**3GPP TSG-RAN WG2 #113bis-e *R2-210xxxx***

**E-meeting, April 2021**

Agenda Item: 8.15.2

Source: Ericsson

Title: Summary of [706]

Document for: Discussion, Decision

# Introduction

This is to discuss the [706] as follows.

* [AT113bis-e][706][V2X/SL] Alignment between Uu DRX and SL DRX (Ericsson)

 **Scope:** Summarize and discuss Uu DRX and SL DRX alignment issues and options based on the companies’ contributions including which RRC state needs to be considered (RRC connected, RRC idle/inactive or both?), who will coordinate the DRX (gNB or UE?), which DRX needs to be coordinated/updated (Uu DRX, SL DRX or both?), etc. Note the issues covered by [POST113-e][704] will not be handled here.

 **Intended outcome:** Discussion summary in R2-2104472.

**Deadline:** 4/19, 10:00am (UTC), R2-2104472 should be available before next Monday session on SL enhancement

For rapporteur to have enough time drafting summary report, we would like to have the following two phases:

* Phase 1: collect companies’ views by 2021-04-15 22:00 UTC
* Phase 2: rapporteur will finalize summary report based on inputs of phase 1 by 2021-04-19 10:00 UTC

# Discussion

We summarize issues related to alignment between Uu DRX and SL DRX in this section.

## Term clarification

Uu DRX is configured is configured per UE and per cell group based on which a UE monitors UL/DL/SL grants. While SL DRX is defined for NR SL based on which a UE monitors SCI. A SL DRX is valid for all Uu RRC states. For a UE supporting both Uu and SL, Uu DRX and SL DRX are separately configured. It is more flexible and allows inter-band operation (i.e. Uu in one carrier and SL in other carrier).

It is desirable to align Uu DRX and SL DRX to maximize the benefits of DRX

* Maximize the power saving in a UE supporting both Uu DRX and SL DRX
* Facilitating SL mode-1 wherein the gNB schedules a SL transmission

“Alignment” means some parameters in a DRX configuration are the same as or is a subset of or a shifted version of the corresponding parameters in the other DRX configuration. The issue has been discussed in [13].

From Rapporteur’s understanding, alignment of a Uu DRX and a SL DRX may comprise at least one of the following

1. Full overlapping between Uu DRX and SL DRX in time
2. Partial overlapping between Uu DRX and SL DRX in time
3. Non-overlapping between Uu DRX and SL DRX in time

The first two bullets are straightforward. By doing that, UE can maximum the power saving. while third bullet is relevant in case the UE is configured with single RF chain. In this case, UE has to switch between Uu and SL.

**Q1-1: do companies agree that alignment of Uu DRX and SL DRX for UE comprises the full overlapping between Uu DRX and SL DRX in time?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes | Depending on UE processing capability, full overlapping is the most power saving mode if UE can handle Uu and PC5 simultaneously. However, it is UE best effort. |
| Xiaomi | comment | We understand options listed in Q1-1,2,3 are up to gNB or TX UE’s implementation to choose how to align the Uu DRX and SL DRX. We don’t see much difference from signalling point of view to support all of these options. |
| OPPO | Yes |  |
| CATT | Yes | We agree the full overlapping case is one valid target for alignment. |
| InterDigital | Yes |  |
| Samsung | Yes |  |
| Spreadtrum | Yes |  |

**Q1-2: do companies agree that alignment of Uu DRX and SL DRX for UE comprises the partial overlapping between Uu DRX and SL DRX in time?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes | Uu DRX and SL DRX may have different pattern or parameters. Full overlapping may not always be achieved. The partial overlapping can also reduce power consumption as much as possible. |
| Xiaomi | comment | Same as Q1-1 |
| OPPO | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes |  |
| Samsung | Yes |  |
| Spreadtrum | Yes |  |

**Q1-3: do companies agree that alignment of Uu DRX and SL DRX for UE comprises the non overlapping between Uu DRX and SL DRX in time (i.e., UE with single RF chain)?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes | If UE cannot handle Uu and PC5 simultaneously, i.e., with single RF chain, non overlapping active times are needed. Furthermore, adjacent active times are beneficial for more power saving gain since UE can save extra power consumption when on/off switching. |
| Xiaomi | comment | Same as Q1-1 |
| OPPO | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes |  |
| Samsung | Yes |  |
| Spreadtrum | Yes |  |

## Cast types

Regarding cast types, it is natural that RAN2 shall first focus on unicast scenario to achieve alignment of Uu DRX and SL DRX.

Whether RAN2 shall also study groupcast and broadcast, is discussed in [9]. As described in [9], the situation is somewhat clear for the unicast, alignment in case of groupcast and broadcast operation needs further discussion. In case of groupcast, while there is no AS level interaction between the members of a particular group as per legacy NR SL V2X design, some DRX related information can still be provided by the group members themselves to their respective gNB(s). Specifically, corresponding to the traffic patterns for a given sidelink service, the UE can indicate its preferred SL DRX configuration to the network. The network can then provide the appropriate DRX configuration for each UE within the group by taking into account the requested configuration and seek to maximize the alignment between the Uu and SL DRX wake up time. For broadcast, since the UE is not aware of the pattern for any incoming traffic on account of its connection-less nature, it can simply inform the network based on upper layer information or internal implementation.

From Rapporteur’s understanding perspective, for GC and BC, all UEs will share common SL DRX configurations, which are associated to L2 Destination address and/or PQI (i.e., depending on RAN2 discussion outcome on SL DRX configuration granularity). It is feasible for gNB to consider assistance information provided by UE so that gNB can provide proper Uu DRX configuration and/or SL DRX configuration to UE to achieve alignment.

**Q2-1: do companies agree that RAN2 shall develop mechanisms to achieve alignment of Uu DRX and SL DRX for all cast types including unicast, groupcast and broadcast?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo |  Yes | From our understanding, broadcast and groupcast may have common DRX patterns based on destination L2 ID and/or PQI. If UE can report them to gNB, it is left to gNB smart implementation to provide proper Uu DRX configuration for more power saving. |
| Xiaomi | Yes | All cast types should be considered when achieving alignment of Uu DRX and SL DRX. However, this doesn’t mean DRX for all the cast type should be overlapped, which may result in transmission collision. |
| OPPO | See comments | The alignment between Uu DRX and SL DRX is needed, as for the 3 cast types:* UC: as rapporteur said, the situation is clear, some mechanisms should be developed to let the gNB be aware of the UE specific DRX.
* GC/BC: all UE share common SL DRX, the existing mechanism, i.e. the SUI provided by UE can achieve the alignment purpose, therefore no need for developing additional mechanism.
 |
| CATT | Yes | For alignment of Uu DRX and SL DRX, the effect of power saving can be enhanced obviously. In order to achieve this goal ,we should study the related mechanism for all cast types including unicast, groupcast and broadcast. |
| InterDigital | Yes | Alignment should be applicable for all cast types. For unicast, alignment may be achieved by aligning the SL DRX to the Uu DRX or vice versa, while for groupcast/broadcast, only the Uu DRX can be aligned to the SL DRX. |
| Samsung | Yes or no (see comments) | For unicast, definitely yes. For groupcast/broadcast, the intention is yes, however we may achieve that without introduction of new mechanism. For example, assuming gNB configures the required SL DRX information (e.g. DRX cycle length, on-duration timer per PQI) and the UE informs the interested L2 id and corresponding PQI to the gNB, gNB can aware the corresponding DRX configuration. So, for groupcast/broadcast, intention is yes but whether we need any new mechanism or not depends on how to support SL DRX for groupcast/broadcast.  |
| Spreadtrum | Yes | All cast types should be considered for power saving efficiency. |

## RRC states

For a UE supporting both Uu and SL, we expect that Uu DRX and SL DRX are separately configured. This allows the flexibility in changing one of the DRX without affecting the other and allows inter-band operation (i.e. Uu in one carrier and SL in another carrier). However, since both DRX are meant for the same purpose, i.e., saving power, it is desirable to align Uu DRX and SL DRX to maximize their benefits.

With the Uu DRX mechanism, UE monitors the PDCCH discontinuously and sleeps during the remaining time. The Uu DRX mechanism can be applied in all RRC states including RRC\_CONNECTED, RRC\_INACTIVE and RRC\_IDLE. A UE in RRC\_CONNECTED typically monitors the PDCCH for DL assignments or UL grants, whilst a UE in RRC\_INACTIVE or RRC\_IDLE typically monitors the PDCCH for a paging message.

Paging allows the network to reach UEs in RRC\_IDLE and in RRC\_INACTIVE state through Paging messages. While in RRC\_IDLE the UE monitors the paging channels for CN-initiated paging; in RRC\_INACTIVE the UE also monitors paging channels for RAN-initiated paging. A UE needs not monitor paging channels continuously though; the Uu DRX in RRC\_IDLE or RRC\_INACTIVE (is also refereed as to Paging DRX) is defined where the UE is only required to monitor paging channels during one Paging Occasion (PO) per DRX cycle.

As specified in the RRC, paging cycle is rather infrequent. So, additional power saving for aligning paging DRX and SL DRX is limited.

*PagingCycle ::= ENUMERATED {rf32, rf64, rf128, rf256}*

1. Additional power saving for aligning paging DRX and SL DRX for a UE in RRC IDLE or RRC INACTIVE is limited.

In addition, in order to align paging DRX cycles and SL DRX cycles, potential spec changes may affect both SA2 and RAN, therefore causing large standardization efforts.

1. Potential spec changes for aligning paging DRX and SL DRX may cause large standardization efforts.

Given limited time frame for Rel-17, RAN2 is therefore suggested to focus on DRX core functionality, i.e., alignment of Uu DRX in RRC\_CONNECTED and SL DRX. Alignment between paging DRX and SL DRX shall be down-prioritized for Rel-17.

According to the contributions submitted by companies, it is clear that all companies support alignment of Uu DRX and SL DRX in RRC CONNECTED, which is the baseline for the WI study objective.

**Q3-1: do companies agree that alignment of Uu DRX and SL DRX for UE in RRC CONNECTED shall be a baseline?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| OPPO | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes |  |
| Samsung | Yes |  |
| Spreadtrum | Yes |  |

However, it is controversial between companies on whether alignment of Uu DRX and SL DRX for UE in non RRC CONNECTED, i.e., RRC IDLE and RRC INACTIVE.

Based on submitted contributions, companies’ views are summarized in the below table

|  |  |  |
| --- | --- | --- |
| Support  | Don’t support  | To study |
| VIVO, XIAOMI, ZTE | Ericsson, Qualcomm, Samsung | CATT |

Since not all companies have expressed their views on the RRC state, rapporteur would like to raise the below question.

**Q3-2: do companies agree that alignment of Uu DRX and SL DRX shall be also supported for UE in RRC IDLE and RRC INACTIVE?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes with comments | It can be up to UE implementation to decide/modify proper SL DRX parameters, e.g., offset, to achieve alignment between Uu IDLE/INACTIVE cycle and SL DRX. |
| Xiaomi | Yes | We see power saving gain to align Uu DRX and SL DRX for IDLE UE. Also, the spec impact is rather limited. Anyway the signalling exchange between TX UE and RX UE is required to align Uu DRX and SL DRX for connected UE. We could reuse the same design to exchange information about IDLE Uu DRX. |
| OPPO | No | Agree with rapporteur that the additional power saving aligning paging DRX and SL DRX for a UE in RRC IDLE or RRC INACTIVE is limited. Besides the large standardization efforts issue raised by rapporteur, there will be more restrictions on SL transmission since the PO for a UE cannot be adjusted.So at least we can save the specification effort to achieve this, and rely on UE/NW implementation if anyone would like to pursue that. |
| CATT | No | Support this will cause more spec impacts raised by rapporteur, we should focus on the RRC CONNECTED state in the current stage. |
| InterDigital | No | This can be left to future releases if needed. |
| Samsung | No | This should be considered only when we still have time after the completion of DRX alignment for RRC connected UEs.  |
| Spreadtrum | No | Leave to future releases. |

## Who determines alignment

This issue is related to discussion outcome of RRC state.

For UE in RRC CONNECTED, regarding who determines alignment of Uu DRX and SL DRX, the contributions [1-7][9][12-13] have expressed their views. The below two options are proposed

Option 1: up to UE, i.e., UE adjusts its SL DRX configuration in order to aligned with Uu DRX

Option 2: up to gNB, i.e., gNB provides proper DRX configuration and SL DRX configuration to achieve alignment. In this option, UE may provide assistance information to gNB.

In the above options, UE may be a TX UE or RX UE, depending on which option will been decided for controlling alignment of SL DRX between TX UE and RX UE (i.e., depending on outcome of [POST113-e][704]). In this email discussion, we describe the options in an agnostic fashion, i.e., don’t distinguish between TX UE and RX UE. Similarly, for gNB, we also don’t distinguish between TX UE’s gNB and RX UE’s gNB.

From Rapporteur’s view, because the gNB has rich knowledge of the system and UEs served by the system, how to achieve a good alignment between Uu DRX and SL DRX should be controlled by the gNB. In this way, it would be feasible to achieve a good trade-off between system performance and UE performance.

It is worth noting that the final questions and corresponding proposals will be updated to reflect outcome/agreement from [POST113-e][704]. In other words, if RAN2 will adopt TX centric option, it will be TX UE’s gNB to determine alignment of Uu DRX and SL DRX for UEs in RRC CONNECTED. If RAN2 will adopt RX centric option, it will be RX UE’s gNB to determine alignment of Uu DRX and SL DRX for UEs in RRC CONNECTED.

**Q4-1: for UE in RRC CONNECTED, which option do companies think shall be chosen for determining alignment of Uu DRX and SL DRX?**

* **Option 1: up to UE, i.e., UE adjusts its SL DRX configuration in order to aligned with Uu DRX**
* **Option 2: up to gNB, i.e., gNB provides proper DRX configuration and SL DRX configuration to achieve alignment. In this option, UE may provide assistance information to gNB.**
* **Option 3: Other (please specify in the comment section)**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comments |
| vivo | Option 2 | We understand that for a connected UE, its SL DRX configuration is provided and controlled by its serving gNB, as well as Uu DRX configuration.Hence, alignment is just up to gNB. |
| Xiaomi | Both | We don’t think RAN2 would specify how to do the alignment. It’s up to UE or gNB’s implementation to decide appropriate configuration to achieve alignment. UE only need to provide assistant information to peer UE and gNB. |
| OPPO | Option 2 | For unicast, if the UE is in CONNECTED, agree with rapporteur that it’s more feasible to rely on gNB to achieve a good trade-off between system performance and UE performance.For group/broadcast, since the SL-DRX is up to network to configure, it is always up to gNB. |
| CATT | Option2 | For UE in RRC CONNECTED state, considering the Uu DRX is determined by the gNB, with less spec impacts, we prefer to choose option2.  |
| InterDigital | Option 2 and option 3 | Option 2 allows a better flexibility to align both Uu DRX and SL DRX while allowing SL DRX to consider multiple links compared to option 1. However, we see another option where the UE decides the DRX configuration (e.g. with the peer UE in unicast), and then provide the decided configuration to the gNB so that the Uu DRX can be aligned with SL DRX. We think both options should be used.  |
| Samsung | Option 2 | Option 2 is definitely baseline and we don’t really see the need of option 3 in addition to option 2.  |
| Spreadtrum | Option 2 | Option 2 is the most efficient solution, since the gNB provides both Uu and SL DRX configurations for RRC\_CONNECTED UE. |

For UE in RRC IDLE or RRC INACTIVE, if RAN2 decides to support alignment of Uu DRX and SL DRX. The only feasible option would be to up to UE implementation.

if RAN2 decides to support alignment of Uu DRX and SL DRX for UE in RRC IDLE and INACTIVE, it is worth noting that the final questions and corresponding proposals will be updated to reflect outcome/agreement from [POST113-e][704]. In other words, if RAN2 will adopt TX centric option, it will be up to TX UE’s implementation to determine alignment of Uu DRX and SL DRX (e.g., adjust SL DRX according to Uu DRX) for the two UEs in RRC IDLE and INACTIVE. If RAN2 will adopt RX centric option, it will be up to RX UE’s implementation to determine alignment of Uu DRX and SL DRX (e.g., adjust SL DRX according to Uu DRX) for the two UEs in RRC IDLE and INACTIVE.

**Q4-2: for UE in RRC IDLE and INACTIVE, if RAN2 decides to support alignment of Uu DRX and SL DRX, do companies agree that the alignment is up to UE implementation?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes | See the above reply for Q3-2. |
| Xiaomi | Yes | Same as Q4-1 |
| OPPO | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes, but | We prefer to not have such alignment at all for this release, as power savings is minimal. |
| Samsung | Yes only if RAN2 decides that support.  |  |
| Spreadtrum | Yes |  |

## Alignment scenarios

In addition, a UE may connect to one or multiple neighbour UEs via SL connections. To this end, we envision the following two scenarios for aligning Uu DRX and SL DRX:

* Scenario 1: Alignment of Uu DRX and SL DRX of the same UE
* Scenario 2: Alignment of Uu DRX of Tx UE and SL DRX of Rx UE (relevant to SL Mode-1).

From Rapporteur’s understanding, Scenario 1 is needed according the study objective of the WID.

* *Specify mechanism aiming to align sidelink DRX wake-up time with Uu DRX wake-up time in an in-coverage UE*

Scenario 2 is mainly motivated for Mode 1 scheduling, otherwise, when gNB schedules a SL grant to a TX UE, the transmission corresponding to the grant would be lost if RX UE is in DRX INACTIVE TIME.

**Q5-1: do companies agree that alignment scenario 1, i.e., alignment of Uu DRX and SL DRX of the same UE shall be considered?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes |  |
| Xiaomi | Yes |  |
| OPPO | Yes |  |
| CATT | Yes |  |
| InterDigital | Yes |  |
| Samsung  | Yes |  |
| Spreadtrum | Yes |  |

**Q5-2: do companies agree that alignment scenario 2, i.e., Alignment of Uu DRX of Tx UE and SL DRX of Rx UE?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| vivo | Yes with comments | TX UE needs to request resource allocation in the active time of RX UE. From our view, SL resource scheduling request is more similar to UL data. In Uu, a scheduling request for UL data can be triggered anytime, i.e., there is no need to follow DRX restriction. Hence, Uu DRX of TX UE does not impact on SL DRX resource request.Nevertheless, if TX UE has a requirement on power saving, it can be FFS for TX UE alignment between Uu DRX of TX UE and SL DRX of RX UE. It is worthwhile noting that, in this case, the full-overlapping DRX solution may be not beneficial because sequentially, TX UE needs to acquire the grant from gNB during Uu DRX active time (including SR triggering) first, and then sends the TB to RX UE, accordingly. |
| Xiaomi | Comment | If we agree TX centric DRX configuration, the Uu DRX of TX UE and SL DRX of RX UE are both configured by TX UE’s gNB. It’s up to gNB’s implementation to align them. No additional effort is needed. |
| OPPO | See comments | We understand since scenario-2 is for mode-1, it means the Tx UE is in CONNECTED, and the objective of this alignment is to make sure the mode1 SL grant is appropriately allocated by gNB considering the SL DRX of the Rx UE. To achieve that, the Tx UE should report the Rx UE’s DRX condition to the serving gNB to make sure gNB is aware of the active time of the counter part UE. As for how to achieve the appropriate resource allocation, it can be up to NW implementation.  |
| CATT | Yes | We agree with this scenario and think that it can be up to NW implementation for mode-1 and Tx-centric is adopted. |
| InterDigital | Yes |  |
| Samsung | See comments | We agree with OPPO. It seems it was covered by email discussion on TX/RX centric issue hosted by OPPO. It may be good first to see what will be concluded from that discussion.  |
| Spreadtrum | Yes |  |

1. xxx.

# Conclusion

We have the following proposal:

[Proposal 1 xxx.](#_Toc69160470)

# Reference

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# Appendix