |
| vivo | Yes with comments | We agree that UEs should also monitor PSSCH for 2nd step SCI. And this makes the SL DRX definition is different from Uu (where in Uu UE only monitors PDCCH). |

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

|  |  |
| --- | --- |
| Company | Comments |
| Lenovo, MotM | At least PSFCH also needs to be received. |
| OPPO | No.  DRX is only used to define the reception of control channel, while  - the reception of other PHY channel (e.g., PSFCH, PSBCH) does not have to be included in the definition of DRX;  - the UE is not restricted to perform control channel reading during the active time, e.g., as in Uu, the UE can perform RRM measurement in/out of active time, which is not restricted by the spec. |
| Xiaomi | UE shall also monitor PSFCH. Retransmission timer is used to control PSFCH monitoring for TX UE. |
| ASUSTeK | Agree with OPPO that PSFCH and PSBCH do not have to be included in the definition of DRX. |
| HW | Firstly, we have not agreed UE should monitor PSSCH during the active time and this is still FFS.  Secondly, we agree with OPPO that DRX is defined to control the UE to monitor the control channels e.g., PDCCH in Uu and PSCCH in SL, other channels should not be included in the definition of DRX. |
| Apple | For UE in ACTIVE, it monitors all SL-related channels as same as specified for a Rel-16 NR V2X UE. |
| InterDigital | SL DRX definition can be based on SCI reception (PSCCH and PSSCH) as in Uu. |
| vivo | Agree with OPPO that other PHY channel (e.g., PSFCH, PSBCH) does not have to be included in the definition of DRX.  In other words, they can be received in any time when the UE is expected to receive, no matter in DRX active time or not. |

## UE behaviours in the SL inactive time

Additionally, RAN2 can discuss UE behaviors in the SL inactive time. For example, RAN2 has to decide whether to allow reception of PSFCH or S-SSB in the SL inactive time. From the perspective of ensuring the reliability of SL operation, at least UE should be able to receive PSFCH or S-SSB even in the SL inactive time.

**Question 4.2-1 is there any channel/signal (e.g., PSFCH, S-SSB) that the UE should receive exceptionally at SL Inactive time?**

|  |  |
| --- | --- |
| Company | Comments |
| OPPO | As replied in Q4.1-2, we do not think that DRX functionality has to include the reception of all PHY channel, e.g., the reception of PSFCH/PSBCH does not have to be controlled by DRX (similarly, in Uu, one does not rely on DRX to define the reception of PHICH, PBCH), regardless it is in DRX (in)active time or not. |
| Xiaomi | UE could monitor PSBCH if necessary. |
| ASUSTeK | We think PSFCH and PSBCH shall operate independently of SL DRX. |
| HW | We share the same view as OPPO. |
| Apple | Reception of PSFCH and SLSS is independent of DRX |
| InterDigital | Share the views of other companies that reception of other channels is independent of DRX. |
| vivo | Same reply in Question 4.1-2. |

# SL DRX Timer

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

|  |
| --- |
| 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?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Lenovo, MotM | Not all | We need to distinguish between HARQ FB enabled transmission and Blind retransmissions (BR). In Uu there is no BR mode. Therefore, we need some different handling for SL DRX and can’t simply copy Uu DRX mechanism. BR retransmission occasion can be determined in SCI and those retransmission occasions shall be considered as *ActiveTime* and therefore, HARQ RTT timer may not be needed. The SL DRX mechanism should be as simple as possible. |
| OPPO | Yes | We agree further discussion on RTT/Re-tx timer is needed considering feedback |
| Xiaomi | Generally yes | The timer handling may be different from Uu design. The detailed design should be further discussed. |
| ASUSTeK | Yes |  |
| HW | Yes for On-duration timer, Inactivity timer  Yes for HARQ RTT timer and Retransmission timer if PUCCH is configured  FFS for HARQ RTT timer and Retransmission timer if PUCCH is not configured | Regarding to CATT’s comments, even if HARQ feedback is disabled, it is possible to feedback on PUCCH if TX UE wants to ask for a retransmission. In this case, HARQ RTT timer and retransmission timer is needed.  2> else if HARQ feedback has been disabled for the MAC PDU and no sidelink grant is available for next retransmission(s) of the MAC PDU, if any:  3> instruct the physical layer to signal a negative acknowledgement corresponding to the transmission on the PUCCH according to clause 16.5 of TS 38.213 [6].  Therefore, we think in case PUCCH is configured, then HARQ RTT timer and retransmission are needed to monitor the retransmission scheduling, similar as in Uu. But if PUCCH is not configured, then blind retransmission may be performe, in this case how to ensure the TX UE is able to monitor the blind retransmission should be FFS. |
| Apple | Yes for ON-duration, Inactivity times.  No for HARQ RTT timer and Retransmission Timers | As retransmission resource is indicated in SCI, we do not see a need for any ambiguity of retransmission timing and there is no need for the RTT timer and retransmission timers. The inactivityTimer is enough to handle HARQ cases. |
| InterDigital | Yes for ON-duration and inactivity timers.  No for HARQ RTT and retransmission timers | As mentioned by Apple, retransmission resource is indicated in SCI, so the equivalent Uu timers seem unnecessary for SL. |
| vivo | Yes with comments | The 4 timers are similar to Uu only for unicast and groupcast with HARQ enabled. But for unicast, groupcast with HARQ disabled and broadcast, HARQ RTT timer, and Retransmission timer are not needed. |

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?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
| Lenovo, MotM |  | Why talk about “PC5 Unicast link”?  In Uu the different timer settings are not motivated by QoS requirements. For Uu we have only one DRX configuration per UE/DRX group.  However, if we have preconfigured DRX configuration per PQI or service then this implies already that On-duration/ Inactivity timer, offset are set independent per PQI(s). Besides on-duration timer and inactivity timer, the start offset can also be set to different value for each PQI(s). |
| OPPO | No | In Uu, the secondary DRX group is to handle FR2 instead of different QoS. So similarly, there is no need to further differentiate DRX configuration between different QoS. |
| Xiaomi | Yes | The traffic may be different for different PC5 unicast link. |
| ASUSTeK | Yes |  |
| HW | See comments | Firstly, we don’t think “PC5 unicast link” should be used, this has been discussed in Rel-16 and it should be “PC5-RRC connection”.  Secondly, we share the same view as OPPO that DRX group in Uu is for FR2, therefore we don’t think it makes sense to consider DRX groups and configure different set of values for a certain PC5-RRC connection in SL.  At last, we think if the question is to ask if we need to support different set of values for a certain PC5-RRC connection, as we commented above, our answer is “No”. But if the question is to ask if different set of values can be configured for different PC5-RRC connections, then our answer is “Yes”. |
| Apple | Yes | Our understanding is that DRX cycle lengths can also be diversified to adapt to different power saving or QoS requirements in different PC5 unicast links. |
| InterDigital | Yes | As commented in our answers in section 2.2, the UE specific DRX configuration can be per pair of source/destination L2 ID. In our understanding, DRX configuration can include the value of on duration and inactivity timer. |
| vivo | See comments | The answer is related to Question 2.2-2, i.e., depending on the option to support the UE specific SL DRX configuration. |

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?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
| Lenovo, MotM |  | It is ok to set common RTT timer and Retx timer across PQIs, since this is not unicast link specific. |
| OPPO | No | In Uu, the DRX HARQ RTT timer and DRX Retransmission timer are set in a per-UE manner. So similarly, we believe a per-link/direction setting (after link establishment, as replied in Q2.2-2) of SL DRX HARQ RTT timer and SL DRX Retransmission timer is reasonable.  And we prefer aligned/same granularity between the configuration of on-duration/inactivity timer and the configuration of RTT/re-transmission timer. |
| Xiaomi | No | The RTT and retransmission timer depends on the TX resource allocation method of Tx UE. The Tx resource allocation method of each TX UE may be different. For example, one TX UE is out-of-coverage using mode 2 and another TX UE is in connected using mode 1. Therefore, the timer should be configured separately. |
| ASUSTeK | No | RTT and retransmission timer should be able to be configured differently between PC5 links. For instance, each Tx UE uses different SL configured grant with different slot offset values for slot offset between the PSFCH associated with PSSCH, the Rx UE should have different retransmission timer values for each cases. |
| HW | No | UE can maintain these timers per SL HARQ process but the values can be configured per PC5 unicast link as the configuration is carried via PC5 RRC signalling. As the SL process is shared among multiple SRC-DST pairs, then the value of these two timers is not fixed but need to be changed according to the PC5 connection the SL process is associated with. |
| Apple | No | We need to first to examine why those timers are needed. |
| InterDigital | No | Same view as Apple |
| vivo | No | We prefer the configuration of RTT/re-transmission timer considered in the same manner with the configuration of on-duration/inactivity timer. |

## 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. |
| Lenovo, MotM | Not all | Same answer as for Unicast. |
| OPPO | See comment | As replied to Q2.3-1, we are open to both options:   * No DRX configuration, but just rely on resource pool configuration; * DRX configuration is defined (within the resource pool). In this case, on-duration timer, HARQ RTT timer, and Retransmission timer are necessary.   While inactivity timer needs to be further discussed, i.e., at least for the case where there is no stable topology between UEs in a group, the usage of inactivity timer is not feasible.  As replied in Q5.1-1, we agree further discussion on RTT/Re-tx timer is needed considering feedback |
| Xiaomi | Generally yes | The timer handling may be different from Uu design. The detailed design should be further discussed. |
| ASUSTeK | Yes |  |
| HW | FFS See comments | Broadcast and groupcast in nature are quite similar, so a unified mechanism can be adopted to both, e.g., dedicated resource pool.  The specific aspects for groupcast, e.g., HARQ feedback can be FFS, i.e., whether to introduce some HARQ related timers on top of dedicated resource pool. |
| Apple | Yes for ON-duration, Inactivity times.  No for HARQ RTT timer and Retransmission Timer | For SL group cast case, this is similar to a synchronous HARQ process as in LTE UL case, and there is no need for those timers. |
| InterDigital | Yes for Inactivity timer only (See comments) | We agree with Huawei that separate resource pool can be used to define the on-duration, and we can consider an inactivity timer on top of such pool definition.  For HARQ and retransmission timers, as mentioned in previous answers, we are not sure these are needed. |
| vivo | Yes | Generally, the 4 timers can be introduced for SL groupcast similar to unicast.  Regarding the need of inactivity timer, given that Uu SC-PTM also supports the inactivity timer even though some UEs may join in the middle of the multicast service, the situation is similar for SL, we don’t see necessity to excluded this timer for SL. |

**Question 5.2-2 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?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
| Lenovo, MotM |  | Same answer as for Unicast. |
| OPPO | See comment | As replied in Q5.2-1, we are not sure about inactivity timer.  For on-duration timer, as replied in Q2.1-2, we are open to per-QoS or UE-common configuration. |
| Xiaomi | Yes | The traffic may be different for different group. |
| ASUSTeK | Yes |  |
| Apple | Yes | Same answer as unicast. |
| InterDigital | Yes | If we agree to an inactivity timer, then it should be part of the DRX configuration (which could be per service). |
| vivo | See comments | The answer is related to Question 2.1-2, i.e., depending on the option to support the UE common SL DRX configuration. |

**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?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| OPPO | See comment | As replied in Q2.1-2 and Q5,2-2, we are open to per-QoS or UE-common configuration.  On the other hand, similar to unicast, we prefer aligned/same granularity between the configuration of on-duration timer and the configuration of RTT/re-transmission timer. |
| Xiaomi | No | Same to Q 5.1-3 |
| ASUSTeK | No |  |
| Apple | No | First, we do not think the timers are needed. Even if this is needed, it is unclear why the timer value is linked to a group service. |
| InterDigital | No | Same view as Apple. |
| vivo | See comments | The answer is related to Question 2.1-2, i.e., depending on the option to support the UE common SL DRX configuration. |

## 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?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Lenovo, MotM | Yes |  |
| OPPO | See comment | As replied to Q2.3-1, we are open to both options:   * No DRX configuration, but just rely on resource pool configuration; * DRX configuration is defined (within the resource pool). In this case, on-duration timer are necessary.   Inactivity timer is not feasible for broadcast without stable topology.  On the other hand, although there is no HARQ feedback, HARQ retransmission is supported for broadcast, so there is no essential difference between broadcast and group/unicast in terms of the necessity of RTT/re-transmission timer.  As replied in Q5.1-1, we agree further discussion on RTT/Re-tx timer is needed considering feedback |
| Xiaomi | Yes |  |
| ASUSTeK | Yes at least for on-duration timer | FFS for Inactivity timer. |
| HW | See comments | As we replied on Question 2.3-1, we are not sure whether timer based mechanism should be supported for broadcast and we prefer to adopt some kind of “dedicated resource pool” mechanism which requires the UE carrying out DRX will only receive on the dedicated resource pattern in the pool.  However, if RAN2 agrees to use timer based mechanism for broadcast, we think onduration timer should be supported to wake up the UE periodically for broadcast service, which is actually quite similar as “dedicated resource pool”.  But for inactivity timer, we don’t think this should be supported as there may be some data loss for later arrived UEs which missed the previous message that wakes up the other UEs and fails to extend the active time by in-activity timer. |
| Apple | Yes |  |
| InterDigital | Yes for Inactivity timer only (See comments) | Same reasoning as our answer to 5.2-1. |
| vivo | Yes | The timers can be defined in a unified way with unicast/groupcast with HARQ disabled as much as possible. |

**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?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes |  |
| Lenovo, MotM | Yes |  |
| OPPO | See comment | As replied in Q2.1-2 and Q5,2-2, we are open to per-QoS or UE common configuration. |
| Xiaomi | No | Since there is no RRC connection in broadcast, the broadcast service type or PQI is not known to RX UE before receiving the packet in broadcast.  The DRX timers are handled in MAC. RX UE’s MAC is not able to tell the service type included the received MAC PDU. It’s not possible for MAC to start different timers based on service type. |
| ASUSTeK | Yes, see comment | If broadcast type shares a per-cast type common SL DRX configuration, no independent values are needed for different services; Otherwise, independent values can be configured. |
| HW | See comments | As we replied on Question 5.3-1, if RAN2 agrees to use timer based mechanism for broadcast, we think onduration timer should be supported but inactivity timer should not be supported.  Regarding to whether to support only value or multiple values (e.g., per service type/per QoS) for onduration timer, we think this needs FFS pending on SA2 progress as we replied on Question 2.1-2. |
| Apple | Yes |  |
| InterDigital | Yes | Same reasoning as our answer to 5.2-2. |
| vivo | See comments | The answer is related to Question 2.1-2, i.e., depending on the option to support the UE common SL DRX configuration. |

# 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?**

|  |  |  |
| --- | --- | --- |
| Company | Answer (yes or no) | Comments |
| CATT | Yes | It should be supported at least for sidelink unicast. |
| Lenovo, MotM |  | Something similar is required just to inform the peer that there’s no more data for transmission. But since peer may still have some data to transmit, the two UEs can’t enter DRX sleep with respect to each other unless the peer also signals that it does not have any data to transmit either. Note, one UE may have multiple active Peer UEs. |
| OPPO | No | In this release, we can focus on the core DRX functionality. |
| Xiaomi | Generally yes | It’s beneficial for TX UE to inform there is no incoming transmission. However the RX UE behaviour should be further discussed, since there may be multiple TX UEs. |
| ASUSTeK | No | We share the same view with OPPO.  Besides, in Uu, DRX command MAC CE is generated by the network. In SL, the behaviour for how and when to trigger the MAC CE is unclear for Tx UE. |
| HW | Yes | Same view as CATT |
| Apple | No | In SL communication, a UE shall not force a peer UE to enter DRX cycle immediately. It can only adjust its own DRX behaviour, so if such a SL MAC CE is to be supported, this is not a command from Tx to Rx, but Rx UE’s own declaration message of its own DRX state. |
| InterDigital | Yes | Same view as CATT. |
| vivo | Yes with comment. | We support DRX Command MAC CE but only for SL unicast. |

# 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?**

|  |  |  |
| --- | --- | --- |
| 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. |
| Lenovo, MotM | Yes |  |
| OPPO | Yes | We can further discuss the details of Uu-DRX on SL grant later. |
| Xiaomi | Yes |  |
| ASUSTeK | Yes |  |
| HW | Yes |  |
| Apple | Yes |  |
| InterDigital | Yes | This should be the assumption for Rel17, since this release will consider enhancements for P-UEs. |
| vivo | Yes | This feature is postponed in Rel-16 due to no requirement for V-UE and lack of time. However, it should be supported considering the objective of P-UE power saving in Rel-17. |

# 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