**3GPP TSG RAN WG1 Meeting #103-e R1-20xxxxx**

**E-meeting, October 26 - November 13, 2020**

**Agenda Item: 7.2.5**

**Source: Moderator (Huawei)**

**Title: Summary #1 of email discussion [103-e-NR-L1enh-URLLC-01] on remaining issues on enhanced PDCCH monitoring capability**

**Document for: Discussion and Decision**

# Introduction

The email discussion is to discuss the remaining issues on DCI format design.

 [103-e-NR-L1enh-URLLC-01] Email discussion/approval on remaining issues on enhanced PDCCH monitoring capability – Chengyan (Huawei)

* Issue B-1: Time variation of “aligned” status for PDCCH spans across DL cells
* Issue B-2: Whether to apply M-TRP on the Rel-15 cells for case 3
* Discussion and decision by 10/29, TPs by 11/5

This document summarizes the above issue and provide some initial proposals for discussion. Companies are encouraged to provide the first round views by 10/27, then we can adjust the proposals and prepare the TPs for the next step discussions.

# Enhanced PDCCH monitoring capability

This section summarize the issues on enhanced PDCCH monitoring capability.

## Issue B-1: Time variation of “aligned” status for PDCCH spans across DL cells

The following text has been captured in section 10 of TS38.213.

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| A UE can indicate a capability to monitor PDCCH according to one or more of the combinations $\left(X,Y\right)$ = (2, 2), (4, 3), and (7, 3) per SCS configuration of $μ=0$ and $μ=1$. A span is a number of consecutive symbols in a slot where the UE is configured to monitor PDCCH. Each PDCCH monitoring occasion is within one span. If a UE monitors PDCCH on a cell according to combination $\left(X,Y\right)$, the UE supports PDCCH monitoring occasions in any symbol of a slot with minimum time separation of $X$ symbols between the first symbol of two consecutive spans, including across slots. A span starts at a first symbol where a PDCCH monitoring occasion starts and ends at a last symbol where a PDCCH monitoring occasion ends, where the number of symbols of the span is up to $Y$. If a UE indicates a capability to monitor PDCCH according to multiple $\left(X,Y\right)$ combinations and a configuration of search space sets to the UE for PDCCH monitoring on a cell results to a separation of every two consecutive PDCCH monitoring spans that is equal to or larger than the value of $X$ for one or more of the multiple combinations $\left(X,Y\right)$, the UE monitors PDCCH on the cell according to the combination $\left(X,Y\right)$, from the one or more combinations $\left(X,Y\right)$, that is associated with the largest maximum number of $M\_{PDCCH}^{max,\left(X,Y\right),μ}$ and $C\_{PDCCH}^{max,\left(X,Y\right),μ}$ defined in Table 10.1-2A and Table 10.1-3A. The UE expects to monitor PDCCH according to the same combination $\left(X,Y\right)$ in every slot on the active DL BWP of a cell.…If a UE is configured only with $N\_{cells,r16}^{DL,μ}$ downlink cells for which the UE is provided *monitoringCapabilityConfig-r16* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration $μ$, and with $N\_{cells,r16}^{DL,(X,Y),μ}$ of the $N\_{cells,r16}^{DL,μ}$ downlink cells using combination $\left(X,Y\right)$ for PDCCH monitoring, where $\sum\_{μ=0}^{1}N\_{cells,r16}^{DL,μ}>N\_{cells}^{cap-r16}$, a DL BWP of an activated cell is the active DL BWP of the activated cell, and a DL BWP of a deactivated cell is the DL BWP with index provided by *firstActiveDownlinkBWP-Id* for the deactivated cell, the UE is not required to monitor more than $M\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅M\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ PDCCH candidates or more than $C\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅C\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ non-overlapped CCEs - per set of spans on the active DL BWP(s) of all scheduling cell(s) from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells within every $X$ symbols, if the union of PDCCH monitoring occasions on all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells results to PDCCH monitoring according to the combination $\left(X,Y\right)$ and any pair of spans in the set is within $Y$ symbols, where first $X$ symbols start at a first symbol with a PDCCH monitoring occasion and next $X$ symbols start at a first symbol with a PDCCH monitoring occasion that is not included in the first $X$ symbols - per set of spans across the active DL BWP(s) of all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells, with at most one span per scheduling cell for each set of spans, otherwise where $N\_{cells,r16}^{DL,j}$ is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration $j$. If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig-r16* = *r15monitoringcapability* and *monitoringCapabilityConfig-r16* = *r16monitoringcapability*, $N\_{cells}^{cap-r16}$ is replaced by $N\_{cells,r16}^{cap-r16}$. |

In the RAN1#102-e meeting, the following proposal was discussed but no consensus was achieved.

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| * *A UE doesn’t expect slot-dependent aligned spans vs. unaligned spans variation, i.e. either aligned spans or unaligned spans for all slots.*
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Some companies provide further views in the contributions for RAN1#103-e, and the related to issues are summarized as below:

**Question 1: Interpretation of the allowed gNB configuration**

Based on the discussion in RAN1#102-e, it seems most companies agree with the principle of the proposal above, however it was not agreed due to different understanding of the allowed gNB configuration.

* ***Interpretation 1****: All three cases below allowed assuming both case 2 and case 3 belongs to unaligned span case*



* + ***Support****: Intel, Ericsson, Vivo*
	+ ***Pros****:*
		- *No limitation of network configuration*
	+ ***Cons:***
		- *Slot-dependent aligned spans vs. unaligned spans variation may happen at the UE side, which is not desirable from UE implementation perspective*
* ***Interpretation 2****: Only case 1 and case 2 are allowed*



* + ***Pros****:*
		- *Ensure no slot-dependent aligned spans vs. unaligned spans variation at the UE side*
	+ ***Cons:***
		- *Limitation of network configuration*

**Feature lead**: It seems most companies agree that interpretation 1 is better from the configuration flexibility perspective, unless we cannot achieve consensus on how to address the UE complexity concern at the UE side, I would suggest not consider interpretation 2 at this stage.

### Question 2: Solutions to allow interpretation 1 above while address the complexity concern at the UE side

To leave the flexibility on configuration and also address the UE complexity on determining aligned span and unaligned span, the following options are considered:

* ***Option 1****: Network sends RRC signaling concerning the CCs at the same numerology and (X,Y) indicates “aligned span” or “unaligned span” designation to a UE*
	+ ***Support****: Apple*
	+ ***Feature lead:***
		- *Pros: Reduced UE complexity and relaxing the limitation of gNB configuration*
		- *Cons: The RRC signaling structure (e.g. the groups of cells needs to be indicated) may depend on the search space configuration on the cells*
* ***Option 2****: define a small set of reference slot(s) (e.g., N slots) to determine whether the spans are aligned or unaligned for CA, where N is less than the maximum PDCCH monitoring periodicity in the configured search space sets, e.g., N=1 or 2*
	+ ***Support****: Ericsson, Vivo,*
	+ ***Feature lead:***
		- *Pros: Reduced UE complexity and relaxing the limitation of gNB configuration to some extent*
		- *Cons: gNB still needs to ensure unaligned case within the reference slots, therefore still some limitation at the gNB side*
* ***Option 3****: Determine the combination (X, Y) using* ***synthetic*** *monitoring occasions*
	+ ***Support****:*
	+ *Endorse the following text proposal for TS 38.213 Section 10.*

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| 10 UE procedure for receiving control information**\*\*\* Unchanged text is omitted \*\*\***A UE can indicate a capability to monitor PDCCH according to one or more of the combinations $\left(X,Y\right)$ = (2, 2), (4, 3), and (7, 3) per SCS configuration of $μ=0$ and $μ=1$. A span is a number of consecutive symbols in a slot where the UE is configured to monitor PDCCH. Each PDCCH monitoring occasion is within one span. If a UE monitors PDCCH on a cell according to combination $\left(X,Y\right)$, the UE supports PDCCH monitoring occasions in any symbol of a slot with minimum time separation of X symbols between the first symbol of two consecutive spans, including across slots. A span starts at a first symbol where a PDCCH monitoring occasion starts and ends at a last symbol where a PDCCH monitoring occasion ends assuming a PDCCH monitoring occasion exists in all slots if it exist in any slot, where the number of symbols of the span is up to Y. If a UE indicates a capability to monitor PDCCH according to multiple $\left(X,Y\right)$ combinations and a configuration of search space sets to the UE for PDCCH monitoring on a cell results to a separation of every two consecutive PDCCH monitoring spans that is equal to or larger than the value of $X$ for one or more of the multiple combinations $\left(X,Y\right)$, the UE monitors PDCCH on the cell according to the combination $\left(X,Y\right)$, from the one or more combinations $\left(X,Y\right)$, that is associated with the largest maximum number of $M\_{PDCCH}^{max,\left(X,Y\right),μ}$ and $C\_{PDCCH}^{max,\left(X,Y\right),μ}$ defined in Table 10.1-2A and Table 10.1-3A. The UE expects to monitor PDCCH according to the same combination $\left(X,Y\right)$ in every slot on the active DL BWP of a cell.**\*\*\* Unchanged text is omitted \*\*\*** |

* + *Endorse the following text proposal for TS 38.213 Section 10.1.*

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| 10.1 UE procedure for determining physical downlink control channel assignment <Unchanged parts are omitted>If a UE is configured only with $N\_{cells,r16}^{DL,μ}$ downlink cells for which the UE is provided *monitoringCapabilityConfig-r16* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cell(s) using SCS configuration $μ$, and with $N\_{cells,r16}^{DL,(X,Y),μ}$ of the $N\_{cells,r16}^{DL,μ}$ downlink cells using combination $\left(X,Y\right)$ for PDCCH monitoring, where $\sum\_{μ=0}^{1}N\_{cells,r16}^{DL,μ}>N\_{cells}^{cap-r16}$, a DL BWP of an activated cell is the active DL BWP of the activated cell, and a DL BWP of a deactivated cell is the DL BWP with index provided by *firstActiveDownlinkBWP-Id* for the deactivated cell, the UE is not required to monitor more than $M\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅M\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ PDCCH candidates or more than $C\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅C\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ non-overlapped CCEs - per set of spans on the active DL BWP(s) of all scheduling cell(s) from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells within every $X$ symbols, if the union of PDCCH monitoring occasions on all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells results to PDCCH monitoring according to the combination $\left(X,Y\right)$ and any pair of spans in the set is within $Y$ symbols assuming a PDCCH monitoring occasion exists in all slots on a scheduling cell if it exist in any slot on the scheduling cell, where first $X$ symbols start at a first symbol with a PDCCH monitoring occasion and next $X$ symbols start at a first symbol with a PDCCH monitoring occasion that is not included in the first $X$ symbols - per set of spans across the active DL BWP(s) of all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells, with at most one span per scheduling cell for each set of spans, otherwise where $N\_{cells,r16}^{DL,j}$ is a number of configured cells with SCS configuration $j$. If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig-r16* = *r15monitoringcapability* and *monitoringCapabilityConfig-r16* = *r16monitoringcapability*, $N\_{cells}^{cap-r16}$ is replaced by $N\_{cells,r16}^{cap-r16}$.<Unchanged parts are omitted> |

**Please provide your views on the above options. If you have other solutions, please indicate here also.**

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| *Company* | *View* |
| ZTE | Option 3 is under assumption that the same span pattern repeats in every slot. So, if a UE doesn’t support different span patterns for different slots, we prefer Option 3 which aligns the definition in FG 3-5b. If a UE supports different span patterns for different slots, we prefer Option 1 or simply go for Interpretation 2 (Case 3 is not allowed).  |
| *Quectel* | We share same view as ZTE. |
| *CATT* | We prefer option 3. Agree with the insights from FL. For the proposed TP, the first change seems not relevant to the CA case. The second part is sufficient.  |
| *Samsung* | OK in principle for option 2 with N=1 or option 3. Text can be discussed later.Option 1 is not currently possible. Option 2 is OK for N=1 – i.e. UE checks in one slot whether ‘aligned’ or ‘non-aligned’ and assumes same outcome in all other slots. Option 3 seems similar to option 2 for N=1.  |
| *Spreadtrum* | Option3.It is same as FG 3-5b and would be good to use the unified method to generate span patterns. |
| *HW/HiSi* | **For Question 1,** We agree on interpretation 1 and the underlying problem is how to assess whether CCs are aligned or not (see question 2).**For Question 2:****Option 3:** We are supportive of Option 3. The “synthetic MOs” for each CC should be considered, which is ensured used with the proposed red text “assuming a PDCCH monitoring occasion exists in all slots on a scheduling cell if it exist in any slot on the scheduling cell”. (As ZTE pointed out this align with the definition in FG 3-5b). Then, according to the already existing text in the spec, the union over all MOs across all cells is constructed.**Option 1:** We are not supportive of Option 1. This option requires a new RRC parameter, which should be avoided at this stage. Also, we have already defined rules a how to assess whether CCs are aligned or not. Even if a UE would be informed by a RRC parameter, the UE would still need to use these rules. From this perspective, it might be redundant to introduce a new RRC parameter for determination on aligned/un-aligned span case. On the other hand, if the intention with the RRC parameter is to replace the rules, then the UE and gNB still need to have the same understanding, when the UE has enough processing capacity to perform the scaling according to aligned spans. We are not sure if a new RRC parameter does solve this issue. **Option 2:** We are not supportive of Option 2. We think that the proponent’s original intention with this option is to allow more flexibility when allocating MO while still considering the CCs to be aligned. However, for UE complexity reasons, the number of reference slots suggested to be small. In this case, not much flexibility is allowed why there is still specification effort required. It would be much simpler to go with Option 3 instead. |
| *Nokia, NSB* | **Option 3** As noted by some companies above, Option 1 would require RRC changes (which should be out of question at this stage). Comparing Option 2 and Option 3, as HW pointed out Option 3 would be simpler.  |
| *Vivo* | We prefer Option 2 and we can agree on N=1 or 2.For the aligned span case, it is expected that there would be aligned spans case for Rel-16 PDCCH monitoring capability in all slots considering complexity of UE implementation. For the unaligned span case, on the other hand, it is not necessary to restrict the spans in all slots are unaligned or the same, otherwise it would put limit on the network flexibility of configuration. Therefore, when UE determines unaligned spans case in the first N slots, there is no restriction for all the other subsequent slots. |
| *Qualcomm* | We prefer Option 3 if it means that the number of spans per slot and their locations are identical across all slots of a given carrier. Not sure what “assuming a PDCCH monitoring occasion exists in all slots on a scheduling cell if it exist in any slot on the scheduling cell” means. According to the response from HW, this is similar to the span formation for FG 3-5b. However, under FG 3-5b, some spans can be empty. Hence, the monitoring occasions do not need to be exactly the same in all slots. Some explanations could be helpful.  |
| *Intel* | We are also fine with Option 2 with N = 1 or with Option 3. For Option 2, perhaps we could say “*define a small set of reference number of slot(s) (e.g., N slots) to determine*”?Regarding Option 3, our understanding, similar to other above, is that it is implementing the “overlay/bitmap” based span-definition of FG #3-5b. To Qualcomm’s comment, our interpretation is that this *assumption* is for the purpose of determining (X,Y) combination and aligned vs. non-aligned characterization; it does not imply that there is actual PDCCH monitoring configured at the same symbols in every slot. |

### Question 3: Whether/how to set a time window for which a set of spans is considered for unaligned span case

For the non-aligned case, as no time window is defined for the span set construction, a span set including two spans which are sufficiently separated in time domain (e.g., tens of slots) still needs to be checked. The number of span sets to be checked will be exponentially increased as the span pattern cannot repeat in a long time.

* ***Option 1****: Limit the time window to one slot*
	+ ***Support****: Ericsson*

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| ---------------------------------Start of Text Proposal on TS 38.213 v16.3.0-----------------------10.1 UE procedure for determining physical downlink control channel assignment <Unchanged parts are omitted>If a UE is configured only with $N\_{cells,r16}^{DL,μ}$ downlink cells for which the UE is provided *monitoringCapabilityConfig-r16* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration $μ$, and with $N\_{cells,r16}^{DL,(X,Y),μ}$ of the $N\_{cells,r16}^{DL,μ}$ downlink cells using combination $\left(X,Y\right)$ for PDCCH monitoring, where $\sum\_{μ=0}^{1}N\_{cells,r16}^{DL,μ}>N\_{cells}^{cap-r16}$, a DL BWP of an activated cell is the active DL BWP of the activated cell, and a DL BWP of a deactivated cell is the DL BWP with index provided by *firstActiveDownlinkBWP-Id* for the deactivated cell, the UE is not required to monitor more than $M\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅M\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ PDCCH candidates or more than $C\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅C\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ non-overlapped CCEs - per set of spans on the active DL BWP(s) of all scheduling cell(s) from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells within every $X$ symbols, if the union of PDCCH monitoring occasions on all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells results to PDCCH monitoring according to the combination $\left(X,Y\right)$ and any pair of spans in the set is within $Y$ symbols, where first $X$ symbols start at a first symbol with a PDCCH monitoring occasion and next $X$ symbols start at a first symbol with a PDCCH monitoring occasion that is not included in the first $X$ symbols - per set of spans within a slot across the active DL BWP(s) of all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells, with at most one span per scheduling cell for each set of spans, otherwise where $N\_{cells,r16}^{DL,j}$ is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration $j$. <Unchanged parts are omitted>--------------------------------------End of Text Proposal on TS 38.213 v16.3.0------------------ |

* ***Option 2****: Limit the time window to all spans that have overlapped symbols with a same X-symbol window*
	+ ***Support****: Quectel*

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| < Unchanged parts are omitted >If a UE is configured only with $N\_{cells,r16}^{DL,μ}$ downlink cells for which the UE is provided *monitoringCapabilityConfig-r16* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration $μ$, and with $N\_{cells,r16}^{DL,(X,Y),μ}$ of the $N\_{cells,r16}^{DL,μ}$ downlink cells using combination $\left(X,Y\right)$ for PDCCH monitoring, where $\sum\_{μ=0}^{1}N\_{cells,r16}^{DL,μ}>N\_{cells}^{cap-r16}$, a DL BWP of an activated cell is the active DL BWP of the activated cell, and a DL BWP of a deactivated cell is the DL BWP with index provided by *firstActiveDownlinkBWP-Id* for the deactivated cell, the UE is not required to monitor more than $M\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅M\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ PDCCH candidates or more than $C\_{PDCCH}^{total,(X,Y),μ}=\left⌊N\_{cells}^{cap-r16}⋅C\_{PDCCH}^{max,(X,Y),μ}⋅{N\_{cells,r16}^{DL,(X,Y),μ}}/{\sum\_{j=0}^{1}N\_{cells,r16}^{DL,j}}\right⌋$ non-overlapped CCEs - per set of spans on the active DL BWP(s) of all scheduling cell(s) from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells within every $X$ symbols, if the union of PDCCH monitoring occasions on all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells results to PDCCH monitoring according to the combination $\left(X,Y\right)$ and any pair of spans in the set is within $Y$ symbols, where first $X$ symbols start at a first symbol with a PDCCH monitoring occasion and next $X$ symbols start at a first symbol with a PDCCH monitoring occasion that is not included in the first $X$ symbols - per set of spans across the active DL BWP(s) of all scheduling cells from the $N\_{cells,r16}^{DL,(X,Y),μ}$ downlink cells fully or partially overlapped with a same X symbols， with at most one span per scheduling cell for each set of spans, otherwise where $N\_{cells,r16}^{DL,j}$ is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration $j$. If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig-r16* = *r15monitoringcapability* and *monitoringCapabilityConfig-r16* = *r16monitoringcapability*, $N\_{cells}^{cap-r16}$ is replaced by $N\_{cells,r16}^{cap-r16}$.< Unchanged parts are omitted > |

**Please provide your views on the above options. If you have other solutions, please indicate here also.**

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| *Company* | *View* |
| ZTE | Option 1 is preferred. |
| *Quectel* | We support Option 2.Option 1 is in fact re-defining the Rel-15 slot-based CA PDCCH monitoring behavior by replacing the per-slot budget $M\_{PDCCH}^{max,slot,μ}$ with per combination (X,Y) budget $M\_{PDCCH}^{max,\left(X,Y\right),μ}$, which is undesired and confusing for UE implementation.On the other hand, $M\_{PDCCH}^{max,slot,μ}$ is a per-combination (X,Y) (or per X-symbol) budget rather than a per-slot budget, it does not make much sense to force a set of spans which are spreading over a slot to comply with a per X-symbol budget.Option 2 is already conservative and safe enough. Option 1 is over-conservative and contradicting with Rel-15 slot-based CA PDCCH monitoring. |
| *CATT* | Option 2. Agree with Quectel’s comments. |
| *Samsung* | Option 2 – text can be simplified from “fully or partially overlapped with a same X symbols” to “within same X symbols”.  |
| *Spreadtrum* | Option1We have back-to-back span patterns, they do not have overlapped symbols within a X-symbol window, but they may increase the complexity of UE implementation when handling the two closed monitoring occasions belong to different X-symbol windows.  |
| *HW/HiSi* | Support Option 1. Agree with comment from Spreadtrum.  |
| *Nokia, NSB* | Option 2, as Samsung pointed out the details of the text can still be discussed later on  |
| *Vivo* | Option 1Similar to Spreadtrum’s views. The back-to-back span patterns can be configured by gNB. If only check non-aligned span case *with a same X-symbol window*, it may increase the complexity of UE implementation.  |
| *Qualcomm* | Option 1. |
| *Intel* | If we go with Option 3 in response to Question 2, then is the addition per Option 1 or Option 2 necessary? Do we not get a repeating pattern in terms of “span pattern” determination (that repeats every slot)? If so, then the UE can just consider the situation within a slot duration as the time window to check against BD/CCE limits.While the constraint would not do any harm if we agree to Option 3 in response to Question 2, but for other cases, neither of the options in response to current question seem to address the UE complexity issue due to the “back-to-back” effect. Just like Spreadtrum and supporters of Option 1 have pointed out the shortcoming of checking per “X symbols”, the same issue exists across slot boundaries, unless we go with Option 3 in response to Question 2 (since there is no guarantee that the span pattern repeats every slot).On the other hand, even without Option 3 for Question 2, we are now wondering if any “time window” definition is necessary. The second bullet says that the UE does not expect the sum limits across spans across carriers do not exceed the specified limit, for a given configuration. With such a guarantee, why the UE needs to check over a long horizon for potential violation? Is this not similar in spirit as the reason why we agreed to no overbooking for spans beyond the first span in a slot for a primary cell? That is, the UE does NOT need to count the configured number of candidates against the specified limits for spans other than the first span in a slot in primary cells.Thus, in summary, it is not clear if we need to define any time window for the second bullet at all. |

## Issue B-2: Whether/how to extend Rel-16 PDCCH monitoring capability to multi-TRP case whether to apply M-TRP on the Rel-15 cells for case 3 (i.e. both cell(s) with Rel-15 monitoring capability and cell(s) with Rel-16 monitoring capability are configured)

A common understanding in the RAN1 #101 email discussion is that there is no need to extend the M-TPR in Rel-16 MIMO with Rel-16 PDCCH monitoring capability [4] because all enhancements for reliability (URLLC) are through single-DCI based operations (assuming ideal backhaul) in M-TRP operation, which does not require any modification of Rel-15 spec on monitoring capability. However whether the M-TPR in Rel-16 MIMO can be extended to only the Rel-15 cells in CA case 3 (mixed Rel-15 and Rel-16 monitoring capabilities) is not clear.

* **Interpretation 1**: M-TPR in Rel-16 MIMO can be extended to only the Rel-15 cells in CA case 3.
	+ *Support: ZTE, Samsung, Quectel*
* **Interpretation 2**: M-TPR in Rel-16 MIMO cannot be extended to the Rel-15 cells in CA case 3.
	+ *Support: Quectel (ok), Huawei/HiSilicon, ZTE (can accept)*

**From feature view**: It seems we need to discuss this issue in order to make the specification clear. However, more views are needed before making any proposal here.

**Please indicate which interpretation do you prefer and please also provide your reasons also.**

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| *Company* | *View* |
| ZTE | We are fine with both interpretations while slightly prefer Interpretation 1. Because, at least the cells configured with Rel-15 PDCCH monitoring capability in CA case 3 can be configured with two values of CORESETPoolIndex to improve throughput for eMBB with Multi-DCI based M-TRP. |
| *Quectel* | Either way is OK for us generally. We slightly prefer Interpretation 2 for the reasons:* Less or no change to existing specification. We need to carefully check every detail of the specification to not miss anything if we go with Interpretation 1, which may raise more discussions at this late stage;
* The use cases of Interpretation 1 are not clear and lack of justifications.
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| *CATT* | Interpretation 2. |
| *Samsung* | Interpretation 1 – because it does not make sense to preclude M-TRP for a UE (for eMBB services) just because the UE also supports URLLC. Rel-15/Rel-16 PDCCH monitoring are orthogonal in the specs and no other issue exists. |
| *Spreadtrum* | Interpretation 2. It is not preclude M-TRP, only preclude M-DCI scheduling with M-TRP transmission. Single-DCI still can be used for the Rel-15 cells if they support M-TRP.Interpretation 1 is trying to combine M-DCI scheduling together with span based PDCCH monitoring. M-DCI scheduling typically used in non-coherent joint transmission especially non-ideal backhaul scenario. From our view, we do not understand that why M-DCI scheduling and span based PDCCH monitoring should be simultaneously configured. |
| *HW/HiSi* | Interpretation 2.In our view this interpretation is simpler for the network operation. What seems under discussion here is a joint feature that M-TRP is extended to only Rel-15 cells for Case 3 (mixed PDCCH monitoring). We have not had this discussion about joint features earlier. To start it now seems risky and might have impact that we cannot foresee. For example, a UE can support multiple combinations of Rel15/Rel-16 PDCCH monitoring capability. In case the gNB wants to change the capability combination for the mixed monitoring (i.e. changing the number of supported Rel-15 cells), the other TRP would also be impacted if this kind of operation should be supported. Another issue is out-of-order scheduling, it is supported when Multi-DCI-based M-TRP is enabled, but it is not supported in URLLC. If M-TRP in Rel-16 MIMO can be extended to only the Rel-15 cells in CA case 3, it needs further discussion on whether to support out of order in such case. |
| *Nokia/NSB* | Interpretation 2Reasoning: Clearly from feature support, as e.g. pointed out by Samsung, Interpretation 1 would be preferable (i.e. why to restrict by specification if no other issues). But at the same time we do agree with the comment by Huawei about OoO HARQ operation (which would still need to be clarified). If OoO HARQ would then also be supported for Interpretation 1 (i.e. joint decision of Interpretation 1 & support of OoO HARQ), we would be fine with Interpretation 1.  |
| *Vivo* | Interpretation 2 is preferred. It should be clarified whether other issues exist when two features are configured simultaneously.  |
| *Intel* | While we understand the motivation from a spec perspective to allow for combinations as in Interpretation 1 in view of reduced coupling between “eMBB” and “URLLC” configurations and that from perspective of PDCCH monitoring, the R15 and R16 cells could be independent, we are a bit concerned with potential coupling due to other associated scheduling/HARQ procedures. Hence, Interpretation 2 is preferred considering we are well beyond usual maintenance phase for Rel-16. There seems to be potential new issues and combinations (examples of discussions already visible above) that could be brought up, while a strong motivation may not necessarily exist for such combinations from a practical use-case perspective. Thus, we prefer not to agree to combination just from a PDCCH monitoring perspective and then having to devise additional conditions/constraints to manage potential coupling and issues. |

Note that once we have agreement here, we can further discuss the potential TP for this issue.

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