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

**E-meeting, April 2021**

Agenda Item: 8.15.2.1

Source: OPPO

Title: Summary of [POST113-e][704][V2X/SL] TX UE centric or RX UE centric DRX configuration determination (OPPO)

Document for: Discussion, Decision

# Introduction

This is for the following email discussion

**[POST113-e][704][V2X/SL] TX UE centric or RX UE centric DRX configuration determination (OPPO)**

**Scope:** Continue the discussion the remained issues regarding who will determine DRX configurations (including TX UE centric vs RX UE centric DRX configuration determination), covering both in and out of coverage scenario.

**Intended outcome:** Discussion summary

**Deadline:** Long email discussion

# Discussion

## For OOC scenario

In this email discussion, we will limit to unicast case.

Base on online discussion at RAN2#113

4: For unicast, for OOC scenario, the UE who sends out the DRX configuration decides on the DRX configuration. FFS on whether pre-configuration and/or the assistance information from the peer UE is also taken into account when determining the DRX configuration.

5: For unicast, for OOC scenario, adopt per-direction DRX configuration is as baseline. FFS on whether it is TX-centric or Rx-centric, i.e. TX UE or RX UE decides it.

As discussed in R2-2102183, the per-direction DRX configuration is something as follows:

*But to look into the core issue, rapporteur suggest the following simplification for the scenario:*

* *Start from OOC scenario to avoid the discussion on gNB involvement as a start point;*
* *Do not touch the failure handling or the negotiation procedure (i.e., in case the DRX configuration is not preferred by the peer UE) in this discussion;*
* *Do not touch the assistance information (information from peer UE to assist the DRX configuration decision) in this discussion;*

*Based on the assumption above, firstly we can look at the options on the table.*

***Option-A: Per-direction DRX configuration***

*Option-A1: Per-direction DRX configuration + Tx-centric manner, i.e., it is the Tx-UE who decide the DRX configuration of Rx-UE, and send it to Rx-UE.*

*NOTE: in the figure below, the timing for UE1/2 send out the configuration is not restricted.*

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*Figure 1 Per-direction DRX configuration + Tx-centric manner*

*Option-A2: Per-direction DRX configuration + Rx-centric manner, i.e., it is the Rx-UE who decide the DRX configuration of Rx-UE, and send it to Tx-UE.*

*NOTE: in the figure below, the timing for UE1/2 send out the configuration is not restricted.*

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*Figure 2 Per-direction DRX configuration + Rx-centric manner*

**NOTE: In the following, the discussion is for a single direction, i.e., UE1 as TX-UE and UE2 as RX-UE. The other direction is not shown in the figure by assuming a symmetric procedure is applied to UE2 as TX-UE and UE1 as RX-UE.**

On the one hand, based on the discussion in RAN2#113, rapporteur understand there is no clear majority on either TX or RX centric manner.

* TX-centric: UE1 send out the DRX configuration to UE2 for UE1=>UE2 direction;
* Rx-centric: UE2 send out the DRX configuration to UE1 for UE1=>UE2 direction;

On the other hand, for each option, there are companies proposing assistance information from the counterpart UE, to avoid unilateral decision, which (assistance information) is in the scope of RAN2#113 discussion in R2-2102183.

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| InterDigital | Yes | […]To the above options, we should add:* **Option A3**: Per direction DRX configuration, TX centric, using information from the RX UE. Here, the TX UE first receives information from the RX UE, decides the DRX configuration for the RX UE based on the information provided, and sends the DRX configuration to the RX UE.
* **Option A4:** Per direction DRX configuration, RX centric, using information from the TX UE. Here the RX UE first receives information from the TX UE, decides its DRX configuration from the received information, and sends its DRX configuration to the TX UE.

[…]  |

* Assistance information for TX-centric: UE2 send out the DRX configuration to UE1 for UE1=>UE2 direction;
* Assistance information for RX-centric: UE1 send out the DRX configuration to UE2 for UE1=>UE2 direction;

So rapporteur suggests we ignore the form of signalling for a while, and if merge

* The two as signalling from UE2 as RX-UE on the DRX configuration;
* The two as signalling from UE1 as TX-UE on the DRX configuration;

**Q1: For the direction of UE1 as Tx-UE and UE2 as Rx-UE, if define**

* **Signaling-1: As signalling from UE2 (RX-UE) to UE1 (TX-UE) including the DRX configuration;**
* **Signaling-2: As signalling from UE1 (TX-UE) to UE2 (RX-UE) including the DRX configuration;**

**which signalling should be supported (regardless of the signalling form, e.g., as configuration, or as assistance information or etc.)**

**Option-1: Both signalling-1 and signalling-2;**

**Option-2: Signalling-1 only;**

**Option-3: Signalling-2 only;**

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| Company | Option | Comment |
| OPPO | Option-1 or Option-3 | Considering the legacy signalling framework on PC5, signalling from Tx-UE to Rx-UE for the configuration of direction from Tx-UE to Rx-UE is necessary.While the assistance signalling from Rx-UE to Tx-UE can be used additionally to take preference from Rx-UE into account. |
| CATT | Option-1 or Option-3 | Signalling 2 should be used as the baseline for configuring DRX parameter and Signalling 1 can be used as assistant information for determining the DRX configuration for the direction from UE1 to UE2. We support that the assistance information can be involved but as an optional choice. |
| Nokia | Option-1 | As the Tx-UE is in principle the one setting up the connection, we think the precedence should in principle lie at this entity. However, given the fact that the Tx-UE may not have any other connections to which it would like to coordinate for the best power savings, at least the Rx-UE should be allowed to send assistance information.As to the above coordination, we also foresee that in such a case as above, the Tx-UE may not care as much on the actual setting, and hence the Rx-UE could make the final decision. In order to make such operation less complex, but Tx assistance information would be beneficial in this case as well, as the Rx UE then will know why it is allowed to set the configuration.We could potentially discuss in RAN113-b when it would be optimal for either the UE performance that the Rx/Tx decides the configuration. |
| vivo | At least Option-3 FFS for Option-1 | Option-3 is preferable since legacy PC5 configuration is from Tx-UE to Rx-UE. We think option-3 is the baseline.Furthermore, the assistance signalling from Rx-UE to Tx-UE can be considered additionally to achieve better power saving performance of Rx-UE. |
| Xiaomi | Option 1 | There has to be one UE, either Tx or Rx, to determine the DRX parameters, i.e. DRX cycles, timers. This UE acts as commander. On the other hand, the other UE should be allowed to send assistant information to commander. So, in either Tx or Rx centric manner, signalling on two direction should be supported. |
| Ericsson (Min) | Option-1  | We support TX-centric option, we think it is more aligned with Rel-16 SL signalling framework. in that case, signaling-1 means assistance information provided by RX UE. We think the assistance information is necessary for the TX UE (if TX UE is not in coverage) and TX UE’s serving gNB (if TX UE is in coverage) to make suitable SL DRX configuration. |
| HW | See comments | We would like to support some kind of assistance information transfer when determining the DRX configuration but we think the detailed information should be FFS, e.g., traffic pattern, resource configuration etc., and should not be limited to DRX configurations only. Therefore, for the direction of UE1 as Tx-UE and UE2 as Rx-UE, we would like to support the following signalling 1 and signalling 2:* **Signaling-1: As signalling from UE2 (RX-UE) to UE1 (TX-UE);**
* **Signaling-2: As signalling from UE1 (TX-UE) to UE2 (RX-UE);**
 |
| ZTE | Option-1 | According to our understanding, the Tx UE knows the traffic QoS requirement and the traffic pattern which may have impacts on DRX cycle and offset of the Rx UE. And the Rx UE knows its power saving requirement and can coordinate awake time from different peer UE. Therefore, both the Tx UE and the Rx UE can be involved in determining the SL DRX configuration for a Rx UE. So even if TX-centric option is adopted, it is better for the RX UE to send the suggested DRX configuration to the TX UE before the TX UE makes the final decision for the SL DRX configuration. |
| Sony | Option-1 | We also support TX-centric option. IEither Rx or TX needs to be in control of the decision, and it is reasonable that the TX UE which starts the communication decides. The Assistance is needed for the RX UE to signal its limitations from other SL communication links etc.  |
|  Intel | Option-3 or Option-1  | We agree with comments from Nokia that since it is the TX UE which is primarily the “controller” for this direction (as per the legacy way) and is also aware of the traffic pattern, TX-centric approach makes more sense. At the same time, in order to achieve tangible power saving gains, the RX UE should be coordinated with by use of some assistance signalling.  |
| Lenovo | Option-3, comment for Option-1 | We think Tx centric could be a baseline, which aligns legacy sidelink signalling framework. And we also support assistance information from Rx UE to assist Tx UE determine the SL DRX configuration. But seems in the discussion part, the content of assistance information is directly assumed as SL DRX configuration. We would like to support assistance information, but also echo Huawei that the content of assistance information needs more discussion. |
| Spreadtrum | Option 1 | We support Tx centric option which is aligned with sidelink design principle from LTE. Meanwhile, we believe some assistance information from the Rx UE is useful. |
| Convida Wireless | Option 1 | In our view, both the TX UE and RX UE have information that may help determine the DRX configuration. One entity is responsible for determining the DRX configuration and informing the peer about this configuration – to make a proper DRX configuration, this entity should rely on assistance from the peer entity. So both Signaling-1 and Signaling 2 are needed, regardless TX centric or RX centric. |
| Fraunhofer  | Option 1 or Option 3 | We think TX centric approach aligns with the legacy PC5 signalling framework. Additionally, the TX UE can determine the DRX configuration taking into account the assistance information provided by the RX UE:* Signaling 1: Assistance information (RX UE->TX UE)
* Signaling 2: DRX Configuration (TX UE->RX UE)
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| ASUSTeK | Option 1 | We prefer per-direction SL DRX so that signalling for SL DRX configuration of UE1-to-UE2 (as UE2 is RX UE) and SL DRX configuration of UE2-to-UE1 (as UE1 is RX UE) are needed. Thus, we support Option 1. |
| InterDigital | Option 1 | We think both signaling are needed in order for one UE to send a possible set of allowable DRX configurations and assistance information, and for the other UE to make the decision of the configuration to be used based on the assistance information provided. In Rel16, the TX UE has access to the SLRB configuration(s), therefore in this case, the TX UE can send this information to the RX UE for the RX UE to make the decision. |

Then the next question is in which form the signalling-1/2 is to be delivered, possible signalling includes:

Option-A: Using *RRCReconfigurationSidelink;*

Option-B: Using *RRCReconfigurationFailureSidelink*, e.g., this message is used to suggest a DRX configuration that is different from the one included in *RRCReconfigurationSidelink*;

Option-C: Using a new PC5-RRC message, e.g., one can mimic the UAI message as used in Uu-RRC;

**Q2a: If one answer option-1 and/or option-2 for Q1, i.e., agree the necessity of signaling-1 (i.e., signalling from UE2 (RX-UE) to UE1 (TX-UE) including the DRX configuration), which PC5-RRC message can be used to carry signaling-1?**

**Option-A: Using *RRCReconfigurationSidelink;***

**Option-B: Using *RRCReconfigurationFailureSidelink*, e.g., this message is used to suggest a DRX configuration that is different from the one included in *RRCReconfigurationSidelink*;**

**Option-C: Using a new PC5-RRC message, e.g., one can mimic the UAI message as used in Uu-RRC;**

**Option-D: Other**

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| Company | Option | Comment |
| OPPO | Option-B or Option-C | Comparing the two approaches, i.e., TX-centric and RX-centric

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| Disadvantage | If rely on Rx-UE to control the DRX configuration | If rely on Tx-UE to control the DRX configuration |
| 1 | Two RX-UE may require a TX-UE to send data on the same resource, but that is infeasible since TX-UE can only perform one single transmission at one slot. | different TX-UE may require a same RX-UE to wake up at different time, so increase the power consumption. |
| 2 | It violates the sidelink design framework of “Tx-centric” since Rel-12, i.e., Tx-UE itself (or the network behind) to decide on the transmission. In more details, the Rx-UE has no information on Tx-side traffic characteristics and resource configuration. Signaling-wise, currently PC5-RRC design is to rely on TX-UE to configure SDAP/PDCP/RLC/MAC/PHY configuration. If DRX configuration becomes an exceptional case, i.e., only this parameter is configured by Rx-UE, then when there is any causality / coupling between DRX and other parameters, it becomes a chicken-and-egg issue, i.e., two related parameters configured by two separate entities (i.e., TX-UE and RX-UE), which may further cause discussion / work on how to coordinate between the two entities |  |
| 3 | Without information of Tx-side traffic characteristics and resource configuration, it is not feasible to rely on Rx-UE to make a final decision on the DRX configuration  |  |

I.e., it seems TX-centric approach have more (less) advantages (disadvantages), especially considering that the only disadvantage can be alleviated by assistance information from RX-UE.For option-B, it allows the Rx-UE to decide on a DRX configuration which is different from the one sent by Tx-UE configuration. For option-C, it allows the Rx-UE to suggest a DRX configuration before the Tx-UE sending a DRX configuration. |
| CATT | Option-C | In our understanding, the signalling sent from Rx UE to Tx UE is a kind of assistant information, we would like to design a new PC5-RRC message for it. |
| Nokia | Option-C, A, B | We think that Option-C may be preferred, but A and B may also work.As a comment to OPPOs described disadvantages;For bullet 2; in our view, an Rx-Centric approach can also been seen as assuming that the assistance information from the Rx-UE is followed completely by the Tx-UE. Hence, the difference between Rx and Tx centric becomes quite vague. Assuming that the Tx-UE provides first assistance information towards Rx-UE, and the Rx-UE then provides back a i.e. subset (single selection) of these configurations to which the Tx-UE follows, then it comes with the advantages of what some call Rx-Centric, but is still compliant with the Tx-Centric nature. Such information could very roughly be seen as the 3 step exchange of UE capabilities.For bullet 3; the information can be made available at the Tx side through assistance information from the Tx-UEFollowing the above, we might need to assume a message flow which is in theory Tx-Centric, but includes transfer of assistance information from both UEs. |
| vivo | Option-C | We share the similar view with OPPO and prefer TX-UE centric DRX configuration procedure.Option-C like Msg can be used for RX-UE to send its preference on DRX like Uu *UEAssistanceInformation* Msg before the Tx-UE sending a DRX configuration, e.g. DRX on/off preference, DRX parameters suggestion.Option-B like Msg can be used for RX-UE to negotiate the detailed DRX parameters with TX-UE after receiving TX-UE’s DRX configuration, e.g. update offset to align between different TX-UEs for better power saving benefits. We understand the intention of Option-B is to reuse the existing PC5 RRC messages. Besides *RRCReconfigurationFailureSidelink*, Option-B like Msg may also be complete Msg (*RRCReconfigurationCompleteSidelink*).Option A is also possible, e.g.,piggybacked in the other directional reconfiguration Msg (*RRCReconfigurationSidelink*).Among the three Options, Option C is the most flexible which can happen without relying on the triggering of PC5 RRC configuration procedure. Therefore, Option C is preferred. |
| Xiaomi | Option C | We prefer Tx centric manner, which means the signalling-1 from Rx to Tx is assistant information. The problem of option A is that Rx UE would trigger T400 upon ***RRCReconfigurationSidelink*** transmission. Tx UE has to response ***RRCReconfigurationCompleteSidelink*** or ***RRCReconfigurationFailureSidelink*** to stop the timer. Otherwise, RX UE would tirgger RLF. Either message is not suitable as respond to assistance information.The problem of option B is to limit the assistance information can only be sent after reception of Sidelink DRX configuration from Tx UE, which is not sufficient. Rx UE should be allowed to send assistance information beforehead.A new message is cleaner and provides most flexibility. Tx UE is not required to response to this message as UAI in Uu. Rx UE could send this message before Tx UE provides DRX configuration. |
| Ericsson (Min) | Option-C | for our understanding, this UE assistance information shall only contain information relevant to DRX feature, shall not contain any other configuration information. It shall totally mimic UAI as in UU.Regarding TX centric or RX centric, agree with OPPO’s analyses. TX centric option shall be selected.Regarding Option B or Option C, we think Option B is not suitable for the below reasons* RX UE is only able to provide assistance information afterwards, i.e., after reception of the DRX configuration sent by the TX UE, this would limit the flexibility.
* Leads to bigger spec changes, i.e., RRC spec needs to be updated to capture different UE behaviours upon reception of a ***RRCReconfigurationFailureSidelink*** carrying assistance information***.***

In our mind, Option C is the only preferred option, which gives a clean design and be able to achieve the best flexibility. |
| HW | Option A | We think the disadvantage listed by the rapporteur for RX centric mechanism can be alleviated by assistance information from TX UE as well, i.e., TX-side traffic characteristics and resource configuration can be sent from TX UE to RX UE as assistance information and then the RX UE determines the DRX configuration with the assistance information taken into account. In Rel-17, we are discussing about DRX, of which is to reduce the RX UE’s power consumption. RX UE centric mechanism is the most power-saving mechanism as the RX UE only needs to determine and maintain only one or limited number of DRX configurations as per its demand of power saving. However if we adopt TX centric mechanism, then due to multiple to one nature, one RX UE needs to maintain multiple DRX configurations from different TX UEs, and the ”wake up” time configured by these TX UEs may spread over most of the whole time domain, leading to DRX unrealistic at all. Therefore, we think it does not make sense to follow the Rel-16 signalling framework at the cost of consuming more UE power，which is not aligned with the intention of this objective. Regarding to which PC5-RRC message to carry the signalling 1 (DRX configuration from RX UE to TX UE), we think the *RRCReconfigurationSidelink* which used to carry the other sidelink configurations can be used to carry the DRX configuration.  |
| ZTE | Option-C | According to our understanding, the TX-centric solution means the TX UE side makes the final decision of sidelink DRX for the RX UE, before that the RX UE shall provide the assistant information to help the TX UE makes the final decision. So if TX-centric solution is adopted，Option-C is suitable to provide the DRX configuration assistant information from the RX UE to the TX UE. If the RX UE has been configured with multiple DRX configuration for different PC5 link, in order to avoid wake up at too much time, the RX can sent the current SL DRX configuration to the new TX UE as the DRX configuration assistant information, then the TX UE shall take the current SL DRX configuration of the RX UE into acount when deciding the SL DRX configuration for the related link. |
| Sony | Option-C | We prefer the Tx-centric decision but based on assistance data through signalling 1. We agree with Ericsson that with Option-C the design can be clean and the signalling can be efficient.  |
| Intel | Option-A or Option-C  | We think the RRCReconfigurationSidelink message can be leveraged to exchange DRX related signalling; considering a TX-centric approach;option-C can be used for signal~~l~~ing-1 by RX UE to provide assistance information for coordination with TX UE.   |
| Lenovo | Option C | If such signalling means Rx UE configure SL DRX configuration for Tx UE, then Option A may be preferredIf such signalling means Rx UE send assistance information to Tx UE, to assist Tx centric configuration, then Option C is preferred. We support Tx centric and option C |
| Spreadtrum | Option C | Option C is used to transfer the assistance information in Tx-centric method. |
| Convida Wireless | Too early to decide | In our view, this will depend on whether TX centric or RX centric approach is adopted. Our preference is a TX centric approach, and for such a case, we feel that Option C would be most appropriate, as the signaling-1 would be used to carry the assistance information. |
| Fraunhofer | Option C | We prefer the TX centric decision. The TX UE can determine the DRX configuration taking the assistance information provided by the RX UE into account:* Option C: Assistance information (RX UE->TX UE)
* Option A: DRX Configuration (TX UE->RX UE)
 |
| ASUSTeK | Option A or C | We share the same view with Huawei that RX-centric method is more efficient on power saving on RX UE side. We think RX UE could derive the SL DRX configuration by itself (from pre-configuration or NW configuration) and send the SL DRX configuration to TX UE as assistance information. The RX UE’s SL DRX configuration as assistance information can be sent via the RRCReconfigurationSidelink message or other PC5-RRC message. |
| InterDigital | Option B (with comments) | We prefer to not specify a new procedure/message in Rel17 for configuration of DRX, and re-use the existing sidelink reconfiguration framework.However, there could be two messages used and both should be considered for signaling 1: RRCReconfigurationFailureSidelink and RRCReconfigurationComplete.Specifically, the complete message could be used to select a configuration from the suggested configurations provided by the TX UE. |

**Q2b: If one answer option-1 and/or option-3 for Q1, i.e., agree the necessity of signaling-2 (i.e., signalling from UE1 (TX-UE) to UE2 (RX-UE) including the DRX configuration), which PC5-RRC message can be used to carry signaling-2?**

**Option-A: Using *RRCReconfigurationSidelink;***

**Option-B: Using *RRCReconfigurationFailureSidelink*, e.g., this message is used to suggest a DRX configuration that is different from the one included in *RRCReconfigurationSidelink*;**

**Option-C: Using a new PC5-RRC message, e.g., one can mimic the UAI message as used in Uu-RRC;**

**Option-D: Other**

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| Company | Option | Comment |
| OPPO | Option-A | Comparing the two approaches, i.e., TX-centric and RX-centric

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| Disadvantage | If rely on Rx-UE to control the DRX configuration | If rely on Tx-UE to control the DRX configuration |
| 1 | Two RX-UE may require a TX-UE to send data on the same resource, but that is infeasible since TX-UE can only perform one single transmission at one slot. | Different TX-UE may require a same RX-UE to wake up at different time, so increase the power consumption. |
| 2 | It violates the sidelink design framework of “Tx-centric” since Rel-12, i.e., Tx-UE itself (or the network behind) to decide on the transmission. In more details, the Rx-UE has no information on Tx-side traffic characteristics and resource configuration. Signaling-wise, currently PC5-RRC design is to rely on TX-UE to configure SDAP/PDCP/RLC/MAC/PHY configuration. If DRX configuration becomes an exceptional case, i.e., only this parameter is configured by Rx-UE, then when there is any causality / coupling between DRX and other parameters, it becomes a chicken-and-egg issue, i.e., two related parameters configured by two separate entities (i.e., TX-UE and RX-UE), which may further cause discussion / work on how to coordinate between the two entities |  |
| 3 | Without information of Tx-side traffic characteristics and resource configuration, it is not feasible to rely on Rx-UE to make a final decision on the DRX configuration  |  |

I.e., it seems TX-centric approach have more (less) advantages (disadvantages), especially considering that the only disadvantage can be alleviated by assistance information from RX-UE.By using option-A, it allows a simple two step configuration as the very basic procedure, i.e., *RRCReconfigurationSidelink* + *RRCReconfigurationCompleteSidelink* (in case the DRX configuration is acceptable to Rx-UE). |
| CATT | Option-A | In Uu, RRC reconfiguration is used for DRX configuration. It is reasonable to inherit it in SL, e.g. to use *RRCReconfigurationSidelink* to configure the sidelink DRX parameters. |
| Nokia | Please see answer to Q2a |  |
| vivo | Option-A | Follow the legacy PC5 configuration procedure from Tx-UE to Rx-UE. |
| Xiaomi | Option A | We prefer Tx centric manner, which means the signalling-2 from Tx to Rx is DRX command. It’s straightforward to reuse existing configuration message. |
| Ericsson (Min) | Option-A | It is straightforward to reuse the existing RRC signaling, i.e., *RRCReconfigurationSidelink.* |
| HW | Option C | Option B seems to support some kind of “configure-reject-configure” procedure which should be discussed in detail. Actually in Rel-16 SL, there is no such kind of “reject” procedure and this is also not aligned with the Uu logic, i.e., it is not possible for a UE to reject the Uu configuration from the NW. In addition, if “reject” is allowed, what if one UE keeps rejecting the configuration from the peer UE and the TX UE and RX UE cannot achieve consensus? Therefore, from our perspective, we don’t think “reject” procedure should be supported. With Option C, we can directly convey the assistance information in a new PC-5 RRC message to the RX UE before the RX UE determining the DRX configuration and then the RX UE takes the assistance information into account when configuring the DRX configuration to the TX UE.  |
| ZTE | Option-A | If Tx centric manner is adopted, the legacy PC5 configuration procedure from Tx-UE to Rx-UE can be reused. |
| Sony | Option A | The decided configuration can be signalled through existing RRC signalling |
| Intel | Option A | We think it is natural to leverage the RRC signalling procedure to exchange the DRX related signalling  |
| Lenovo | Option A | For Tx centric manner, this signalling is for assistance information. In this case, Rx UE could send information of other unicast link SL DRX configuration, or information relates to Uu DRX configuration. In this sense, we think the determination does not need to consider SL DRX configuration in pre-configuration. |
| Spreadtrum | Option A | Option A is used to transfer the DRX configuration for the concerned unicast link. |
| Convida Wireless | Too early to decide | In our view, this will depend on whether TX centric or RX centric approach is adopted. Our preference is a TX centric approach, and for such a case, we feel that Option C or Option A would be most appropriate, as the signaling-2 would be used to carry the DRX configuration. |
| Fraunhofer  | Option A  | Same as in Q2a |
| ASUSTeK | Option A or C | Please see our comment on Q2a. |
| InterDigital | Option A (with comments) | We agree with OPPO that option A allows a 2-step configuration approach. However, it should be possible to provide multiple configuration options (suggestions) to the RX UE to allow the RX UE to select one of several options based on its current power-savings preference and other ongoing unicast links.  |

Then the third question is how for the UE to derive the DRX configuration that is to be included in the signaling, which is the continuation of the agreement from RAN2#113 as follows

4: For unicast, for OOC scenario, the UE who sends out the DRX configuration decides on the DRX configuration. FFS on whether pre-configuration and/or the assistance information from the peer UE is also taken into account when determining the DRX configuration.

**By assuming the questions (Q1 and Q2a/b) above have already covered the FFS point on assistance information**, the only left FFS is on pre-configuration, i.e., whether it is has to be taken into account or not.

**Q3a: If one answer option-1 and/or option-2 for Q1, i.e., agree the necessity of signaling-1 (i.e., signalling from UE2 (RX-UE) to UE1 (TX-UE) including the DRX configuration), in case of OOC scenario, how for UE2 to derive the DRX configuration that is to be included in signaling-1 (assuming the necessity of assistance information has been covered by Q1/Q2a/Q2b)?**

**Option-A: Decided by UE implementation without relying pre-configuration*;***

**Option-B: Decided by UE implementation taking into account of input from pre-configuration;**

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| Company | Option | Comment |
| OPPO | Option-A | In practice, pre-configuration can only achieve common configuration between Ues (no matter it is one or multiple DRX configuration), which is not aligned with the design spirit of unicast DRX configuration, i.e., per-direction DRX configuration. |
| CATT | Option-A | This signalling should be optional, how to derive the DRX configuration depends on UE implementation, no specification effort is needed. |
| Nokia | Option-A as WA is ok for us | Assuming this is for Unicast, option-A may be the best solution, however, we feel sympathy for option-B since the pre-configuration also holds the resource pool description, and therefore may also contain optimal settings of the DRX.In the end, we may not get the best answer to this question before we agree on how the pre-configuration looks, hence this may be a working assumption which can be further elaborated |
| vivo | Option-A | From our understanding, Tx-UE can decide DRX configuration based on pre-configuration like the legacy PC5 configuration procedure. But Rx-UE assistance information can be based on its preference or alignment requirement, i.e. no need to redundantly consider pre-configuration for RX UE. |
| Xiaomi | Option B | We prefer Tx centric manner, which means the signlling-1 is assistance information.We assume this question only cover the case that UE2 (RX UE) is OOC, which means UE1 (TX UE) could be IC or OOC.In case there are both IC and OOC UE1s paired with UE2. It’s beneficial for UE2 to consider pre-configuration so that the wakeup time among different UE pairs could overlap to reduce monitoring. |
| Ericsson (Min) | Option-B | For option B, it is not up to **UE implementation**. It is regulated UE behaviours.If there are pre-configured DRX configurations, RX UE can of course consider them when sending assistance information to TX UE. In an example, RX UE may be preconfigured with multiple DRX configurations, corresponding to different services, RX UE can prepare information according to the service/application when sending assistance information to TX UE.In addition, as Nokia pointed out, there may be pre-configuration regarding resource pool at RX UE, in this case, it would be beneficial to let RX UE consider pre-configuration.  |
| HW | Option-A | Same view as OPPO.  |
| ZTE | Option-B | Although we agree that there is no need to pre-configure all the parameters of SL DRX for unicast, but the pre-configuration information used for groupcast/broadcast can be taken into account when deciding the SL DRX for unicast in order to make the awake time for unicast and groupcast/broadcast overlapped as more as possible.  |
| Sony | Option B | By considering the preconfigured configurations when creating the assistance data the signalling may be easier and the UE behaviour will be more consistent. |
| Intel | Option A | We have similar view as Nokia in that this ultimately depends on how we design pre-configuration, but we slightly prefer Option-A  |
| Lenovo | Option A | For Tx centric manner, this signalling is for assistance information. In this case, Rx UE could send information of other unicast link SL DRX configuration, or information relates to Uu DRX configuration. In this sense, we think the determination does not need to consider SL DRX configuration in pre-configuration. |
| Spreadtrum | Option A | We do not see spec impact to support assistance information. |
| Convida Wireless | Option B | Same view as Ericsson. Our preference is a TX centric approach, and for such a case, the RX UE needs a mechanism to determine what assistance information to send. This mechanism could rely on pre-configured parameters or pre-configured DRX configurations. |
| Fraunhofer | Option B | We agree with Ericsson’s view. |
| ASUSTeK | Option B |  |
| InterDigital | Option A | We think pre-configuration is used to tie the DRX configuration(s) to the QoS/bearer configuration (as in Rel16), and this is only relevant for the TX UE.Therefore, the RX UE does not require assistance information. |

**Q3b: If one answer option-1 and/or option-2 for Q1, i.e., agree the necessity of signaling-2 (i.e., signalling from UE1 (TX-UE) to UE2 (RX-UE) including the DRX configuration), in case of OOC scenario, how for UE1 to derive the DRX configuration that is to be included in signaling-1 (assuming the necessity of assistance information has been covered by Q1/Q2a/Q2b)?**

**Option-A: Decided by UE implementation without relying pre-configuration*;***

**Option-B: Decided by UE implementation taking into account of input from pre-configuration;**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| OPPO | Option-A | In practice, pre-configuration can only achieve common configuration between Ues (no matter it is one or multiple DRX configuration), which is not aligned with the design spirit of unicast DRX configuration, i.e., per-direction DRX configuration. |
| CATT | Option-A | According to the current specification, the pre-configuration is based on sidelink RLC bearer. But it has been agreed that for SL unicast (after SL unicast link is established), SL DRX configuration can be configured per a pair of source/destination. Hence, how to configure the SL DRX configuration based on pre-configuration is questionable (the granularity is mismatched). |
| Nokia | Option-A as WA is ok for us | Please see Q3a |
| vivo | Opiton-B | Same as Q3a. |
| Xiaomi | Option A | We prefer Tx centric manner, which means the signlling-2 is DRX command.Tx UE should consider the assistance from RX UE to determine the DRX configuration. If no assistance information is provided, it’s up to Tx implementation to decide. |
| Ericsson (Min) | Option-B | For option B, it is not up to **UE implementation**. It is regulated UE behaviours.If there are pre-configured DRX configurations, TX UE can of course consider them when setting up a link/RB towards RX UE. In an example, TX UE may be preconfigured with multiple DRX configurations, corresponding to different services, TX UE can select a proper DRX configuration according to the service/application when setting up the link/RB. |
| HW | See comments  | As we replied in Q1, from our perspective, signalling 2 from TX UE to RX UE is assistance information of which the detailed content should be FFS, e.g., traffic pattern, resource configuration etc., and should not be limited to DRX configurations only. Therefore before we answer this question, we need to firstly determine the detailed content of the assistance information and if we finally decide to include DRX configuration into the assistance information, we share the same view as rapporteur that the DRX configuration should be decided by UE implementation without relying on pre-configuration.  |
| ZTE | Option-B | If Tx centric manner is adopted, the TX UE shall take the DRX assistant information from the RX UE and the TX resource pool which is preconfigured into account when deciding the SL DRX. However, no additional preconfiguration information is needed. |
| Sony | Option-B | By considering the preconfigured configurations when creating the DRX configuration the signalling may be easier and the UE behaviour will be more consistent. |
| Intel | Option A | Same comment as in Q3a  |
| Lenovo | Option A | The SL DRX configuration or assistance information from Tx UE needs to take traffic arrival time into account, to adapt to traffic as much as possible. Also may need to consider assistance information from Rx UE for Tx centric manner. Does not need to consider SL DRX configuration in pre-configuration |
| Spreadtrum | Option A | We share the same view with Lenovo. |
| Convida Wireless | Option B | We assume that question has the typos highlighted by CATT and Huawei.Our preference is a TX centric approach, and for such a case, the TX UE needs a mechanism to determine the DRX configuration. This mechanism could rely on pre-configured DRX configurations. |
| Fraunhofer | Option B | Same as Q3a. |
| ASUSTeK | Option B | We share the same view with Ericsson. |
| InterDigital | Option B (with comments) | We also agree with the suggested wording change from Ericsson to delete “by implementation”, since any use of pre-configuration should exclude the UE selecting based entirely on implementation.Then since the TX UE is selecting a set of DRX configurations/suggestions to be sent to the RX UE, the selection should be done similar to an SLRB configuration selection in Rel16 – therefore relying on pre-configuration. |

## For IC scenario

For in-coverage scenario, RAN may be involved in the whole procedure, e.g., for a signalling-X from UE-A to UE-B (Please note that UE-A can be either UE-1 or UE-2, i.e., either TX-UE or RX-UE, and similarly for UE-B. The questions below has clarified the applied UE explicitly),

* The first question is how for the UE-A to generate the signalling, taking into account of SIB/dedicated-RRC or not;
* The second question is whether the UE-B needs to reflect the signalling to network using dedicated-RRC or not;



**Q4a: If one answer option-1 and/or option-2 for Q1, i.e., agree the necessity of signaling-1 (i.e., signalling from UE2 (RX-UE) to UE1 (TX-UE) including the DRX configuration), If UE-2 is in-coverage, in RRC\_IDLE/RRC\_INACTIVE state, how for UE2 to derive the DRX configuration that is to be included in signaling-1?**

**Option-A: Decided by UE implementation without relying SIB*;***

**Option-B: Decided by UE implementation taking into account of input from SIB;**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| OPPO | Option-A | Same logic as for pre-configuration, i.e., SIB cannot achieve per-UE configuration, so no need to take into account. |
| CATT | Option-A |  |
| Nokia | Option-A as WA is ok for us | Same with Q3b, getting help from SIB may prove beneficial |
| vivo | Option-A | Similar with pre-configuration, i.e. for assistance information no need to redundantly consider SIB. |
| Xiaomi | Option B | We prefer Tx centric manner, which means the signlling-1 is assistance information.To reduce power consumption, UE should align DRX between Uu and Sidelink as much as possible. RX UE should provide Uu DRX related information to TX UE. DRX cycle in IDLE/Inactive could be from NAS/dedicated signalling/SIB. If the DRX cycle is from SIB, RX UE should take into account the input of SIB. |
| Ericsson (Min) | Option B | It is too early to exclude information/input from SIB. The SIB may contain configuration information regarding resource pool and other useful information. In this case, it would be beneficial to let the RX UE to consider those information.  |
| HW | Option-A |  |
| ZTE | Option-B | Same with Q3a |
| Sony | Option-B | Same idea as for Q3a, by considering the SIB information when creating the assistance data the signalling may be easier and the UE behaviour will be more consistent. |
| Intel | Option B | As also mentioned by Xiaomi, if we consider the WID objective of alignment between Uu and SL DRX active times, it would be useful to consider the information in SIB when deriving the DRX configuration for SL  |
| Lenovo | Option A | Does not think IDLE DRX on Uu should be considered |
| Spreadtrum | Option A |  |
| Convida Wireless | Option B | Agree with Ericsson |
| Fraunhofer  | Option B | Taking input from the SIB might be beneficial for the RX UE as it contains information such as e.g. resource pool.  |
| ASUSTeK | Option B | We share the same view with Ericsson. |
| InterDigital | Option A | Similar to Q3A, the RX UE does not consider NW configuration, since this is already considered at the TX UE side. |

**Q4b: If one answer option-1 and/or option-2 for Q1, i.e., agree the necessity of signaling-1 (i.e., signalling from UE2 (RX-UE) to UE1 (TX-UE) including the DRX configuration), If UE-2 is in-coverage, in RRC\_CONNECTED state, how for UE2 to derive the DRX configuration that is to be included in signaling-1?**

**Option-A: Decided by UE implementation without relying dedicated RRC or SIB*;***

**Option-B: Decided by UE implementation taking into account of input from SIB;**

**Option-C: Decided by UE implementation taking into account of input from dedicated RRC;**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| OPPO | Option-A or Option-C | Same logic as for pre-configuration, i.e., SIB cannot achieve per-UE configuration, so no need to take into account. While dedicated-RRC may help the network to take it into control. |
| CATT | Option-C with comment | For RRC\_CONNECTED UE, the sidelink DRX configuration from UE2 to UE1 can be decided by UE2’s serving gNB. But how to derive the assistant information sent from UE2 to UE1 should be UE2 implementation, e.g., taking into account of input from dedicated RRC, but it does not need to specify. |
| Nokia | Option-A, or Option-C |  |
| vivo | Option-A or Option-C | Option A is based on similar logic as the above case of pre-configuration and SIB of PC5 unicast DRX configuration. i.e. the assistance information from UE-2 doesn’t need to consider this.Option-C is useful, e.g. to align between Uu DRX and SL DRX, at least the dedicated RRC including the Uu DRX configuration should be considered |
| Xiaomi | Option C | We prefer Tx centric manner, which means the signlling-1 is assistance information.To reduce power consumption, UE should align DRX between Uu and Sidelink as much as possible. RX UE should provide Uu DRX related information to TX UE. DRX cycle in connected is from dedicated signalling. Therefore, RX UE should take into account the input of dedicated signaling. |
| Ericsson (Min) | Option B and Option C | With dedicated RRC, the gNB can signal UE specific configuration/information to the UE. With the SIB, the gNB can signal configurations/information common to all UEs, e.g., information regarding resource pools.  |
| HW | Option-A | With the received assistance information taking into account, the RX UE itself can determine the DRX configuration by UE implementation without relying on RRC or SIB.  |
| ZTE | Option-C | We think it is a basic principle that the RRC connceted UE shall be in the control of the serving gNB. So it is reasonable for the UE to take dedicated RRC into account. |
| Sony | Option-B or Option-C | Same idea as for Q3a, by considering the SIB information when creating the assistance data the signalling may be easier and the UE behaviour will be more consistent. |
| Intel | Option C | We think it would be good to consider dedicated signalling for deriving the DRX configuration at UE2, considering it is for unicast case.  |
| Lenovo | Option C | Dedicate RRC signalling may contain Uu DRX configuration, which needs to be taken into account by Rx UE |
| Spreadtrum | Option C |  |
| Convida Wireless | Option C with comment | In our view, if a RX UE is RRC Connected, it should receive the DRX configuration from its serving cell. |
| Fraunhofer  | Option C and Option B |  |
| ASUSTeK | Option C |  |
| InterDigital | Option A and C | In principle option A is sufficient for the same reasons as mentioned in previous question. However, to consider alignment of Uu and SL DRX, option C may be needed. |

**Q4c: If one answer option-1 and/or option-2 for Q1, i.e., agree the necessity of signaling-1 (i.e., signalling from UE2 (RX-UE) to UE1 (TX-UE) including the DRX configuration), if UE-1 is in-coverage, in RRC\_CONNECTED state, whether UE-1 needs to report the DRX configuration received in signaling-1 to the serving network?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| OPPO | Yes | As answered for Q5b, since the dedicated-RRC is necessary for network to take DRX configuration into control, the report of signalling-1 is also useful. |
| CATT | Yes | Because the network decides the sidelink DRX configuration for RRC\_CONNECTED UE. |
| Nokia | Yes |  |
| vivo | Not always | UE-1 is TX UE. We support that most of PC5 DRX parameters come from its serving cell via dedicated RRC signaling. So when TX UE receives assistance information from RX, there is no need for TX UE to report.However, there is an exceptional case, i.e. PC5 DRX parameters changed in PC5 negotiation between Tx-UE and Rx-UE, e.g. Rx-UE modified DRX cycle offset. In this case, there is need to report newest PC5 DRX parameters to serving cell.  |
| Xiaomi | Yes | Connected Tx UE receives the DRX configuration from gNB. |
| Ericsson (Min) | Yes | For UE in RRC connected, the gNB shall be always involved in controlling/configuring a SL DRX configuration. |
| HW | Yes | From our perspective, signalling 1 from UE2 to UE1 is the configured DRX configuration from RX UE to TX UE. After reception of the DRX configuration, the TX UE in RRC\_CONNECTED should report this configuration to the NW to assist the NW in the following scheduling and deciding the Uu DRX.  |
| ZTE | Yes | The network shall consider the DRX configuration of the RX UE when allocating sidelink resource to the TX UE. |
| Sony | Maybe | Not essential in all cases that the gNB knows in detail about the decided DRX configuration. UE 1 and UE 2 may be connected to different gNBs and even different NWs, so than UE 2 may also need to report it to its gNB?  |
| Intel | Yes |  |
| Lenovo | Yes | If Tx UE receive SL DRX configuration from Rx UE, Tx UE needs to report to gNB since in mode 1, gNB need to schedule the resource for transmission and gNB needs to know the SL DRX configuration |
| Spreadtrum | Yes |  |
| Convida Wireless | Yes | UE1 should provide the SL DRX configuration to its serving cell. This is especially useful when UE1 uses resource allocation mode 1, as gNB needs to know when to assign resources for SL transmissions to UE2. |
| Fraunhofer | Yes |  |
| ASUSTeK | Yes | Reporting RX UE’s SL DRX configuration to gNB can help gNB to schedule SL grants for TX UE at RX UE’s SL active time. |
| InterDigital | Yes |  |

**Q5a: If one answer option-1 and/or option-3 for Q1, i.e., agree the necessity of signaling-2 (i.e., signalling from UE1 (TX-UE) to UE2 (RX-UE) including the DRX configuration), If UE-1 is in-coverage, in RRC\_IDLE/RRC\_INACTIVE state, how for UE1 to derive the DRX configuration that is to be included in signaling-2?**

**Option-A: Decided by UE implementation without relying SIB*;***

**Option-B: Decided by UE implementation taking into account of input from SIB;**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| OPPO | Option-A |  |
| CATT | Option-A |  |
| Nokia | Option-A as WA is ok for us | Same with Q3b, getting help from SIB may prove beneficial |
| vivo | Option-B | Like legacy SLRB configuration acquisition, NW is up to control DRX configuration and responsible for compromise performance between QoS requirements/service experience and power saving gain. |
| Xiaomi | Option B | We prefer Tx centric manner, which means the signlling-2 is DRX command.Tx UE A has to decide DRX configuration in the way that wake up time has to be aligned with the Tx resource, otherwise Rx UE can’t receive Tx UE’s signal. The Tx resource pool is included in SIB. Therefore, Tx UE has to take into account of input from SIB. |
| Ericsson (Min) | Option B | Agree with VIVO and Xiaomi.  |
| HW | See comments | As we replied in Q1, from our perspective, signalling 2 from TX UE to RX UE is assistance information of which the detailed content should be FFS, e.g., traffic pattern, resource configuration etc., and should not be limited to DRX configurations only. Therefore before we answer this question, we need to firstly determine the detailed content of the assistance information and if we finally decide to include DRX configuration into the assistance information, we share the same view as rapporteur that the DRX configuration should be decided by UE implementation without relying on SIB. |
| ZTE | Option B | If Tx centric manner is adopted, the TX UE shall take the DRX assistant information from the RX UE and the TX resource pool which is included in SIB into account when deciding the SL DRX. |
| Sony | Option B | The DRX configuration always needs to apply to the sidelink configurations received by SIB. New input regarding the DRX configurations may also be included in the SIB.  |
| Intel | Option B | Similar reasoning as in Q4a |
| Lenovo | Option B | Agree with vivo and Xiaomi |
| Spreadtrum | Option B |  |
| Convida Wireless | Option B | UE1 needs a mechanism to determine the DRX configuration. This mechanism could rely on DRX configurations received in the SIB. |
| Fraunhofer | Option B | The UE1 can rely on the information e.g. the resource pool provided by the SIB additionally. |
| ASUSTeK | Option B |  |
| InterDigital | Option B | Similar reason as in Q3b.We also agree with the wording suggestion from Ericsson. |

**Q5b: If one answer option-1 and/or option-3 for Q1, i.e., agree the necessity of signaling-2 (i.e., signalling from UE1 (TX-UE) to UE2 (RX-UE) including the DRX configuration), If UE-1 is in-coverage, in RRC\_CONNECTED state, how for UE1 to derive the DRX configuration that is to be included in signaling-2?**

**Option-A: Decided by UE implementation without relying dedicated RRC or SIB*;***

**Option-B: Decided by UE implementation taking into account of input from SIB;**

**Option-C: Decided by UE implementation taking into account of input from dedicated RRC;**

**Option-D: Decided by serving cell of the UE;**

|  |  |  |
| --- | --- | --- |
| Company | Option | Comment |
| OPPO | Option-C | Dedicated-RRC is necessary to take DRX configuration into network control.Same logic as for pre-configuration, i.e., SIB cannot achieve per-UE configuration, so no need to take into account.  |
| CATT | Option-C |  |
| Nokia | Option-A, or Option-C |  |
| vivo | Option-C | Like legacy procedure, the configuration of Connected Tx-UE comes from its serving cell via dedicated RRC. |
| Xiaomi | Option C | Connected Tx UE receives the DRX configuration from gNB. |
| Ericsson (Min) | Option B and Option C | See comments in Q4b. And again, wording in Option B and Option C are not correct. See comments in above questions. For UE in coverage, it shall be the gNB that controls/configures information. |
| HW | See comments | See our reply on Q5a. If DRX configuration is included in assistance information, we think it should be decided by UE implementation without relying on RRC or SIB.  |
| ZTE | Option-D | If Tx centric manner is adopted, the TX UE shall send the DRX assistant information from the RX UE to the serving cell, and the serving cell can decide the SL DRX with taking the DL DRX into account if the allignment between SL and DL DRX is needed. |
| Sony | Option B and Option C | Same idea as before, by considering the information from the NW when creating the DRX configuration the signalling may be easier and the UE behaviour will be more consistent. |
| Intel | Option C | Similar reasoning as in Q4b  |
| Lenovo | Option C or D | In connected mode, since needs to coordinate with Uu DRX configuration, as well as dedicate resource pool configuration, at least UE needs take into account of dedicate RRC signalling. Or let serving cell to decide is more straightforward. |
| Spreadtrum | Option C or D |  |
| Convida Wireless | Option C with comment or option D | If IC, our view is that gNB of UE1 could be in control of the DRX configuration or it could provide input to UE1 to help UE1 decide the configuration. UE1 may get this control/input from its serving cell via dedicated RRC. |
| Fraunhofer | Option C and Option B | When the TX UE is in RRC connected state the DRX configuration can be controlled by the gNB. Therefore, the UE can get the configuration via dedicated RRC. |
| ASUSTeK | Option C |  |
| InterDigital | Option C | We think this is aligned with any configuration selection at the TX UE in Rel16 when the UE is in RRC\_CONNECTED.  |

**Q5c: If one answer option-1 and/or option-3 for Q1, i.e., agree the necessity of signaling-2 (i.e., signalling from UE1 (TX-UE) to UE2 (RX-UE) including the DRX configuration), If UE-2 is in-coverage, in RRC\_CONNECTED state, whether UE-2 needs to report the DRX configuration received in signaling-2 to the serving network?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comment |
| OPPO | Yes | It is necessary for UE2 network to take into account the SL DRX configuration when deciding the Uu DRX configuration. |
| CATT | Yes |  |
| Nokia | Yes |  |
| vivo | Yes | Reporting is useful for cooperation between Uu DRX and SL DRX. |
| Xiaomi | Yes | It’s useful for gNB to perform resource scheduling. |
| Ericsson (Min) | Yes | For UE in RRC connected, the gNB shall be always involved in controlling/configuring a SL DRX configuration. |
| HW | No  | See our reply on Q5a. We should firstly determine whether DRX configuration is included in assistance information. Even if there is DRX configuration in assistance information, the RX UE does not need to report this assistance information to the NW considering significant signalling overhead and can determine the DRX configuration by its implementation and then transfers the determined DRX configuration to the TX UE via PC-5 RRC message.  |
| ZTE | Yes | The report is necessary if the allignment between SL and DL DRX is needed. |
| Sony  | Maybe | Same answer as in Q4c |
| Intel | Yes |  |
| Lenovo | Yes | Agree with vivo |
| Spreadtrum | Yes |  |
| Convida Wireless | Yes | Agree with Oppo – this may help network when deciding the Uu DRX configuration of UE2 |
| Fraunhofer | Yes |  |
| ASUSTeK | Yes |  |
| InterDigital | Yes |  |

1. xxx.

# Conclusion

We have the following proposals

[Proposal 1 xxx.](#_Toc62216175)

# Reference