3GPP TSG-RAN WG2 Meeting #109 electronic R2-2001913

Elbonia, 24th–28th February 2020

Source: CATT

Title: Summary of open issues for PDCCH

Agenda Item: 6.11.2

Document for: Discussion and Decision

# Introduction

This contribution provides a summary of the contributions posted in the Agenda Item 6.11.2 PDCCH-based power saving signals/channel Additional stage-3 RAN2 aspects. The addressed issues are classified as:

* New issues not addressed in the email discussions
* Issues already addressed in the email discussions [108#78] (MAC running CR [3][4]) and [108#38] (RRC running CR [1][2]);

For each new issue, companies are invited to provide their answers to the following questions:

* Does the issue need to be solved for rel-16?
* If yes, what are the companies’ opinion(s) on solution(s)?

# Discussion

* 1. **New issues not addressed in the email discussions**

### *Issue #1: Capturing CSI reporting when the drx-onDurationTimer is not started due to DCP indication, but the MAC entity is in Active Time during on-duration due to other reasons*

Company/Tdoc: CATT [5]

Proposed solution: When evaluating Active Time when *drx-onDurationTimer* is not started due to DCP, the same triggers, with same ambiguity period (4ms) as in legacy should be taken into account.



Proposed TP (wrt [3]):

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1> if DCP is configured for the active DL BWP:

2> in current symbol n, if the symbol occurs within *drx-onDurationTimer* duration and *drx-onDurationTimer* would not be running considering DCP occurrence(s) associated with the current DRX cycle until [x] ms prior to symbol n as specified in this clause; and

2> if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause:

3> not transmit periodic SRS and semi-persistent SRS defined in TS 38.214 [7];

3> not report semi-persistent CSI;

3>  if *ps-Periodic\_CSI\_Transmit* is not configured with value *true*:

4>  not report periodic CSI on PUCCH.

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*Q1a. Do you think this issue needs to be solved for Rel-16?*

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | Yes | We agree with CATT’s analysis. |
| Apple | No | When NW configures the WUS, the offset between WUS occasion and on duration should take the ambiguity period into account. |
| Xiaomi | Yes | The case CATT mentioned is valid.  The SRS/CQI report should be based on the deciding of whether UE is in active time. There are a lot of triggers for UE into active time, e.g. MAC CE , UE initiating SR, receiving a positive PDCCH-WUS etc.  We are wondering whether we can put all these triggers together when describing the conditions for SRS/CQI reporting. I remembered in the first version of our drafted 38.321, it was captured like this:  in current symbol n, if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received, Scheduling Request sent and DCP occured until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause:  2> not transmit periodic SRS and semi-persistent SRS defined in TS 38.214 [7];  2> if the MAC entity would not be in Active Time considering DCP occured until 4 ms prior to symbol n when evaluating all DRX Active Time conditions as specified in this clause and *ps-Periodic\_CSI\_TransmitOrNot* is configured with value *true*:  3> not report CSI on PUCCH except for periodic CSI on PUCCH, and semi-persistent CSI on PUSCH.  2> else:  3> not report CSI on PUCCH and semi-persistent CSI on PUSCH.  We think the above capturing is logically clearer.I know that some may want to take the DCP out and put it in a separate place. Well, in that case, we still need to consider the concurrency of those triggers as CATT says. |
| Nokia | Yes, but | This is needed for the case when DCP can be received without ambiguity. However, we should consider this together with issue 9b as there can be ambiguity in receiving the DCP as well. |
| Huawei | Yes | Agree that legacy behavior should be performed in Active Time. |
| Ericsson | Yes, but | In the figure above, in our understanding, two use cases are depicted, i.e. first the use case DCP is not triggered but periodic CSI is reported during *drx-OnDurationTimer* and the other use case where SR starts Active Time and the UE reports CSI during Active Time.  CATT] The focus here is on the 2nd usecase:  1) DCP tells to not start drx-onDurationTimer  2) Other event (SR, downlink scheduling, …) trigger Active Time  Due to 1) the above text will result in UE *not* reporting/transmitting CSI/SRS during on-duration although it is in Active Time, and so should report/transmit CSI/SRS.  We understand that for the first use case there is no ambiguity. For the second use case the ambiguity exists when the Active Time ends due to DRX command, but this is already captured in legacy text.  [CATT] Yes indeed, legacy text already covers this i.e. does not mute CSI/SRS in such case. But the new (black) text above comes on top (after) and adds the muting.  PS: we are not sure if CATT points to a very specific corner case, where UE is reporting periodic CSI when DCP is not triggered, and UE is in Active Time due to SR as depicted in figure above, but this Active Time is ended within 4 ms of the end of the drx-onDurationTimer due to DRX command? We assume that the Active Time covers the CSI reporting behavior of the UE in that case.  [CATT] This is not related to the ending of Active Time. |
| ZTE | Yes | Agree, this is legacy behavior. |
| CATT | Yes | To Apple: this is different from the ambiguity period which is discussed in issue #9a and which is captured in above TP by “until [x] ms prior to symbol n”.  To Xiaomi: if captured together with other legacy contributors to the ambiguity period, the DCP would result in an ambiguity period of 4ms, which is what companies seem to try to avoid in Issues #9a.  To Nokia: we agree to address both issues #1 and #9b, but we don't see that the TP addressing issue #9b would have an impact on the above TP.  To Ericsson: see our answer inline. |

*Q1b. If the answer to Q1a is Yes, do you agree with the proposed solution (TP)?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
| Qualcomm | Yes |  |
| Xiaomi | No | See above. |
| Nokia | Yes |  |
| Huawei | Yes |  |
| ZTE | Yes |  |
| CATT | Yes |  |

### *Issue #2: Impact of DCP associated with a long DRX cycle on the short DRX cycles within this long DRX cycle*

Company/Tdoc: vivo [7]

Proposed solution: PDCCH-WUS only locates before *onDuration* timer for long DRX cycle and such PDCCH-WUS can be also used to control the activation/deactivation of *onDuration* timer for short DRX cycle in the same long DRX cycle.



*Rapporteur:* This issue depends on the outcome of the issue of Short DRX support for DCP.

*Q2a. Do you think this issue needs to be solved for Rel-16?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | No | In our understanding, at any point of time, UE uses either short or long DRX. When short DRX cycle is running, if WUS is not configured (or not supported) for short DRX cycle, then there is no WUS occasions to monitor. |
| Apple | No | We do not support the WUS applicability on short DRX cycle. |
| Xiaomi | No | We have the same understanding with QC. And it goes a littler far away since we have not decided the WUS applicability on short DRX cycle. |
| Nokia |  | It should be possible for the NW to configure WUS to be applicable for Short and/or Long DRX cycle. |
| Huawei | No |  |
| Ericsson | No | Our understanding is that current agreements/assumptions say that WUS is not supported with Short DRX cycle. In our understanding this means that WUS and Short DRX cycle can be configured simultaneously, but when the UE is in short DRX cycle the UE does not monitor WUS.  We would like to see a proper/full use of WUS with short DRX cycle, and do not see the need for the proposed compromise. |
| ZTE | No |  |
| CATT | No | The issue assumes DCP only applies to Long DRX, per RAN1 WA. But we think in such case DCP should have no impact at all on the Short DRX on-durations. |

*Q2b. If the answer to Q2a is Yes, do you agree with the proposed solution?*

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| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
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### *Issue #3: UE behaviour when it is configured with multiple DCP monitoring occasions and detects one*

Company/Tdoc: OPPO [9]

Proposed solution: If UE detects WUS indicating UE to wake up, UE can skip the left WUS monitoring occasions associated with the next occurrence of *drx-onDurationTimer*.

*Rapporteur:* This issue looks more in the RAN1 domain.

*Q3a. Do you think this issue needs to be solved by RAN1 or RAN2?*

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| --- | --- | --- |
| **Company** | **RAN1/RAN2** | **Comments (if any)** |
| Qualcomm | RAN1 | How to monitor WUS is a PHY layer issue and hence should be discussed by RAN1. |
| Apple | RAN1 | This is a physical layer issue and should be discussed by RAN1. |
| Xiaomi | RAN1 |  |
| Nokia | RAN1/2 | To make some progress, compromise could be that this should be configurable by the NW whether one or all monitoring occasions need to be monitored. |
| Huawei | RAN1 | It is PHY layer issue. |
| Ericsson | RAN1 | We think that RAN1 should discuss and agree on this, if needed. If this needs to be specified, it should only be specified in PHY, and not duplicated in MAC. |
| ZTE | RAN1 |  |
| CATT | RAN1 |  |

*Q3b. If the answer to Q3a is RAN2, do you think this issue needs to be solved for Rel-16?*

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| **Company** | **Yes/No** | **Comments (if any)** |
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*Q3c. If the answer to Q3b is Yes, do you agree with the proposed solution?*

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| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
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### *Issue #4: Notification of SI/PWS change and DCP*

Company/Tdoc: Intel Corporation [11]

Proposed solution: RAN2 assumes that a UE using WUS can still rely on legacy mechanism to receive notifications of SI or PWS change (as other paging DCI can be received in parallel to PDCCH-WUS).

*Rapporteur:* As mentioned in [11], “RAN1 is considering that paging DCI could be monitored in parallel to WUS when required by a UE. Therefore, no new solution is required unless RAN1 indicates otherwise”. Given no further work is expected from RAN1, it seems nothing needs to be done and the current situation is already what is proposed.

*Q4a. Do you think this issue needs to be solved for Rel-16?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | No | We think the current behaviors are fine and no further enhancement is needed. |
| Apple | No | The WUS indication is just to control the UE monitoring the PDCCH for the UE dedicated transmission, and there is no impact the SI/paging mechanism. |
| Xiaomi | No | Legacy behavior is ok. Intel’s optimization can be considered in R17. |
| Nokia | No | We assume that nothing needs to be done in RAN2 unless RAN1 indicates otherwise. Our understanding is that there is no issue. |
| Huawei | No | No further enhancement is needed. |
| Ericsson | No | We do not see the need to enable paging via WUS, anyways this topic should not be discussed in RAN2. |
| ZTE | No |  |
| CATT | No | We agree with Nokia. |

*Q4b. If the answer to Q4a is Yes, do you agree with the proposed solution?*

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| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
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### *Issue #5: Improving Power Saving when the UE is configured to report L1 RSRP/CSI report irrespective of DCP indications*

Company/Tdoc: Apple [12]

Proposed solution: NW configures UE to report CSI/SRS in sparse mode, i.e. report once per N DRX cycles.



*Q5a. Do you think this issue needs to be solved for Rel-16?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | Yes | We think this is an important feature to have, given that network now has the option to require UE to report L1-RSRP even if DCP indicates no wakeup. This is because network may configure L1-RSRP with short periodicity during active traffic, in order to continuously refine UE’s serving beams to achieve high throughput. But if DCP indicates no data, then there is no need for UE to report L1-RSRP frequently. Network only needs occasional L1-RSRP report to ensure UE has a working PDCCH beam to receive DCP. This can be done by scaling up the periodicity of L1-RSRP when there is no data, as proposed by [12]. |
| Apple | Yes | It can provide both benefits in NW and UE side at the same time. NW can track UE radio quality and UE can save power compared to legacy periodic CSI report. |
|  |  |  |
| Xiaomi | ? | Well, sounds reasonable. But we are not sure. Will the sparse reporting impact the effect of beam management?  Not sure of the gain. |
| Nokia | No | This does not seem to be inline with RAN1 agreements. This is new functionality we don’t think is needed. i |
| Huawei | No | No further enhancement is needed. |
| Ericsson | No | RAN1 has already discussed this and agreed to enable L1-RSRP reporting based on NW configuration, when DCP is not triggered. When configured to report L1-RSRP the UE should be report according to the RRC configuration. |
| ZTE | No | This is not included in the RAN2 discussion scope |
| CATT | No | This is an optimization also involving RAN1 which is too late to address. It might have been rather discussed in RAN1. |

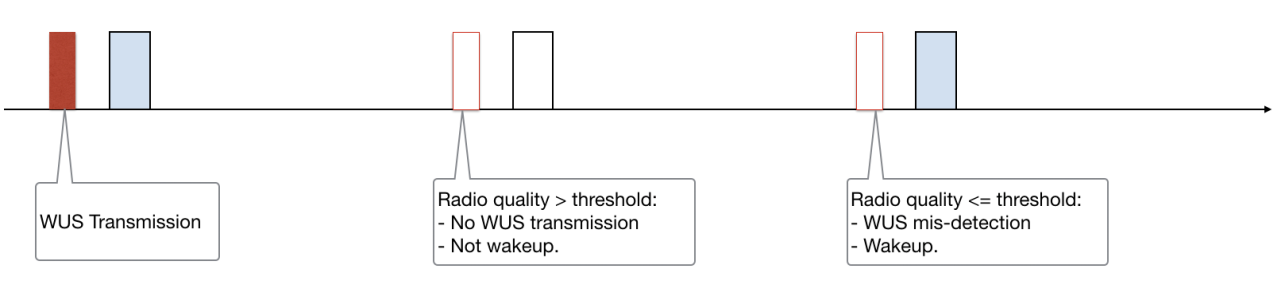
*Q5b. If the answer to Q5a is Yes, do you agree with the proposed solution?*

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| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
| Qualcomm | Yes |  |
| Apple | Yes | If UE keeps in “sleep” DRX cycle for N-1 times, UE will wakeup in the Nth “sleep” DRX cycle for the L1\_RSRP/CSI report.  According to current running CR, if NW configures L1\_RSRP/CSI report for each DRX cycle, it can assume the N=1.  Therefore, this solution has little impact to the running CR, which is just to allow NW to configure a value of “N” to UE.  Actual NW deployment could decide the optimal value of “N” taking into account necessary UE and NW performance characteristics. |
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### *Issue #6: DCP mis-detection avoidance*

Company/Tdoc: Apple [12]

Proposed solution: Support periodical wake up and/or always wake up in poor radio condition mechanism.



*Q6a. Do you think this issue needs to be solved for Rel-16?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | No | We think similar effect can already be achieved with the existing behaviors. For example, network can learn about UE’s link quality from UE’s measurement report. If link quality has dropped and mis-detection of DCP may become a concern, NW can configure UE to wake up if WUS is not received. Or alternatively, what is proposed can be just UE implementation, i.e. UE can choose to wake up and monitor PDCCH if it feels that is necessary when its link quality has dropped to a sufficiently low level. |
| Apple | Yes | According to current agreements, even though UE can report L1-RSRP/CSI report to NW to help NW tracking the UE radio quality, if UE does not wake up, NW has no way to change the UE’s configuration.  Therefore, we should allow UE to wake up at least once when the current radio quality is worse than a pre-configured threshold in order to help NW to adjust the configuration within a timely manner. |
| Xiaomi | No | I guess Apple’s intention was to target the case that the UE cannot receive wake up signal in poor radio condition for a long time. In that case, based on the previous agreement the RLM or RRM measurements are not impacted by WUS design, it would potentially mean that UE would be performing beam failure detection, radio link monitoring. |
| Nokia | No | NW can already achieve this behavior by configuring measurements and can de-configure the DCP, for instance. In addition the UE should be able to receive DCP in worse radio conditions than normal PDCCH, because it can be assumed that DCP has lower payload.  The proposed solution seems to require UE to wake up always. |
| Huawei | No | Agree with Qualcomm. |
| Ericsson | Yes, but… | We like this idea and consider it more efficient then a semi-static RRC configuration. But we also agree that missed WUS detection should and has been discussed in RAN1, not sure if RAN2 should come up with an idea on top of that at this point in time when we are about to close… |
| ZTE | No | Even though this proposal seems reasonable ,but I can not make sure whether it can start in RAN2 since the RSRP measurement is performed in RAN1. |
| CATT | No | We view this as an optimization not absolutely necessary at this late stage. |

*Q6b. If the answer to Q6a is Yes, do you agree with the proposed solution?*

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| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
| Apple | Yes | Solution 1: NW can configure UE to wakeup per N DRX cycle regardless of the WUS indication;  Solution 2: UE can wakeup when the current radio quality becomes worse, e.g. L1\_RSRP/CSI report < threshold. |
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### *Issue #7: ASN.1 options for capturing the search space for the DCP*

Company/Tdoc: ZTE Corporation, Sanechips [14]

Proposed solution:

Select one from the following options to introduce DCI format 2\_6 in TS38.331.

* Option 1: Introduce a SearchSpace-r16 in which the searchSpaceType-r16 includes all the indications for UE to monitor PDCCH candidates for Rel-15 DCI formats and DCI format 2-6.
* Option 2: Introduce SearchSpaceExt-r16 and searchSpacesToAddModListExt-r16.
* Option 3: Introduce powersavingSearchSpaceList-r16 in PCCCH-Config.

*Q7a. Do you think this issue needs to be solved for Rel-16?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | Yes |  |
| Apple | No | We think the ASN.1 in RRC running CR is ok. According to current CR, the new parameters can be configured for legacy DCI format. Then we do not see the problem. |
| Xiaomi | No | The current ASN.1 in RRC running CR is ok. |
| Nokia |  | RAN1 has agreed the following to re-use the existing SS IE:  “**Conclusion:** (RAN1#98bis Chongqing)  With the above agreement, it is understood that the search space(s) for WUS PDCCH reuses the existing SS IE (i.e., no new SS IE).  ” |
| Huawei | Yes |  |
| Ericsson | Yes | We understood this question to be about the ASN.1 encoding. We share the understanding that the legacy search space is re-used for WUS. |
| ZTE | Yes | As agreed in the first Web conference, the search space for DCP can be configured such that it is also used to monitor other Rel-15 DCIs. To configure the DCI format 2\_6 and a legacy DCI format on a same search space, if we follow the ASN.1 in the current RRC running CR, a legacy *SearchSpace* and a *SearchSpace-v16xy* should be added in which the *SearchSpaceId* should be set to the same value and all the other parameters except for the *searchSpaceType* in the legacy *SearchSpace* and the *SearchSpace-v16xy* should be set to the same value. In this way, there would be a lot of duplication in configuration. To avoid such duplication, we suggest to consider the above three options.  Regarding Nokia’s comment, we think at least option 2 and option 3 are not contradict with RAN1’s agreement which is quite obvious. In addition, we think even the option 1 is not contradict with RAN1 agreement since almost all the fields in the existing SS are reused except for the newly added DCI format 2\_6. |
| CATT | Yes |  |

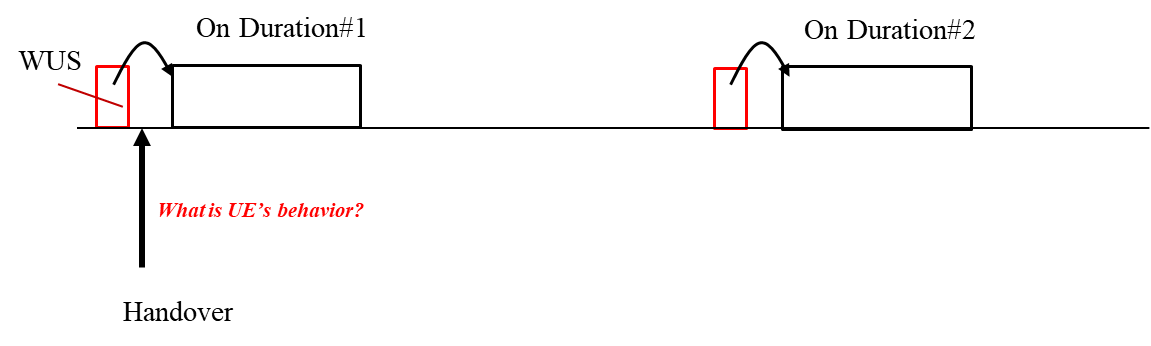
*Q7b. If the answer to Q7a is Yes, which of option 1/2/3 do you prefer?*

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| --- | --- | --- |
| **Company** | **Option** | **Comments and/or other options (if any)** |
| Qualcomm | Option 2, 1 | In decreasing order of preference |
| Huawei |  | No strong view, all options can work. |
| Ericsson | Option 2 | The “Rel-16 CR Merge\_v3” CR (see offline 056) includes a r16 search space extension which includes all the new REL-16 DCI formats, including DCP format 2-6. In case the NW wants to configure a search space with both legacy and REL-16 DCI formats, the NW can configure this using the same *searchSpaceId* in *searchSpacesToAddModList* in and *searchSpacesToAddModList-r16*. The running CR however includes an editor’s NOTE to discuss further:  *Editor’s Note: The structure of the new search space for DCI 2-6 needs further discussion and has to be aligned with all new DCIs introduced in Rel-16.*  In our understanding the running CR is according to option 2 (except that the wording “ext” is not used). |
| ZTE |  | All the three options are acceptable to us. |
| CATT | Option 1 | Option 3 is not preferred as it does not support further extensions of common search space types for other purposes.  In option1, we don't need to include UE specific search space type in SearchSpace-r16 since a search space cannot be configured with common search space types and a UE specific search space type at the same time. And extensions of UE specific search space type have already been introduced in other Rel-WI in legacy search space configurations.  Compared with option 2, we slightly prefer option 1. Although with option 1 these parameters in legacy search space are rewritten, with option 2 the network needs to include an additional search space list (i.e.searchSpacesToAddModListExt-r16) with the same number of entries and the same order as the legacy search space list. The maximum number of searchSpacesToAddModListExt is 10. Therefore, the signalling overhead with option 1 is less than that with option 2 if DCI format 2\_6 is introduced |

### *Issue #8: UE behaviour when it misses DCP during handover*

Company/Tdoc: Xiaomi Communications [16]

Proposed solution: UE starts the associated *drx-onDurationTimer* if UE misses the PDCCH-WUS after handover at a new cell.



*Q8a. Do you think this issue needs to be solved for Rel-16?*

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| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | No | We do not think there is any critical issue to be solved here. |
| Apple | No | UE will first perform RACH procedure during HO, and UE keeps on PDCCH monitoring during the RACH procedure. We do not see the issue. |
| Nokia | No | RA procedure will dictate the PDCCH monitoring upon HO. |
| Huawei | No |  |
| Ericsson | No | We do not think there is an issue to solve. |
| ZTE | No |  |
| CATT | No | We agree with Apple and Nokia |

*Q8b. If the answer to Q8a is Yes, do you agree with the proposed solution?*

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| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
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### *Issue #9: DCP and ambiguity period*

Two distinct issues are now discussed related to DCP and ambiguity period:

* Issue 9a: Does an ambiguity period need to be accounted for considering a DCP occasion when determining whether the UE is during an on-duration period for the purpose of CSI/SRS reporting/transmission?
* Issue 9b: Does an ambiguity period need to be accounted at the time of DCP occasion when determining whether the UE is in Active Time (for the purpose of deciding whether to monitor or not DCP) considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms before the DCP occasion?



#### Issue 9a: Does an ambiguity period need to be accounted for considering a DCP occasion when determining whether the UE is during an on-duration period for the purpose of CSI/SRS reporting/transmission.

This issue was discussed during the email discussion [108#78] (MAC running CR [3][4]) and resulted in all participating companies to agree that no ambiguity period is needed when considering DCP for on-duration determination. And a TP was converged as follows:

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| --- |
| 1> if DCP is configured for the active DL BWP:  2> in current symbol n, if the symbol occurs within *drx-onDurationTimer* duration and *drx-onDurationTimer* would not be running considering DCP occurrence(s) associated with the current DRX cycle ~~until [x] ms prior to symbol n~~ as specified in this clause:  3> not transmit periodic SRS and semi-persistent SRS defined in TS 38.214 [7];  3> not report semi-persistent CSI;  3> if *ps-Periodic\_CSI\_Transmit* is not configured with value *true*:  4> not report periodic CSI on PUCCH. |

*Q9a. Do you agree that no ambiguity period is needed when considering DCP for on-duration determination? If Yes, do you agree the above TP captures it correctly?*

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| --- | --- | --- | --- |
| **Company** | **Proposal**  **Yes/No** | **TP**  **Yes/No** | **Comments (if any)** |
| Xiaomi | Yes |  | * See below. *No ambiguity period is needed when considering DCP for on-duration determination* |
| Nokia |  |  | The ambiguity should apply in scenarios of issues #1 and #9b. |
| Huawei | Yes | Yes |  |
| Ericsson | Yes | Yes | We agree there is no ambiguity for “issue 9a” in figure above, i.e. we also discussed this with issue #1. We assume there is no ambiguity during ps-offset, which is configured taking into account the UE capability.  We agree with the proposed TP correction. |
| ZTE | Yes | Yes |  |
| Qualcomm | Yes | Yes | We don’t think DRX ambiguity period should include or affect DCP. We analyzed this problem in R2-1916175. |
| CATT | Yes | Yes | DCP processing time is addressed in PHY specification. There is no need to specify it in MAC, or even make it visible. |

#### Issue 9b: DCP is only monitored outside Active Time, so is there any ambiguity period associated with the DCP monitoring?

Company/Tdoc: Nokia, Nokia Shanghai Bell [17], ZTE Corporation, Sanechips [21]

Proposed solutions:

* *Nokia, Nokia Shanghai Bell [17]*:

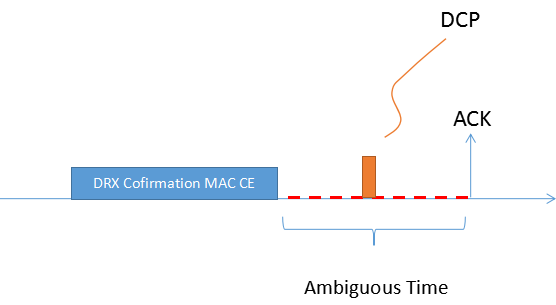
The active time ambiguity period of 4ms applies on whether the UE can monitor the DCP or not (since the UE cannot monitor DCP when in active time).

Proposed TP (wrt [3]):

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| 5.7 Discontinuous Reception (DRX) …  1> if the Short DRX Cycle is used, and [(SFN × 10) + subframe number] modulo (*drx-ShortCycle*) = (*drx-StartOffset*) modulo (*drx-ShortCycle*):  2> start *drx-onDurationTimer* after *drx-SlotOffset* from the beginning of the subframe.  1> if the Long DRX Cycle is used, and [(SFN × 10) + subframe number] modulo (*drx-LongCycle*) = *drx-StartOffset*:  2> if DCP is configured for the active DL BWP:  3> if DCP associated with the current DRX Cycle indicated to start *drx-onDurationTimer*, as specified in TS 38.213 [6]; or:  3> if all DCP occasion(s) in time domain, as specified in TS 38.213 [6], associated with the current DRX Cycle occurred in Active Time considering grants/assignments/DRX Command MAC CE/Long DRX Command MAC CE received and Scheduling Request sent until 4 ms prior to start of the last DCP occasion, or within BWP switching interruption length, or during a measurement gap; or  3> if *ps-Wakeup* is configured with value *true* and DCP associated with the current DRX Cycle has not been received:  4> start *drx-onDurationTimer* after *drx-SlotOffset* from the beginning of the subframe.  2> else:  3> start *drx-onDurationTimer* after *drx-SlotOffset* from the beginning of the subframe.  Editor’s Note: FFS how to progress the support of short DRX cycle for WUS.  Editor’s Note: For DCP overlapping with Active time, it is still FFS in RAN1 whether it refers to all DCP occasions or some DCP occasions. |

* *ZTE Corporation, Sanechips [21]*

[21] specifically addresses the case where DCP occasion occurs right after UE received a DRX Command MAC CE or a Long DRX Command MAC CE:



In such case, the proposed solution is to apply the (long) DRX command (i.e. stop the *drx-onDurationTimer* and *drx-InactivityTimer* ) only when sending the ACK feedback:

“For the case that DCP is configured and the reception of (long) DRX confirmation MAC CE, stop the *drx-onDurationTimer* and *drx-InactivityTimer* in the first symbol after the end of the corresponding transmission carrying the DL feedback of ACK.”

The corresponding TP is:

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| 1> if a *drx-HARQ-RTT-TimerUL* expires:  2> start the *drx-RetransmissionTimerUL* for the corresponding HARQ process in the first symbol after the expiry of *drx-HARQ-RTT-TimerUL*.  1> if a DRX Command MAC CE or a Long DRX Command MAC CE is received:  2> if DCP is configured for the active DL BWP;  3> stop the *drx-onDurationTimer* and *drx-InactivityTimer* in the first symbol after the end of the corresponding transmission carrying the DL feedback of ACK.  2>else;  ~~2~~3> stop *drx-onDurationTimer*;  ~~2~~3> stop *drx-InactivityTimer*.  1> if *drx-InactivityTimer* expires or a DRX Command MAC CE is received:  2> if the Short DRX cycle is configured:  3> start or restart *drx-ShortCycleTimer* in the first symbol after the expiry of *drx-InactivityTimer* or in the first symbol after the end of DRX Command MAC CE reception;  3> use the Short DRX Cycle. |

*Q9b1. Do you think this issue needs to be solved for Rel-16?*

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | Yes | We agree the definition of active time for DCP monitoring should include 4ms ambiguity period, as the one used for CSI/SRS transmission. |
| Apple | No | The configuration of the offset between the WUS occasion and DRX onDuration should take the UE processing time/ambiguity period into account. |
| Xiaomi | Yes | We want to clarify that what we discussed in last night’s email summary is whether the DRX ambiguity period impacts the DCP decoding/processing which leads to whether UE has enough time to report CSI/SRS. It seems we have reached the consensus that the ps\_offset should allow enough processing time for the UE to decide this right at the beginning of drx-onDurationTimer start. So there is no problem at all.  But in this section, Nokia and ZTE brought out another question whether the ambiguity period should be applied on deciding whether the UE expects to monitor DCP in the next occasion(s) since the UE is not required to monitor DCP when in active time. We think it is valid and we should resolve this.  They are separate issues as someone mentioned on the e-meeting.  So Nokia’s solution is ok and can over ZTE’s concern. |
| Nokia | Yes | It seems the above response is talking about issue 9a, not issue 9b..  Since the UE cannot know if it will be in active time during DCP monitoring occasion, we need to apply the ambiguity period for DCP reception. The legacy 4ms period seems to be fine for this.  Only by applying the ambiguity period, NW and UE can be in sync if and how the UE transmits SRS/CSI report. It is problematic for the NW if it does not know what the UE will report. |
| Huawei | Yes |  |
| Ericsson | Yes | There can be ambiguity if the UE can monitor the following DCP occasion after the end of Active Time due to DRX command processing, and we agree with the correction proposed by Nokia. |
| ZTE | Yes | Even though this issue is really existing, the misalignment case is shown as following:  Case 1: NW presume UE shall be in active status while UE is actually in inactive status  Case 2: NW presume UE shall be in inactive status while UE is actually in active status  No matter for which case, if one or more DCP are located in ambiguous time, NW can send a DCP signal to start onduration-timer, if needed. Then UE will not miss anything. |
| CATT | Yes | We agree with Nokia. |

*Q9b2. If the answer to Q9b1 is Yes, which of the proposed solutions (TPs) do you prefer:*

* *Option 1: Nokia, Nokia Shanghai Bell [17]*
* *Option 2: ZTE Corporation, Sanechips [21]*
* *Option 3: Both*
* *Option 4: Other*

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| --- | --- | --- |
| **Company** | **Option** | **Comments and/or other solutions (if any)** |
| Xiaomi | Option1 | See above. |
| Nokia | Option 1 | We did not fully understand how the ZTE proposal works or solves the problem. |
| Huawei | Option 1 | We prefer similar wording as we used for Rel-15 DRX ambiguous period. It can be the baseline, we can finalize the text in 38.321 running CR. |
| Ericsson | Option 1 |  |
| ZTE | Option 4 |  |
| Qualcomm | Option 1 | We prefer the same text as the one used for CSI/SRS transmission. |
| CATT | Option 1 | We think option 1 is sufficient and also covers other contributors to Active Time on top of (Long) DRX Command MAC CE e.g. SR, etc… as in legacy |

### *Issue #10: What should the UE monitor if it misses DCP when configured with SCell dormancy?*

Company/Tdoc: Nokia, Nokia Shanghai Bell [18]

Proposed solution: Agree what the UE shall monitor if it misses DCP when configured with SCell dormancy.

*Rapporteur:* It might be checked first if this is to be discussed in Power Saving WI or in DCCA WI, and in both cases it might rather be a RAN1 issue anyways (since the dormancy state is not visible to MAC).

*Q10a. Do you think this issue needs to be discussed in RAN2 Power Saving session instead of DCCA WI or RAN1?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | No | We should leave this discussion to RAN1. In fact, RAN1 has already been discussing this issue. |
| Apple | Yes | Maybe DCCA is more better to the potential impact on the impact on the SCell dormancy. |
| Xiaomi | ? | To Nokia:  Are you considering the UE’s behavior for Scell groups when UE missing the DCP command?  If you are considering the impact to the Scell state, then RAN1 is discussing this. |
| Nokia | Yes | This is RAN2 functionality and this seems to have no RAN1 specification impact. We should think this issue from the UE power saving point of view. This is occurring only when the UE misses (or cannot monitor) the DCP and starts the on-duration timer. Hence this is UE power saving issue and solution should be considered from UE power saving perspective. |
| Huawei | No | it should be discussed in RAN1, maybe DCCA WI. |
| Ericsson | No | The dormancy state is not visible to L2/3, i.e. this should be discussed, and captured if needed, in RAN1. |
| ZTE | No | Left to RAN1 |
| CATT | No | This whole feature has been transparent to MAC so far. So we would rather take this mis-detection issue to either RAN1 or RAN2-DCCA. |

*Q10b. If the answer to Q10a is Yes, do you think this issue needs to be solved for Rel-16?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Apple | Yes | UE should follow the same principle for both SCell dormancy and non SCell dormancy configuration, i.e. start onDuration timer. |
| Nokia | Yes |  |
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*Q10c. If the answers to Q10a/b are Yes, what should be the solution?*

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| --- | --- |
| **Company** | **Solution (if any)** |
| Apple | NW can configure the UE’s behavior when missing the DCP command, e.g. fallback to default BWP, or keep on current BWP, or switch to dormant BWP. |
| Nokia | For us, it needs to be clear what the UE monitors in this case taking power saving aspects into account. |
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### *Issue #11: Network is not able to perform beam management actions when WUS has not indicated UE to wake-up but UE has transmitted CSI/SRS*

Company/Tdoc: Nokia, Nokia Shanghai Bell [18]

Proposed solution: When UE has reported CSI/transmitted SRS, it would be required to monitor PDCCH for at least part of the on duration. Duration should be configurable by network.

*Q11a. Do you think this issue needs to be solved for Rel-16?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | No | We do not see it as a critical issue that need to be solved in Rel-16, because if network only needs to perform beam refinement, it can wait until the next DRX cycle and wake up UE to do it. If beam(s) fails, UE can initiate BFR itself.  Moreover, the proposed solution is not power efficient. For example, UE is required to monitor PDCCH regardless of whether CSI indicates good or poor link quality. |
| Apple | Yes | It’s not good when NW detect the link problem but cannot do anything timely. |
| Xiaomi | No | If gNB wants to perform beam management actions, it can indicate UE to wake up to report P/SP SRS and CSI for maintaining radio link if necessary. |
| Nokia | Yes | See our Tdoc |
| Huawei | No | Agree with Qualcomm. |
| Ericsson | - | The problem may be dependent on the configured DRX cycle length and UE movements. |
| ZTE | No |  |
| CATT | No | This is pure RAN1 issue and cannot be addressed at this late stage of the WI by either WG. |

*Q11b. If the answer to Q11a is Yes, do you agree with the proposed solution?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
| Apple | No | It’s unnecessary for UE to wake up when the radio quality is good.  We only see the benefit that UE wakeup when the radio quality is worse than a threshold. |
| Nokia | Yes | See our Tdoc |
| Ericsson | - | In case of a solution, it is not clear to us, that the monitoring should depend on radio quality, i.e. it may also depend on UE speed/movements. |
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### *Issue #12: Can DCP and DRX groups be configured together?*

Company/Tdoc: Qualcomm Inc, Samsung [22]

Proposed solution:

RAN2 confirm that the existing RAN1/2 agreements on WUS can still be applied without change when DRX groups are configured. More specifically,

* WUS is configured only on SpCell and UE does not monitor WUS as long as SpCell is in DRX active time;
* If a WUS occasion is not monitored, UE starts DRX on duration timers of both DRX groups at their respective next occurrence;
* Upon a wakeup indication, UE starts DRX on duration timers of both DRX groups at their respective next occurrence

*Q12a. Can DCP and DRX groups be configured together in Rel-16?*

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments (if any)** |
| Qualcomm | Yes | We can expect more power saving when both DRX groups and DCP are configured. This is because DCP does not help save power where there is still active traffic. But with DRX groups, once traffic load drops, network can put FR2 cells to sleep first to save power, by using a separate, much shorter DRX inactivity timer for FR2 cells. Therefore, DCP and DRX groups can be configured together to complement each other’s power saving benefits. As analyzed in [22], the existing DCP procedures still can be applied without change, when DRX groups are configured. Therefore, we think DCP and DRX groups should be allowed to be configured together in Rel-16. |
| Apple | Yes | We do not see any problem.  DCP can also bring the benefit for power efficiency improvement for two DRX groups configuration. |
| Xiaomi | Yes | Yes, since the *OnDuration*s in both DRX groups start at the same time, the common WUS can be used without no problem.  Whether we need to have the WUS to indicate which DRX group to wake up or not still needs further study. |
| Nokia | Yes | DCP should be only configured (based on earlier agreements) on the SpCell, even if there are two DRX groups and the DCP indication should control the onDurationTimer start of both. If DCP monitoring occasion overlaps with (SpCell) active time, UE should start it’s onDurationTimer on the next DRX cycle as agreed earlier. I.e. no change of behavior from DCP perspective. |
| Huawei | No | The impact on the legacy WUS mechanism and CDRX mechanism is not simple, and it may also impacts on RAN1. We don’t prefer this enhancement at this late stage. |
| Ericsson | Yes | Similar view as QC and Apple, i.e. WUS applies to both groups, i.e. *drx-OnDurationTime*r is (re-)started in both groups. |
| ZTE | No | We have already sent to LS to estimate the impact on RAN1, we shall not discuss it until to the reception of RAN1 LS |
| CATT | No | First this discussion assumes DRX groups are supported in Rel-16 which is still to be agreed and won't be discussed in this e-meeting.  Then we agree with Huawei that considering this decision to support DRX groups, if any, may come at a very late stage of the Power Saving WI (note it is considered closed from RAN1 perspective), it makes any potential adjustment to the DCP procedure/configuration/etc impossible to accommodate the coexistence of both features. Among issues we would need to solve:  - If the MAC entity is in Active Time for SpCell (primary DRX group) and outside Active Time in the secondary DRX group, the proposal is that UE ignores the DCP and starts the *drx-onDurationTimer* for both groups which is power inefficient since the secondary DRX group (typically FR2) could have benefited from staying asleep. So this would need some refinement otherwise the DRX groups do not bring any power saving benefit in this particular case.  - On the contrary, if the MAC entity is outside Active Time for SpCell (primary DRX group) and in Active Time (for example on-going RACH or SR) in the secondary DRX group, and DCP tells to not start on-duration timer in its next occurrence, what should UE do regarding on-duration timer for the secondary DRX group?  - How should UE apply the various configurations for CSI reports (follow or not follow DCP) in the different DRX groups? Common configuration/separate configuration?  - Likely several other issues to discover whenever the DRX groups design gets finalized…  Finally, from a performance perspective, we are not convinced of the additional power saving benefit of the DRX groups once a NW deploys the DCP feature. |

*Q12b. If the answer to Q12a is Yes, do you agree with the proposed solution?*

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| **Company** | **Yes/No** | **Comments and/or other solutions (if any)** |
| Apple | Yes |  |
| Ericsson | Yes |  |
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### *Issue #13: UE behavior when a DCP occasion occurs during RAR window*

This issue was discussed in the email discussion [108#78] (MAC running CR [3][4]) but could not get consensus in Tuesday’s Power Saving session, so it is re-discussed here. There are two options:

Option 1: UE monitors DCP (as it monitors other RNTIs in addition to RA-RNTI in legacy) and starts/does not start *drx-onDurationTimer* accordingly on its next occasion.

*Expressed concerns:*

* *Can UE monitor both PDCCH for RA-RNTI and for PS-RNTI?*
* *Can UE monitor both search spaces if RAR and DCP are monitored on different search spaces?*
* *Is this a configuration issue?*

Option 2: UE behaves as if it is in Active Time: it does not monitor DCP and starts *drx-onDurationTimer* on its next occasion.

*Expressed concern:*

* *Why a difference with legacy (where UE is not considered in Active Time during RAR window)?*
* *Since NW is not aware of the UE doing RACH, it would assume it received the DCP and would behave accordingly.*

*Q13.Which of option 1 or 2 do you prefer? Companies are invited to elaborate further on the above mentioned concerns associated with each option in the “Comments” column.*

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| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| Nokia | Option 2 | RAR window is not active time in legacy since the UE does not need to monitor C-RNTI other than in special case (e.g., CFRA BFR, 2-step RA).  However, as the UE may need to monitor also C-RNTI during RAR window (due to CFRA BFR, 2-step RA), it seems we need to apply same principle for monitoring DCP as with Active time, ie., UE starts *drx-onDurationTimer* in case DCP overlaps with RAR response window. |
| Huawei | Option 2 | Although NW is not aware of the UE doing RACH, we don’t see any serious problem. There is the case that NW may indicate to sleep but UE does not monitor WUS and start the next onduration timer, the power waste for only one onduration is not serious since it does not always happen. Besides, there is high possibility that *ra-ContentionResolutionTimer* is running, so the power waste may be ignored. |
| Ericsson | - | We are also not sure what problem we are exactly trying to solve here. We also wonder why we discuss the required WUS monitoring behavior connected to the RAR window? It seems we have a common understanding there can be different cases when the UE is and is not in Active Time during RAR window, i.e. can’t we apply the general rule that UE is only required to monitor WUS outside Active Time here as well, i.e. capture when UE is in Active Time during RAR window the UE shall *drx-OnDurationTimer*? |
| ZTE | Option 2 | It can be treated as active status during the RA response window, and hence there is no need for UE to monitor the DCP. |
| Qualcomm | Option 1 | Our overall preference is to keep the current DCP monitoring behavior, i.e. “DCP is monitored outside DRX active time” as much as possible, and not to add unnecessary exceptions.  In legacy, UE is not considered in DRX active time during RAR window. So far, proponents of Option 2 have not articulated why it is beneficial for UE to skip DCP during RAR window. We therefore prefer the current DCP monitoring behavior is not impacted by RAR window.  As to the concern on simultaneous monitoring of RA-RNTI and PS-RNTI, we think the existing search space prioritization rule in 213 can be followed, i.e. if RA search space and DCP search space are QCL (i.e. they are on the same beam), then UE can monitor both RA search space and PS search space at the same time. Otherwise (e.g. RACH is triggered by BFR), then the current RAN1 spec says that UE should prioritize RA search space over PS search space. Basically, this DCP occasion is invalidated by RAR window. Then UE would start on duration timer in the next DRX cycle.  In summary, we think all the existing behaviors specified by RAN1/2 specs still work. Nothing new needs to be specified. |
| CATT | Option 1 | Similar views as Qualcomm:  RAN1 is discussing at this e-meeting invalid DCP occasions due to collisions with other RNTIs *in the same slot*, e.g. RA-RNTI. It is safe to assume PDCCH to PS-RNTI and RA-RNTI collision in the same slot will invalidate DCP resulting in UE triggering *drx-onDurationTimer* in PHY spec. However, from RAN2 perspective, within RAR window we think the network is aware of the position of DCP and it can schedule the RAR without collision with DCP, or vice-versa e.g. distributing DCP and RAR in different slots. This is an example where multiple DCP occasions can be used to increase the scheduling flexibility. Then, the UE can receive both DCP and RAR and decode DCP to detect whether to wake up for the next DRX on duration occurrence. As a result:  - DCP/RAR collision in the same slot is addressed in RAN1 spec  - No additional precaution should be taken in RAN2 spec for RAR window. |

* 1. **Issues already addressed in the email discussions**

### *MAC-PHY modelling for DCP - Issue #1 of [4]*

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| ***Company/Tdoc*** | ***Related proposal*** |
| Ericsson [6] | Indicate in an LS to RAN1 that start of Active Time and *drx-OnDurationTimer* shall only be captured in 38.321, and ask RAN1 to specify an indication to upper layer when to start PDCCH monitoring during the next DRX cycle. |
| Intel Corporation [11] | Proposal 1. When a UE is configured with the DCP feature, TS 38.321 captures that UE only starts the *drx-onDurationTimer* upon indication for lower layer. LS is sent to inform RAN1 on this agreement in case any clarification is required on all the cases described in TS 38.213 when *drx-onDurationTimer* needs to be started.  Proposal 2. When a UE is configured with the DCP feature, TS 38.321 only reports periodic CSI for next DRX cycle upon indication for lower layer. LS is sent to inform RAN1 on this agreement in case any clarification is required on the cases described in TS 38.213 when *drx-onDurationTimer* is not started and periodic CSI is required. |

### *Support of Short DRX cycle for DCP - Issue #2 of [4]*

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| --- | --- |
| ***Company/Tdoc*** | ***Related proposal*** |
| Ericsson [6] | Indicate in an LS to RAN1 that DCP with short DRX is supported from RAN2 perspective, unless RAN1 concludes that this is technically not feasible. |
| vivo [7] | RAN2 to confirm RAN1 decision that PDCCH-WUS is not applicable for Short DRX cycle at least in Rel-16. |
| Apple [13] | Proposal 1: PDCCH-WUS for short DRX cycles will not be supported in Rel.16  Proposal 2: PDCCH-WUS for short DRX cycles will be taken up for discussion again after Rel.16 is frozen. |
| Nokia [19] | Proposal 1: DCP is supported for both short and long DRX  Proposal 2: DCP for short and/or long DRX is configurable by the network. |
| LG Electronics Inc [20] | Proposal 1. As RAN1’s final decision, i.e., the working assumption still stand, RAN2 should not support Short DRX cycle on DCP. |

### *Partial overlapping for DCP monitoring - Issue #3 of [4]*

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| --- | --- |
| ***Company/Tdoc*** | ***Related proposal*** |
| OPPO [9] | Proposal 1 UE does not monitor PDCCH-WUS if the PDCCH-WUS monitoring occasion partially overlaps with DRX Active Time or measurement gap or BWP switching.  Proposal 2 If some of the configured PDCCH-WUS occasions overlap with DRX Active Time or measurement gap or BWP switching, whether UE monitors PDCCH-WUS on other PDCCH-WUS occasions is configured by network. |
| Nokia [18] | If UE misses one or multiple monitoring occasions before the associated on-duration it monitors the PDCCH i.e. starts the *drx-onDuration* timer. |

### *DRX ambiguous period in DCP - Issue #4 of [4]*

After Tuesday’s Power Saving sessions, the issue is pushed back to offline again and discussed in Section 2.1.9.1 of the current email discussion.

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| ***Company/Tdoc*** | ***Related proposal*** |
| OPPO [10] | Proposal 1 When UE estimates the DRX Active Time status of symbols during period of (4ms-WUSoffset) of *drx-ondurationTimer*, the legacy events are considered irrespective of actual PDCCH-WUS indication.  Proposal 2 When UE estimates the DRX Active Time status of symbols during period other than the periods of (4ms-WUSoffset) of *drx-ondurationTimer*, UE should take into account the PDCC-WUS indication besides the legacy events  Proposal 3 RAN2 discusses whether UE does not perform CSI/SRS transmission if PDCCH-WUS does not indicate UE to wake-up for symbols during period of (4ms-WUSoffset) of *drx-ondurationTimer*. |

# Conclusion

This contribution summarized the contributions posted in the Agenda Item 6.11.2 at this e-meeting, and extracted some new issues to discuss further.

TBC…

# Reference

1. R2-2000843 Running CR for 38.331 for Power Savings MediaTek Inc
2. R2-2000844 Email discussion summary on running 38.331 CR for Power Saving MediaTek Inc.
3. R2-2001615 Running CR for Introduction of Rel-16 NR UE power saving in TS 38.321 Huawei
4. R2-2001616 Report of email discussion [108#78][Power Saving] 38.321 open issues Huawei
5. R2-2000254 New issue on CSI reporting with DCP; CATT
6. R2-2000349 Open issues DCP; Ericsson
7. R2-2000367 PDCCH-WUS not applicable for short DRX cycle; vivo
8. R2-2000368 WUS impact on CSI reporting; vivo
9. R2-2000412 Remaining issues on DCP; OPPO
10. R2-2000413 Impacts of power saivng signalling on CSI reporting; OPPO
11. R2-2000450 Open issues of DCP feature; Intel Corporation
12. R2-2000584 PDCCH-WUS Mechanism; Apple
13. R2-2000599 PDCCH-WUS and Short DRX Cycle; Apple
14. R2-2000665 Discussion on introduction of search space for the DCP; ZTE Corporation, Sanechips
15. R2-2000666 Introduction of search space for the DCP in TS38.331; ZTE Corporation, Sanechips
16. R2-2000811 Discussion on PDCCH-WUS missing problems during handover; Xiaomi Communications
17. R2-2001037 On DRX ambiguous period; Nokia, Nokia Shanghai Bell
18. R2-2001038 On DCP monitoring and CSI/SRS transmission; Nokia, Nokia Shanghai Bell
19. R2-2001040 On short DRX cycle applicability for DCP; Nokia, Nokia Shanghai Bell
20. R2-2001300 Consideration on Short DRX cycle on DCP; LG Electronics Inc.
21. R2-2001463 Remaining issues on WUS signal for Power Saving; ZTE Corporation, Sanechips
22. R2-2001482 Wakeup signaling with DRX groups; Qualcomm Inc, Samsung