**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.  Rapp-> The main intention of this question is for clarification of RAN2 understanding on the alignment scenarios. How they will affect the spec can be further discussed. |
| OPPO | Yes |  |
| CATT | Yes | We agree the full overlapping case is one valid target for alignment. |
| InterDigital | Yes |  |
| Samsung | Yes |  |
| Spreadtrum | Yes |  |
| Huawei, HiSilicon | See comments | We are not sure the intention of this question. How to achieve the alignment and whether to achieve full or partial overlapping should be up to NW and/or UE implementation based on some assistance information when determining the Uu and SL DRX configuration. Regarding to non-overlapping due to single RF chain, we think whether only single chain is supported or not is out of RAN2 scope and RAN2 cannot make such assumption without any configuration from RAN1/RAN4. So at least for now, we cannot conclude whether the alignment between Uu DRX and SL DRX is full overlapping, partial overlapping or non-overlapping.  Rapp-> since single RF chain was supported in Rel-16 V2X, think we can just assume the same scenario will be also supported in NR Rel-17. But, of course, this can be further discussed. |
| Sharp | Yes |  |
| ZTE | See comment | We think whether SL DRX and Uu DRX needs alignment depends on: 1) serving cell TDD configuration; 2) UE capability; 3) the power saving requirement of the UE. Thus, whether full overlapping or partial overlapping is used are up to gNB or TX UE’s implementation. So we do not know why defines the alignment of Uu DRX and SL DRX?  Rapp-> agree, how to align or how large extent the alignment can be achieved depending in the things you have highlighted. Since this question is mainly aiming to achieve a general understanding on the term “alignment”, further details can be discussed in subsequent discussions. |
| Fujitsu | Yes |  |
| Lenovo, MotM | Comment | The SL active time should be a subset of (i.e. overlapping and shorter in time) Uu active time and therefore – either the overlap between the active times or the corresponding overlap in sleep time is being named here as “alignment” in our understanding.  Rapp-> uncertain if I understand the second half of the comment. For the first half, I agree. |
| Nokia | Yes |  |
| Fraunhofer | Yes |  |
| Intel | See comment | Before going into details of the overlapping, it would be good to clarify what exactly “DRX wake up time” means and if/how it is different from DRX active time (which we have defined in previous agreements). In our view, wake up time refers to the time instant when the UE wakes up from DRX sleep while in [13] it is assumed that it is synonymous with DRX active time.  Then, as observed in our paper [9], it can be beneficial to consider some correlation between the Uu and SL DRX cycles regardless of the RF chains makeup (for Uu and sidelink) for a given UE. So, we agree that full, partial and non-overlapping cases should in general all be considered in this alignment. At the same time, is not fully clear how each of these cases affect potential signaling for alignment  Rapp-> rapporteur understands the intention. This email discussion is targeting to achieve a general clarification on the term “alignment”, further details on how to achieve alignment and the signaling are left out from this email discussions. Since this is the first time to discuss alignment of Uu DRX and SL DRX, rapporteur suggests that we focus on general discussions. But generally, I interpret that Intel agrees with the question. |
| Apple | Yes |  |
| Convida Wireless | Yes | Full overlapping is the mechanism that achieves the greatest power savings at the UE. When possible, or if (pre)configured, there should be full overlap between Uu DRX and SL DRX in time |
| Qualcomm | Yes w,  comment | It depends on UE’s capability, power saving, and gNB’s management. Fully overlapping can be one of the cases for Uu DRX and SL DRX alignment, e.g., if SL resource allocation is Mode 1. |
| LG | Yes |  |
| Ericsson | 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 |  |
| Huawei, HiSilicon | See comments | See our reply on Q1-1. |
| Sharp | Yes |  |
| ZTE | comment | Same as Q1-1 |
| Fujitsu | Yes |  |
| Lenovo, MotM | Comment | The SL active time should be a subset of (i.e. overlapping and shorter in time) Uu active time and therefore – either the overlap between the active times or the corresponding overlap in sleep time is being named here as “alignment” in our understanding. |
| Nokia | Yes |  |
| Fraunhofer | Yes |  |
| Intel | See comment | Same comment as in Q1-1 |
| Apple | Yes |  |
| Convida Wireless | Yes | In some cases full overlap may not be possible – for example in some cases it may lead to throughput issues on the SL as all transmissions are during the same active times. For these cases, a partial overlap may be useful. |
| Qualcomm | Yes w,  comment | It depends on UE’s capability, power saving, and gNB’s management. Partially overlapping can be one of the cases for Uu DRX and SL DRX alignment. |
| LG | Yes |  |
| Ericsson | 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 |  |
| Huawei, HiSilicon | See comments | See our reply on Q1-1. |
| Sharp | Yes |  |
| ZTE | comment | Same as Q1-1 |
| Fujitsu | Yes |  |
| Lenovo, MotM | Do not understand the question | We assume the most basic situation is UE with single RF chain and that simultaneous UL and SL transmission is special UE capability and depends on their frequencies, transmit power constraints etc. So, aligning Uu and SL DRX is just about overlapping their active time to the maximum extent – we do not assume that the transmits UL and SL “at the same” transmit opportunity |
| Nokia | Yes |  |
| Fraunhofer | Yes |  |
| Intel | See comment | Same comment as in Q1-1 |
| Apple | Yes |  |
| Convida Wireless | Yes | In some cases, the Uu DRX and SL DRX will have to be non-overlapping |
| Qualcomm | Yes w,  comment | It depends on UE’s capability, power saving, and gNB’s management. No overlapping can be one of the cases for Uu DRX and SL DRX alignment, e.g., if SL resource allocation is Mode 2 only. |
| LG | Yes |  |
| Ericsson | Yes |  |

**Rapporteur summary**: According to the comments received by the companies, it seems that there are majority view on Rapporteur’ suggested term clarification.

In total, there are 15 companies out of 20 support yes, while there are 5 companies have concerns on the intention of the questions, and signaling impacts due to different alignment scenarios. There is one company concerning on the single RF chain scenario, since whether single RF chain can be supported shall be decided in other work groups. But in order to address the concerns of the companies, we can put FFS in the proposals.

In general, the above questions are raised aiming to achieve a general understanding on the potential alignment scenarios, we can leave details to be addressed in subsequent discussions.

Rapporteur would like to try to reach at least a consensus about the above highlighted points and thus would like to suggest:

1. [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the full overlapping between Uu DRX and SL DRX in time. FFS on spec impacts.
2. [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the partial overlapping between Uu DRX and SL DRX in time. FFS on spec impacts.
3. [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the non overlapping between Uu DRX and SL DRX in time (i.e., UE with single RF chain) if single RF chain scenario is supported. FFS on spec impacts.

## 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. |
| Huawei, HiSilicon | See comments | We think the alignment of Uu DRX and SL DRX should focus on unicast. For groupcast and broadcast, we think no additional mechanism is needed as the common DRX configuration for gourpcast and broadcast is configured by the NW or preconfigured and we can rely on the NW implementation/preconfiguration to achieve some kind of alignment.  Rapp-> I interpret that HW supports alignment of Uu DRX and SL DRX for GC/BC, but, of course, RAN2 can further discuss whether additional mechanisms are needed. |
| Sharp | Yes | Alignment of Uu DRX and SL DRX should be applicable for all cast types. |
| ZTE | Yes | We think the power saving performance shall not be ignored for all cast type. however, it is more likely a NW or UE implementation issue. |
| Fujitsu | Yes | Alignment of Uu DRX and SL DRX should be done for all cast types. |
| Lenovo, MotM | Yes |  |
| Nokia | Yes, in principle | However, we are a bit puzzled on how to achieve this considering the fact that each UE may have very different Uu DRX configuration.  We think we should focus on developing a solution for unicast, which may anyway most likely carry most data, and then see if it is applicable to GC/BC or if it can be implicitly done |
| Fraunhofer | Yes | Uu and SL DRX should consider all cast types for power saving efficiency. |
| Sony | No | Groupcast and Broadcast cannot be aligned to a specific UEs idle mode Uu DRX timing, since every UEs have specific/different DRX scheme configured for the Uu interface |
| Intel | See comment | As discussed in [9], the key aspect with respect to this alignment is how the DRX configuration for the case of each cast type is procured. For unicast, since the configuration can be UE/link specific, some signalling to assist the gNB shall be needed (as already discussed in related email discussions). In contrast, for groupcast and broadcast, since RAN2 seems to be heading towards a “common” configuration provided by the network with no potential interaction among member UEs, it is not clear what additional signalling and spec impact is needed for the NW to achieve this alignment |
| Apple | Yes for unicast. FFS for GC/BC | For GC/BC, the common DRX configuration is already provided by gNB so that full/partial/non-overlapping alignment is all up to gNB implementation  Rapp-> I interpret that Apple supports alignment of Uu DRX and SL DRX for GC/BC, but, of course, RAN2 can further discuss whether additional mechanisms are needed. |
| Convida Wireless | Yes | We clearly see a benefit for unicast, where a UE may have multiple SL DRX configurations and a Uu DRX configuration. Alignment would be beneficial from a power savings perspective  There are also benefits for the groupcast and broadcast case. However these already use a common DRX (DRX configuration shared by a number of UEs) and the benefit may not be as significant as for unicast. |
| Qualcomm | Yes w, comment | Yes, for unicast.  Yes, for groupcast and broadcast if UEs are grouped per destination ID/PQI for a common SL DRX. |
| LG | Yes (only unicast) | We have same view with Huawei. We think that no additional mechanism is not needed for common DRX configuration.  Rapp-> I interpret that LG supports alignment of Uu DRX and SL DRX for GC/BC, but, of course, RAN2 can further discuss whether additional mechanisms are needed. |
| Ericsson | Yes |  |

**Rapporteur summary**: According to the comments received by the companies, companies’ comments are summarized in the below.

In total, there are 21 companies out of 21 support yes for unicast. There is two companies proposing to not support alignment for GC/BC. Meanwhile, there are 2 companies suggesting further studies for GC/BC. There are a few companies having comments on GC/BC spec impacts, saying that alignment for GC/BC will be up to gNB’s implementation/pre-configuration.

In addition, it is worth noting that UE may need to send assistance information to gNB, or assistance information may be exchanged between UEs (i.e., unicast), however, it will be addressed in the email discussion 704.

Rapporteur would like to try to reach at least a consensus about the above highlighted points and thus would like to suggest:

1. [Easy][21/21] Alignment of Uu DRX and SL DRX for unicast is supported. FFS on how alignment is achieved.
2. [Easy][19/21] Alignment of Uu DRX and SL DRX for groupcast and broadcast is supported. FFS on whether new mechanisms are needed.

## 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 |  |
| Huawei, HiSilicon | Yes |  |
| Sharp | Yes |  |
| ZTE | Yes |  |
| Fujitsu | Yes |  |
| Lenovo, MotM | Yes |  |
| Nokia | Yes |  |
| Fraunhofer | Yes |  |
| Sony | \*Yes | But, if the UE is involved in SL traffic, it may not have much traffic over Uu. |
| Intel | Yes |  |
| Apple | Yes |  |
| Convida Wireless | Yes |  |
| Qualcomm | Yes |  |
| LG | Yes |  |
| Ericsson | 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. |
| Huawei, HiSilicon | Yes | We do see some benefit on UE power saving if some kind of alignment is applied for UE in RRC IDLE/INACTIVE. Therefore, we think the alignment of Uu DRX and SL DRX for UE in RRC IDLE/IINACTIVE should be supported but the discussion on this part can be deprioritized. |
| Sharp | No |  |
| ZTE | Yes | According to our understanding, the UE may stay in RRC idle/inactive state for a long time, it is not reasonable to ignore the power saving performance for a RRC idle/inactive UE. However, we think the coordination between SL DRX and Uu DRX can be up to UE implementation. |
| Fujitsu | No | Considering the specification impact, we prefer not to support it. |
| Lenovo, MotM | No | At least no specification efforts need to be spent on it. If the PC5 RRC based fine tuning of DRX configuration achieves this – we do not need to preclude or even discuss this. |
| Nokia | No | The benefit is not clear for us. But we are fine to proceed in this direction if time is there. Let us focus on unicast with both connections in RRC\_CONNECTED first, then go to group/broadcast, and thereafter see the benefits of Uu IDLE/INACTIVE |
| Fraunhofer | No | It can be left to future releases. |
| Sony | Yes |  |
| Intel | Yes with comment | If we can achieve this alignment with limited spec impact for IDLE and INACTIVE case, we should not preclude them. But, we agree that we should focus on the RRC\_CONNECTED case first |
| Apple | NO |  |
| Convida Wireless | No | We do see some benefits in aligning the Uu DRX and SL DRX for RRC IDLE and RRC INACTIVE, but we agree with both observations from the Rapporteur. |
| Qualcomm | No | Down scope for Rel 17. |
| LG | Yes | We think that DRX alignment can be performed when a UE is in RRC\_IDLE or INACTIVE state. In this case, the UE has Uu DRX cycle to receive paging message. There is a motivation to align them. |
| Ericsson | No | Down scope for Rel 17. |

**Rapporteur summary**: According to the comments received by the companies, companies’ comments are summarized in the below.

In total, there are 21 companies out of 21 supporting yes for aligning Uu DRX and SL DRX for UEs in RRC CONNECTED. For aligning Uu DRX and SL DRX for UEs in RRC IDLE and RRC INACTIVE, there are 14 out of 21 companies supporting to down-prioritize RRC IDLE and RRC INACTIVE. Rapporteur interprets that we have clear majority to down-prioritize RRC IDLE and RRC INACTIVE.

Rapporteur would like to try to reach at least a consensus about the above highlighted points and thus would like to suggest:

1. [Easy][21/21] Alignment of Uu DRX and SL DRX for UE in RRC CONNECTED shall be a baseline.
2. [For discussion][14/21] RAN2 to down-scope alignment of Uu DRX and SL DRX for UEs in RRC IDLE and RRC INACTIVE from Rel-17.

## 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. |
| Huawei, HiSilicon | See comments | Firstly we think this question only asks about the alignment of Uu DRX and SL DRX of the same UE without considering the alignment of Uu DRX of Tx UE and SL DRX of Rx UE, right?  Even for the alignment for the same UE, we think whether we go with Option 1 or Option 2 depends on whether it is the UE or the NW determines the SL DRX configuration and whether we go with TX centric or RX centric mechanism. Different cases are listed as below  Case1: RX centric+ RX UE determines the SL DRX configuration, then we can rely on the RX UE to adjust the SL DRX configuration to align with RX UE’s Uu DRX or we can rely on the RX UE’s NW to adjust the RX UE’s Uu DRX configuration to align with the SL DRX configuration which is reported from the RX UE.  Case 2: RX centric+ RX UE’s NW determines the SL DRX configuration, then we can rely on RX UE’s NW implementation to achieve alignment when configuring the SL and Uu DRX configuration.  Case 3: TX centric+ TX UE determines the SL DRX configuration, then we can rely on the TX UE to adjust the SL DRX configuration to align with RX UE’s Uu DRX which is carried as assistance information to the TX UE or we can rely on the RX UE’s NW to adjust the RX UE’s Uu DRX configuration to align with the SL DRX configuration which is reported from the RX UE.  Case 4: TX centric+ TX UE’s NW determines the SL DRX configuration, then we can rely on the TX UE’s NW to adjust the SL DRX configuration to align with RX UE’s Uu DRX which is carried as assistance information to the TX UE and then to the TX UE’s NW or we can rely on the RX UE’s NW to adjust the RX UE’s Uu DRX configuration to align with the SL DRX configuration which is reported from the RX UE.  Rapp-> as Rapporteur said in the texts, we don’t distinguish whether it is TX centric or RX centric, since it is being handled by another email discussion 704, the proposals outcome from this email discussion will be updated when 704 has solid conclusion.  Based on the above comments, from my interpretation, if ignoring difference between TX centric or RX centric approaches, it seems that HW supports Option 1 + Option 2 |
| Sharp | Option 2 | When UE is in RRC CONNECTED, gNB is preferred to determine the alignment. |
| ZTE | Option2 | agree with rapporteur |
| Fujitsu | Option 2 | Since Uu DRX configuration is determined by gNB, option 2 seems most efficient. |
| Lenovo, MotM | Option 3 | Further for this option, UE send assistance information e.g. SL DRX configuration, Uu DRX configuration of peer UE etc is useful.  Rapp-> assistance information is being handled by email discussion 704. |
| Nokia | Option 2 | But we understand that the specification effort for this will be on the UE assistance information, if any. |
| Fraunhofer | Option 2 | In RRC connected state the UE should provide assistance information to the gNB and then alignment decision is taken by gNB. |
| Sony | Option 2 | Only gNB has information of all involved UE´s in the SL communication. |
| Intel | Option 2 | Since we assume that it is the gNB that provides both the Uu and the SL DRX configuration to the UE in this case, it is natural that the alignment is also upto the gNB implementation. |
| Apple | Option 2 and Option 3 | We share the same view as InterDigital |
| Convida Wireless | Option 2 and Option 3 | In our view, both gNB option and a form of UE option should be supported. It may depend on:   * whether the SL DRX configuration is TX centric or RX centric. * Whether we are referring to the TX UE gNB or the RX UE gNB   In an RX centric case, we clearly see the benefit of having the RX UE gNB manage the Uu DRX and SL DRX alignment. However, we feel that in the TX centric case, the UEs would be in a better position to manage the alignment – for example RX UE may provide assistance information to the TX UE. |
| Qualcomm | Option 2 |  |
| LG | Option 1 and 2 | Both options seem to be possible. The network can do the alignment for a UE. Also, a UE can perform the alignment with Uu DRX and SL DRX by UE itself. |
| Ericsson | Option 2 |  |

**Rapporteur summary**: According to the comments received by the companies, companies’ comments are summarized in the below.

In total, there are 20 companies out of 21 supporting Option 2. In addition, 3 companies are also supporting Option 1. 3 companies are also supporting Option 3 in addition to Option 2. 1 company supports only Option 3.

Rapporteur would like to try to reach at least a consensus about the above highlighted points and thus would like to suggest:

1. [Easy][20/21] For UEs in RRC CONNECTED, the alignment of Uu DRX and SL DRX is up to gNB, e.g., gNB provides proper DRX configuration and SL DRX configuration to achieve alignment.
2. [For discussion][3/21] For UEs in RRC CONNECTED, in order to achieve alignment of Uu DRX and SL DRX, RAN2 further discusses if UE based option is supported, e.g., UE adjusts SL DRX according to Uu DRX or UE determines SL DRX and reports to gNB.

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 |  |
| Huawei, HiSilicon | See comments | Based on the offline discussion from [POST113-e][704], when the UE is in RRC IDLE/INACTIVE, the UE is responsible for determining the SL DRX configuration with some information from SIB taken into account. Therefore in this case, if RAN2 decides to support alignment of Uu DRX and SL DRX for UE in RRC IDLE/INACTIVE, the alignment should be up to UE implementation taking into account of input from SIB. |
| Sharp | Yes |  |
| ZTE | Yes |  |
| Fujitsu | Yes |  |
| Lenovo, MotM | Yes |  |
| Nokia | Yes |  |
| Fraunhofer | Yes | As discussed in the [POST113-e] [704], it can be decided by UE implementation while taking into account input of the SIB. |
| Sony | Yes |  |
| Intel | Yes | If supported, we assume the UE shall adjust its SL DRX cycle/config to accomplish this alignment in IDLE/INACTIVE. How to take input from SIB in this case can be further discussed |
| Apple | Yes |  |
| Convida Wireless | Yes |  |
| Qualcomm | Yes |  |
| LG | Yes |  |
| Ericsson | Yes |  |

**Rapporteur summary**: According to the comments received by the companies, companies’ comments are summarized in the below.

In total, all companies agree to up to UE implementation on how to achieve alignment of Uu DRX and SL DRX for UEs in RRC IDLE and RRC INACTIVE, if it is supported. There are 3 companies suggest that UE shall consider SIB when determining alignment. Since this has been handled in email discussion 704, we will skip this question in this email discussion.

## 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 |  |
| Huawei, HiSilicon | Yes |  |
| Sharp | Yes |  |
| ZTE | Yes |  |
| Fujitsu | Yes |  |
| Lenovo, MotM | Yes |  |
| Nokia | Yes |  |
| Fraunhofer | Yes |  |
| Intel | Yes | In our understanding, the earlier questions pertain to this exact scenario, i.e. this is the main scenario for which alignment needs to be considered |
| Apple | See comment | We are not sure this is the main case of alignment. Uu reception and SL reception are rather independent and no obvious power saving benefits are perceived. |
| Convida Wireless | Yes |  |
| Qualcomm | Yes |  |
| LG | Yes |  |
| Ericsson | Yes |  |

**Rapporteur summary**: According to the comments received by the companies, companies’ comments are summarized in the below.

In total, 20 out 21 companies agree that alignment scenario 1, i.e., alignment of Uu DRX and SL DRX of the same UE shall be considered.

Given this is a clear majority.

Rapporteur would like to suggest

1. [Easy][20/21] The alignment of Uu DRX and SL DRX of the same UE shall be considered.

**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 |  |
| Huawei, HiSilicon | Yes | If no alignment is performed, it is possible that the SL grant scheduled for the Tx UE during its Uu DRX active time does not fall into the SL DRX active time of the peer Rx UE. If the Uu DRX active time for the TX UE and the SL DRX active time of its peer UE is mismatched with each other, there may be some issue with scheduling, e.g., the SCI scheduling the SL grant corresponding to the DCI within the Tx UE’s Uu DRX active time is not within the Rx UE’s SL DRX active time, or the DCI scheduling the SL grant corresponding to the SCI within the RX UE’s SL DRX active time is not within the Tx UE’s Uu DRX active time. |
| Sharp | Yes |  |
| ZTE | Comment | Scenario 2 is only associated to a RRC connected TX UE, as we know, the Uu DRX configuration for a RRC connected UE is decided by the network, so whether considering scenario 2 is totally NW implementation issue. |
| Fujitsu | Yes with comments | In mode-1, the TX UE’s SL resource is allocated by the gNB in DCI by PDCCH. In order for the RX UE to receive the SL data in the SL resource, it may be better that the TX UE’s Uu DRX active time has some linkage with the SL DRX active time of the RX UE. |
| Lenovo, MotM | Yes with comment | Some assistance from the UE to gNB can take care of this (i.e. Rx UE’s DRX configuration) |
| Nokia | Yes |  |
| Fraunhofer | Yes |  |
| Intel | See comment | For the case envisioned for scenario 2, i.e. mode1 scheduling, we assume the alignment is still upto the gNB as discussed above. So, we the same principle as discussed therein applies and no special handling is needed in our view |
| Apple | Yes | This is needed for mode 1 |
| Convida Wireless | Yes | We agree that some mechanism is needed to make sure that a SL grant received during the Uu active time may be used during the RX UEs SL active time. However, we find the use of the term ‘alignment’ in the question may be misleading. We are not sure if the issue can be solved by making sure that the gNB is aware of the RX UE SL DRX configuration. |
| Qualcomm | Comment | For Tx-centric, it’s straight forward since both Uu DRX and SL DRX are based on the same Tx UE.  For Rx-centric, it could be a little more complicate since Uu DRX based on Tx UE and SL DRX based on Rx UE, especially if Rx UE is under a different gNB’s management. |
| LG | Yes |  |
| Ericsson | Yes |  |

**Rapporteur summary**: According to the comments received by the companies, companies’ comments are summarized in the below.

In total, 14 out 21 companies agree that alignment scenario 2, i.e., alignment of Uu DRX of Tx UE and SL DRX of Rx UE. Several companies think that this scenario can be just left to gNB, since this is also handled in email discussion 704, Rapporteur suggest to put a FFS on gNB impact.

Given this is a clear majority, rapporteur would like to suggest

1. [For discussion][14/21] The alignment of Uu DRX of Tx UE and SL DRX of Rx UE shall be considered. FFS on gNB impact.

# Conclusion

We have the following proposal:

[Proposal 1 [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the full overlapping between Uu DRX and SL DRX in time. FFS on spec impacts.](#_Toc69460339)

[Proposal 2 [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the partial overlapping between Uu DRX and SL DRX in time. FFS on spec impacts.](#_Toc69460340)

[Proposal 3 [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the non overlapping between Uu DRX and SL DRX in time (i.e., UE with single RF chain) if single RF chain scenario is supported. FFS on spec impacts.](#_Toc69460341)

[Proposal 4 [Easy][21/21] Alignment of Uu DRX and SL DRX for unicast is supported. FFS on how alignment is achieved.](#_Toc69460342)

[Proposal 5 [Easy][19/21] Alignment of Uu DRX and SL DRX for groupcast and broadcast is supported. FFS on whether new mechanisms are needed.](#_Toc69460343)

[Proposal 6 [Easy][21/21] Alignment of Uu DRX and SL DRX for UE in RRC CONNECTED shall be a baseline.](#_Toc69460344)

[Proposal 7 [For discussion][14/21] RAN2 to down-scope alignment of Uu DRX and SL DRX for UEs in RRC IDLE and RRC INACTIVE from Rel-17.](#_Toc69460345)

[Proposal 8 [Easy][20/21] For UEs in RRC CONNECTED, the alignment of Uu DRX and SL DRX is up to gNB, e.g., gNB provides proper DRX configuration and SL DRX configuration to achieve alignment.](#_Toc69460346)

[Proposal 9 [For discussion][3/21] For UEs in RRC CONNECTED, in order to achieve alignment of Uu DRX and SL DRX, RAN2 further discusses if UE based option is supported, e.g., UE adjusts SL DRX according to Uu DRX or UE determines SL DRX and reports to gNB.](#_Toc69460347)

[Proposal 10 [Easy][20/21] The alignment of Uu DRX and SL DRX of the same UE shall be considered.](#_Toc69460348)

[Proposal 11 [For discussion][14/21] The alignment of Uu DRX of Tx UE and SL DRX of Rx UE shall be considered. FFS on gNB impact.](#_Toc69460349)

3.1 For chair notes (proposal in priority order)

**Easy Proposals for Block Approval**

[Proposal 1 [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the full overlapping between Uu DRX and SL DRX in time. FFS on spec impacts.](#_Toc69458466)

[Proposal 2 [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the partial overlapping between Uu DRX and SL DRX in time. FFS on spec impacts.](#_Toc69458467)

[Proposal 3 [Easy][16/20] Alignment of Uu DRX and SL DRX for UE may comprise the non overlapping between Uu DRX and SL DRX in time (i.e., UE with single RF chain) if single RF chain scenario is supported. FFS on spec impacts.](#_Toc69458468)

[Proposal 4 [Easy][21/21] Alignment of Uu DRX and SL DRX for unicast is supported.](#_Toc69458469) FFS on how alignment is achieved.

[Proposal 5 [Easy][19/21] Alignment of Uu DRX and SL DRX for groupcast and broadcast is supprted. FFS on whether new mechanisms are needed.](#_Toc69458470)

[Proposal 6 [Easy][21/21] Alignment of Uu DRX and SL DRX for UE in RRC CONNECTED shall be a baseline.](#_Toc69458471)

[Proposal 8 [Easy][20/21] For UEs in RRC CONNECTED, the alignment of Uu DRX and SL DRX is up to gNB, e.g., gNB provides proper DRX configuration and SL DRX configuration to achieve alignment.](#_Toc69458473)

[Proposal 10 [Easy][20/21] The alignment of Uu DRX and SL DRX of the same UE shall be considered.](#_Toc69458475)

**Proposals for Online discussion**

[Proposal 7 [For discussion][14/21] RAN2 to down-scope alignment of Uu DRX and SL DRX for UEs in RRC IDLE and RRC INACTIVE from Rel-17.](#_Toc69458472)

[Proposal 11 [For discussion][14/21] The alignment of Uu DRX of Tx UE and SL DRX of Rx UE shall be considered. FFS on gNB impact.](#_Toc69458476)

**Proposals of Low priority**

[Proposal 9 [For discussion][3/21] For UEs in RRC CONNECTED, in order to achieve alignment of Uu DRX and SL DRX, RAN2 further discusses if UE based option is supported, e.g., UE adjusts SL DRX according to Uu DRX or UE determines SL DRX and reports to gNB.](#_Toc69458474)

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# Appendix