**3GPP TSG RAN WG1#110bis-e R1-221xxxx**

**e-Meeting, October 10th – 19th, 2022**

**Agenda Item: 8.2**

**Source: Moderator (Lenovo)**

**Title: Email discussion [110bis-e-R17-FR2-2-04] for maintenance on PDCCH monitoring enhancements for FR2-2**

**Document for: Discussion, Decision**

# Introduction

As stated by the chairman:

[110bis-e-R17-FR2-2-04] Email discussion for maintenance on PDCCH monitoring enhancements for FR2-2 for issues PDCCH-2, PDCCH-4 and PDCCH-1 (incl. whether this should be handled in UE features) in R1-2210392 – Alex (Lenovo)

Check points: October 14, October 19

# Discussion

FL NOTE: Excerpts from submitted documents are listed in Section 3.

## [ACTIVE] Topic PDCCH-1: multi-slot PDCCH monitoring for for Group (2) SSs

Ericsson [5] and ZTE, Sanechips [1] have provided draft CRs, with an additional discussion document provided by Ericsson [6]. The relevant parts of the two draft CRs for clause 10.1 of 38.213 are provided below side-by-side.

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| ZTE, Sanechips [1] | Ericsson [5] |
| For each DL BWP configured to a UE in a serving cell, the UE is provided by higher layers with search space sets where, for each search space set from the search space sets, the UE is provided the following by *SearchSpace*:  - a search space set index , , by *searchSpaceId*  - […]  - a bitmap, by *monitoringSlotsWithinSlotGroup*, that applies per group of slots and provides a PDCCH monitoring pattern indicating slots in a group of slots for PDCCH monitoring  - a size of the group of slots is same as a size of *monitoringSlotsWithinSlotGroup*  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in dedicated RRC signaling, or for a Type3-PDCCH CSS set, or for a USS set, the PDCCH monitoring pattern indicates only consecutive slots in the group of slots for PDCCH monitoring and, at least for one combination indicated by the UE as a capability, a number of the consecutive slots is not larger than  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in *SIB1*, the PDCCH monitoring pattern indicates only up to 1 slot in the group of slots for PDCCH monitoring  - for a Type0-PDCCH CSS set or for a Type0A-PDCCH CSS set, or for a Type2-PDCCH CSS set, the PDCCH monitoring pattern indicates slots in the group of slots for PDCCH monitoring, and the slots are not restricted to be consecutive, a number of those slots is not larger than the size of *monitoringSlotsWithinSlotGroup* | For each DL BWP configured to a UE in a serving cell, the UE is provided by higher layers with search space sets where, for each search space set from the search space sets, the UE is provided the following by *SearchSpace*:  - a search space set index , , by *searchSpaceId*  - […]  - a bitmap of length *L*, by *monitoringSlotsWithinSlotGroup*, that applies per group of slots and provides a PDCCH monitoring pattern indicating slots in a group of slots for PDCCH monitoring  - a size of the group of slots is same as a size of *monitoringSlotsWithinSlotGroup*  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in dedicated RRC signaling, or for a Type3-PDCCH CSS set, or for a USS set, the PDCCH monitoring pattern indicates only consecutive slots in the group of slots for PDCCH monitoring and, at least for one combination indicated by the UE as a capability, a number of the consecutive slots is not larger than  - for a Type0/0A/2-PDCCH CSS set, the PDCCH monitoring pattern can indicate consecutive or non-consecutive slots in the group of slots for PDCCH monitoring, and the number of slots can be up to *L*  - for a Type1-PDCCH CSS set provided by *ra-SearchSpace* in *PDCCH-ConfigCommon*, the PDCCH monitoring pattern can indicate one slot in the group of slots for PDCCH monitoring |

### First round discussion

**Question PDCCH-1.1a: Do you agree to capture the "Group (2)" agreements in 38.213? Please provide reasons for Yes or No.**

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| **Company** | **Comment** |
| Ericsson (from preparation phase) | RAN2 agreed to a CR to 38.331 last meeting that says "The number of slots for multi-slot PDCCH monitoring is configured according to clause 10 in TS 38.213 [13]." Hence 331 now refers back to 38.213, and the number of slots is not described for Group (2) SSs in the current version of 38.213. LGE mentions that FG24-4 and 24-5 already cover this; however, the FG list in 38.822 is not normative. If companies prefer to capture this in 38.306 (normative spec), then we should send an LS to RAN2 to ask them to change the reference in 38.331 to 38.306 instead of 38.213. We think it is easier just to capture this in 38.213 and avoid such an LS. |
| ZTE, Sanechips (from preparation phase) | We agree with Ericsson’s comment. The easier and straightforward way is to capture Group (2) SSs in TS 38.213 since the description of *monitoringSlotsWithinSlotGroup* in TS 38.331 directly refers to RAN1’s specification, also, it seems incomplete and irrational to only capture the feature for Group (1) SS sets. Hence, TS 38.213 should be updated accordingly. |
| Moderator | Closed; an agreement was reached in GTW on Wed 12 October. Please continue with discussion of a CR/TP in Question PDCCH-1.1b below. |

**Question PDCCH-1.1b: Assuming that the "Group (2)" agreements are to be captured in 38.213, please state any comments on the two draft CR text proposals, or a preference which one is more suitable.**

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| **Company** | **Comment** |
| Moderator | If a majority prefers Ericsson's TP, the usage of "can" should be avoided (e.g. the number of slots is at most equal to *L*.) |
| Ericsson | No strong view on which TP is used as a basis, but if the Ericsson TP is used, then suggest the following updates:   * the number of slots can be up to *L* 🡺the number of slots is at most equal to *L* * provided by *ra-SearchSpace* in *PDCCH-ConfigCommon 🡺* provided by *ra-SearchSpace* in *SIB1* |
| Huawei, HiSilicon | If Ericsson’s TP is adopted, we would suggest to change the length “*L*” to other letter. L is already used in the section for aggregation level. |

## Topic PDCCH-2: multi-slot PDCCH monitoring in CA or NR-DC scenarios

CATT has provided two draft CRs [3] [4] with an additional discussion document [2]. Moderator thinks both draft CRs should be handled and discussed individually.

### [ACTIVE] Topic PDCCH-2.1: Correction on BD/CCE budget of  scheduling cell(s)  for the features extending NR operation to 71 GHz

The relevant parts of draft CR [3] for 38.213 clause 10.1 are given below for easy reference. Please refer to [3] for more context.

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| If a UE is configured with downlink cells for which the UE is not provided *monitoringCapabilityConfig,* or is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and is not provided *CORESETPoolIndex*, with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration where , the UE is not required to monitor, on the active DL BWPs of the scheduling cells,  - more than PDCCH candidates or more than non-overlapped CCEs per slot for each scheduled cell when the scheduling cell is from the downlink cells, or  - more than PDCCH candidates or more than non-overlapped CCEs per slot for each scheduled cell when the scheduling cell is from the downlink cells  - more than PDCCH candidates or more than non-overlapped CCEs per slot for CORESETs with same *coresetPoolIndex* value for each scheduled cell when the scheduling cell is from the downlink cells  is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability.* is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability.* is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability.*  If a UE  - is configured with downlink cells for which the UE is not provided *monitoringCapabilityConfig,* or is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and is not provided *coresetPoolIndex*,  - with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cell(s) using SCS configuration , where , and  - 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  PDCCH candidates or more than non-overlapped CCEs per slot on the active DL BWP(s) of scheduling cell(s) from the downlink cells. is replaced by if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability*. is replaced by , if a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability.* is replaced by .If a UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability.*  […]  If a UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration , and with of the downlink cells using combination for PDCCH monitoring, where , the UE is not required to monitor, on the active DL BWP of the scheduling cell, more than PDCCH candidates or more than non-overlapped CCEs per span for each scheduled cell when the scheduling cell is from the downlink cells. If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability*, is replaced by . If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability,*  is replaced by *.*If a UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability,*  is replaced by *.*  If a UE is configured only with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration , and with of the downlink cells using combination for PDCCH monitoring, where , 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 PDCCH candidates or more than non-overlapped CCEs  - per set of spans on the active DL BWP(s) of all scheduling cell(s) from the downlink cells within every symbols, if the union of PDCCH monitoring occasions on all scheduling cells from the downlink cells results to PDCCH monitoring according to the combination and any pair of spans in the set is within symbols, where first symbols start at a first symbol with a PDCCH monitoring occasion and next symbols start at a first symbol with a PDCCH monitoring occasion that is not included in the first symbols  - per set of spans across the active DL BWP(s) of all scheduling cells from the downlink cells, with at most one span per scheduling cell for each set of spans, otherwise  where is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration . If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability*, is replaced by .If a UE is configured with downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability,*  is replaced by *.*If a UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and *monitoringCapabilityConfig* = *r17monitoringcapability,*  is replaced by *.* |

#### First round discussion

**Question PDCCH-2.1: Do you agree to the draft CR in [3]?**

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| **Company** | **Comment** |
| Ericsson (from preparation phase) | We think the CR is incorrect, and the cases in question are already described in other paragraphs in 38.213. Hence, no CR needed. |
| Ericsson 2 | To elaborate on our comment from the prep phase, the other paragraphs are as follows. The highlighted clauses already cover the cases in draft CR in [3], hence the CR is not needed.  If a UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs of the scheduling cells, and with of the downlink cells using any combination for a group of slots for PDCCH monitoring, where , the UE is not required to monitor, on the active DL BWP of the scheduling cell,  - more than PDCCH candidates or more than non-overlapped CCEs per group of slots for each scheduled cell when the scheduling cell is from the downlink cells, or  - more than PDCCH candidates or more than non-overlapped CCEs per group of slots for each scheduled cell when the scheduling cell is from the downlink cells, or  - more than PDCCH candidates or more than non-overlapped CCEs per group of slots for CORESETs with same *coresetPoolIndex* for each scheduled cell when the scheduling cell is from the downlink cells  If the UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs, is replaced by . If the UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs, is replaced by . If the UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and *monitoringCapabilityConfig* = *r16monitoringcapability* and downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs, is replaced by . If, for one or more of the cells, the UE is provided with *monitoringCapabilityConfig* = *r16monitoringcapability*, .  If a UE is configured downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs of the scheduling cells, and with of the downlink cells using any combination for a group of slots for PDCCH monitoring, where , 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 PDCCH candidates, or more than non-overlapped CCEs, per group of slots on the active DL BWP(s) of scheduling cell(s) from the downlink cells where is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration . If the UE is configured downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* or *monitoringCapabilityConfig* = *r16monitoringcapability*, and *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWP, is replaced by , or by , or by , respectively, and , , and is one of , , or , respectively. If, for one or more of the cells, the UE is provided with *monitoringCapabilityConfig* = *r16monitoringcapability*, . |
| vivo | We think the CR is needed and correct.  The above paragraph referred by Ericsson only handles that cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* in hybrid case.  For example, if the UE is configured with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* and downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs, there are two cell limit: and . is already handled in the above paragraph. However, handling of is missing in current spec and the above CR is targeting to solve this. |
| Huawei, HiSilicon | We shared the view from vivo.  The BD/CCE on the serving cell with r15 and r16 monitoring capability should also be updated with , and , respectively. |

### [ACTIVE] Topic PDCCH-2.2: Correction on the total serving cell(s) number when r17monitoringcapability of monitoringCapabilityConfig is configured for the features extending NR operation to 71 GHz

The relevant parts of draft CR [4] for 38.213 clause 10.1 are given below for easy reference. Please refer to [4] for more context.

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| If a UE is configured downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs of the scheduling cells, and with of the downlink cells using any combination for a group of slots for PDCCH monitoring, where , 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 PDCCH candidates, or more than non-overlapped CCEs, per group of slots on the active DL BWP(s) of scheduling cell(s) from the downlink cells where is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration . If the UE is configured downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* or *monitoringCapabilityConfig* = *r16monitoringcapability*, and *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWP, is replaced by , or by , or by , respectively, and , and is one of , , or , respectively. If, for one or more of the cells, the UE is provided with *monitoringCapabilityConfig* = *r16monitoringcapability*, . |

#### First round discussion

**Question PDCCH-2.2: Do you agree to the draft CR in [4]?**

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| **Company** | **Comment** |
| Ericsson | The current spec is correct, hence this CR is neither needed nor correct. Indeed the summation in the formula should be from 0 .. 6 (and not 5 ..6) since the formula applies to the case when there is a mixture of cells with Rel-15/16/17 monitoring by virtue of the sentence preceding the formula:  If the UE is configured downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* or *monitoringCapabilityConfig* = *r16monitoringcapability*, and *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWP, …  A cell with *r15monitoringcapability* and a cell with *r16monitoringcapability* can be configured with 15, 30, 60, or 120 kHz SCS. This is in contrast to cells with *r17monitoringcapability* which can be configured only with 480 or 960 kHz SCS. Hence it makes sense that the summation in the formula is from 0 .. 6. |
| vivo | We are fine with this CR.  In a case with a mixture of cells with Rel-15/16/17 monitoring capability, the cells with different capability type are independent to follow a limit of BD/CCE. So the summation in the formula for cells with R17 monitoring capability is the number of cells configured with r17 monitoring capability, i.e. from SCS 5 to 6. This is the same as the following spec for r16 monitoring capability that can only be configured in FR1 SCS 0 and 1.  If a UE is configured only with downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r16monitoringcapability* and with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration , and with of the downlink cells using combination for PDCCH monitoring, where , 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 PDCCH candidates or more than non-overlapped CCEs  However, if there is no change, the spec still works since the number of cells configured with r17 monitoring capability for SCS 0 to 4 is 0. We slightly prefer to have this change to align with the spec as R16. |
| Huawei, HiSilicon | We share the similar view as vivo. The BD/CCE should be counted for the serving cell with PDCCH monitoring capability of the same release. Thus, the sum should only be performed for 480 and 960kHz SCS.  Another issue in the current spec we observed is the condition “for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* or *monitoringCapabilityConfig* = *r16monitoringcapability*, and *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWP”.  To my understanding, current text only include the case of r15+17 or r16+17. The case of r15+r16+r17 is not included. maybe native speaker can judge whether my reading is correct or not.  Compared with the TP provided CATT, we would suggest a simpler change as following. It can keep consistent written style with other release.  If a UE is configured downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWPs of the scheduling cells, and with of the downlink cells using any combination for a group of slots for PDCCH monitoring, where , 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 PDCCH candidates, or more than non-overlapped CCEs, per group of slots on the active DL BWP(s) of scheduling cell(s) from the downlink cells where is a number of configured cells with associated PDCCH candidates monitored in the active DL BWPs of the scheduling cells using SCS configuration . If the UE is configured downlink cells for which the UE is provided both *monitoringCapabilityConfig* = *r15monitoringcapability* or *monitoringCapabilityConfig* = *r16monitoringcapability*, and *monitoringCapabilityConfig* = *r17monitoringcapability* for the active DL BWP, is replaced by , or by , or by , respectively. If, for one or more of the cells, the UE is provided with *monitoringCapabilityConfig* = *r16monitoringcapability*, . |

## [ACTIVE] Topic PDCCH-4: SSSG switching with multiple cells and different Xs

LG has provided a draft CR [7] with an additional discussion document [8].

The TP of draft CR [7] for 38.213 clause 10.4 is copied here for easy reference. Please refer to [7] for more context.

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| A UE determines a slot and a symbol in the slot to start or stop PDCCH monitoring according to search space sets for a serving cell that the UE is provided *searchSpaceGroupIdList* or, if *cellGroupsForSwitchList* is provided, for a set of serving cells, based on the largest if the SCS configuration among all configured DL BWPs in the set of serving cells equals to 6, otherwise, based on the smallest SCS configuration among all configured DL BWPs in the serving cell or in the set of serving cells and, if any, in the serving cell where the UE receives a PDCCH and detects a corresponding DCI format 2\_0 triggering the start or stop of PDCCH monitoring according to search space sets. |

### First round discussion

**Question PDCCH-4.1: Do you agree to the draft CR in [7]?**

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| **Company** | **Comment** |
| Ericsson | Support the draft CR |
| Huawei, HiSilicon | We are wondering whether gNB should avoid such configuration considering same nuerology are already configured across multiple cell. If group based SSSG switching are configured across multipe serving cell. |

# References

[1] R1-2208710, Draft CR on multi-slot PDCCH monitoring for TS 38.213, ZTE, Sanechips

[2] R1-2208931, Discussion corrections for  BD/CCE budge of  scheduling cell(s)  for the features extending NR operation to 71 GHz, CATT

[3] R1-2208932, Correction on BD/CCE budge of  scheduling cell(s)  for the features extending NR operation to 71 GHz, CATT

[4] R1-2208933, Correction on the total serving cell(s) number when  r17monitoringcapability of monitoringCapabilityConfig is configured for the features extending NR operation to 71 GHz, CATT

[5] R1-2209177, Draft CR on Group 2 search space configuration, Ericsson

[6] R1-2209178, Discussion on Group 2 search space configuration, Ericsson

[7] R1-2209438, Draft CR for SSSG switching with multiple cells in FR2-2, LG Electronics

[8] R1-2209439, Discussion on SSSG switching with multiple cells in FR2-2, LG Electronics