**3GPP TSG RAN WG1 Meeting #105-e R1-21xxxxx**

**E-meeting, May 10th – May 27th, 2021**

**Agenda Item: 7.1**

**Source: Moderator (Huawei)**

**Title: Summary of [105-e-NR-7.1CRs-08]: Correction on PDCCH blind detection capability for CA in TS38.213**

**Document for: Discussion and Decision**

# Introduction

This document is created to collect company views on the proposed changes in [1].

# Background

In RAN1#98, it was clarified that the PDCCH blind detection capability for CA must be provided if the UE supports carrier aggregation with more than 4 DL CCs.

*Conclusion:*

*Following answers will be captured in reply LS to RAN2.*

* ***If PDCCH blind detection capability for CA (6-5a) is mandatory or optional feature?***

*RAN1 would like to clarify followings regarding FG6-5a.*

* *The PDCCH blind detection capability carries no information if the UE does not support more than 4 DL CCs, while the capability must be provided if the UE supports more than 4 DL CCs, hence the UE shall report this capability (i.e., one from candidate values {4, …, 16}) if the UE supports CA with more than 4 DL CCs.*

# Problem description

According to the following description in section 10 of TS38.213, *pdcch-BlindDetectionCA* will be used to determine the maximum number of PDCCH candidates per slot as long as it is provided to the gNB, i.e. ***pdcch-BlindDetectionCA* is used regardless of the number of CCs configured for the UE.**

When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates per slot that corresponds to  downlink cells, where

-  is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA*

- otherwise,  is the value of *pdcch-BlindDetectionCA*

In addition, when is used to determine the upper bound for the monitored PDCCH candidates and non-overlapping CCEs per slot for each DL BWP as described in section 10.1 of TS38.213, **it does not differentiate whether or not the number of serving cells configured for the UE is larger than 4.**

If a UE is configured with  downlink cells with DL BWPs having SCS configuration  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 slot for each scheduled cell.

If a UE is configured with  downlink cells with DL BWPs having SCS configuration , 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 slot on the active DL BWP(s) of scheduling cell(s) from the  downlink cells.

However, the following description in section 10 of TS38.213 implies that ***pdcch-BlindDetectionCA* will be used only when the UE is configured for CA operation over more with 4 CCs.**

If a UE indicates in UE-NR-Capability a carrier aggregation capability larger than 4 serving cells, the UE includes in UE-NR-Capability an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells.

The above inconsistency leads to some confusions on the determination of when a UE reports the capability of supporting more than 4 CCs but is configured with no more than 4 CCs. Therefore this needs to be fixed in the specification.

Given that there are two parts of the specification implying that the PDCCH blind detection capability will be used regardless of the number of CCs configured for the UE, it was proposed in [1] to remove the condition on the number of serving cells configured for the UE in the following part of the specification.

If a UE indicates in UE-NR-Capability a carrier aggregation capability larger than 4 serving cells, the UE includes in UE-NR-Capability an indication for a maximum number of PDCCH candidates the UE can monitor per slot ~~when the UE is configured for carrier aggregation operation over more than 4 cells~~.

# Company views

## First round discussion

**Q1: Do you agree that there is some insistency with respective to whether the UE reported PDCCH blind detection capability should be used when a UE reports the capability of supporting more than 4 CCs but is configured with no more than 4 CCs? If not, why?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree or not** | **Comment** |
| ZTE |  | It is clear, if UE is configured with more than 4 cells, the UE needs to take N\_cap\_cells into account, for this particular case, the spec is clear and has no issue.  While if UE is configured with less than (equal to) 4 cells, the condition  can is always true. In this case, the UE doesn’t need to take N\_cap\_cells into account to derive M\_max/C\_max. In this case, “*an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells*” is correct.  Based on the above analysis, it seems the current spec is OK. If majority companies prefer to update the spec to make it clearer, maybe one compromised way forward is to put this change in the editor’s CR. |
| CATT | Agree |  |
| vivo | Comment | The text can be interpreted as a UE should only report *pdcch-BlindDetectionCA* when > 4 cells are configured to the UE, but such behavior (UE capability reporting depending on RRC configuration) would be problematic, e.g., what happens if the number of cells is reconfigured to less than 4. |
| Qualcomm | No | The red text is used as a condition for how much PDCCH processing efforts the UE can support as described in “*a maximum number of PDCCH candidates the UE can monitor per slot*” but not a condition for when the UE reports the capability as described in “*the UE includes in UE-NR-Capability an indication*” in the following spec text.   * *If a UE indicates in UE-NR-Capability a carrier aggregation capability larger than 4 serving cells, the UE includes in UE-NR-Capability an indication for a maximum number of PDCCH candidates the UE can monitor per slot ~~when the UE is configured for carrier aggregation operation over more than 4 cells~~.*   If the red text is removed, the spec means that unconditionally the UE should support a PDCCH processing effort equal to “*an indication for a maximum number of PDCCH candidates the UE can monitor per slot*”. This is not true if the UE is configured with more than 4 serving cells but the number of activated cells is less than 4, e.g., 2. |
| Huawei | Yes | Reply to ZTE:  For UEs configured with more than 4 CCs, there is no issue to start with. As explained in section 3, the issue is for UEs that reports the support of more than 4 CCs but configured with no more than 4CCs. For this case, according to the text highlighted below. *pdcch-BlindDetectionCA* will be used to determine the maximum number of PDCCH candidates per slot as long as it is provided to the gNB  When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates per slot that corresponds to  downlink cells, where  -  is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA*  - otherwise,  is the value of *pdcch-BlindDetectionCA*  This is contradicting to the following description which implies that *pdcch-BlindDetectionCA* will be used only when the UE is configured for CA operation over more with 4 CCs.  If a UE indicates in UE-NR-Capability a carrier aggregation capability larger than 4 serving cells, the UE includes in UE-NR-Capability an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells.  Even though  always holds for UE who is supporting more than 4 CCs but configured with no more than 4CC, it is not clear whether is equal to the number of configured CCs or the UE reported PDCCH blind detection capability. This should be clarified from the specification point of view.  Reply to vivo:  Originally we thought about the similar thing but then as Zichao correctly pointed out, a UE capability reporting shall not be dependent on configuration. Therefore, we think it may be more reasonable that “when the UE is configured for carrier aggregation operation over more than 4 cells.” is for “a maximum number of PDCCH candidates the UE can monitor per slot”. As a consequence, there will be an issue on whether the UE reported PDCCH blind detection capability should be used when a UE reports the capability of supporting more than 4 CCs but is configured with no more than 4 CCs as explained in section 3.  Reply to QC:  The reason for the change is not because there is a confusion about UE capability reporting. A UE shall report the PDCCH blind detection capability as long as it is report the capability of supporting more than 4 CCs. This should be clear from the RAN2 LS as listed in Section 2. The quoted specification text is about reporting not about how this capability is used. If the comment is to say a UE shall only use a capability corresponding to the number of configured CCs when the number of configured CCs is no more than 4. The following can be considered. I think Nokia mentioned similar comments during the preparation phase  When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates per slot that corresponds to  downlink cells, where  -  is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA* or if the number of configured downlink cells is no more than 4  - otherwise,  is the value of *pdcch-BlindDetectionCA*  Our view is that there is no practical difference given that the UE will use to determine the upper bound for the monitored PDCCH candidates and non-overlapping CCEs per slot for each DL BWP. |
| Samsung | No | We second ZTE’s analysis and QC’s argument. Actually, we raised the same point in the last meeting. If the UE is configured for not more than 4 CCs, this , condition always holds whether the UE reported *pdcch-BlindDetectionCA* or not. This means the reported capability *pdcch-BlindDetectionCA* is relevant (have effect) only when the UE is configured with more than 4 CCs. The text the CR is proposing to be deleted gives this information. We agreed in the last meeting that the UE being configured with more than 4 cells is not a precondition for reporting of *pdcch-BlindDetectionCA* then there is no contradiction. |
| Apple |  | First, we would like to clarify our understanding on the current specification below:   * *If a UE indicates in UE-NR-Capability a carrier aggregation capability larger than 4 serving cells, the UE includes in UE-NR-Capability an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells.*   Our understanding is a bit different with Vivo’s. Our interpretation is that:   * UE always reports ‘the maximum number of PDCCH candidates the UE can monitor per slot’ when it supports CA with larger than 4 CCs. * The cyan sentence just limits when the reported BD value is applied, i.e., it is applied when UE is configured with #CC more than 4, otherwise it is not applied. * As one example, UE may report maximum number of PDCCH candidates per slot is 6 and it supports 10-CCs CA. While, according to current spec, this reported value is only applied when UE is configured with more than 4 CCs. * With this interpretation, it seems current spec is consistent. * Note that the sentence above does not mean UE reports maximum number of PDCCH candidates on condition that UE is configured with more than 4 CCs CA, instead limiting when the reported value is applied. We see some different understanding on this point. |
| Intel | No | Same understanding of the specs as explained by ZTE and others. We do not see a change of specs is necessary - the text proposed to be deleted should be interpreted to define the condition when the capability is applied. On the other hand, we do not see there would be an issue if the text is removed as well. |

**Q2: Do you agree with proposed changes? If not, why?**

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| --- | --- | --- |
| **Company** | **Agree or not** | **Comment** |
| ZTE |  | If majority companies prefer to remove this part as highlighted above in red to make the spec clearer, we can go with the majority view. |
| CATT | Agree |  |
| vivo | OK |  |
| Qualcomm | No | As explained in our answer to Q1, removing the sentence results in wrong requirement for the UE to process a number of PDCCH candidates equal to “*indication for a maximum number of PDCCH candidates the UE can monitor per slot*” even though the number of activated serving cells is less than 4. |
| Huawei | Agree | We are open to discuss how to fix the inconsistency one way or the other, either the original TP or the alternative TP in Q1. |
| Samsung | No | As explained in our response for Q1, the text the CR is proposing to be deleted gives an additional information on when the reported capability becomes relevant. So we do not support the draft CR. |
| Apple |  | In any case, we do not see the modification here would result in a larger BDs as the maximum BD would be upper bound by the maximum BDs per CC limit.  It would be appreciated if Qualcomm can clarify a bit on this point. |
| Intel | No | Not an essential change. |

## First round summary

In the first round comments, 8 companies provided feedback. 4 companies think that the highlighted text in yellow should be kept while 3 companies agree with the change and 1 company can accept to put the change into an editor CR if the majority agree with the change. Hence the original proposal in R1-2105919 cannot be agreeable. The moderator suggests to have a quick second round discussion

## Second round discussion

If a UE indicates in UE-NR-Capability a carrier aggregation capability larger than 4 serving cells, the UE includes in UE-NR-Capability an indication for a maximum number of PDCCH candidates the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells.

The second round discussion can still focus on the case when the UE reports the capability of supporting more than 4 CCs but is configured with no more than 4 CCs. Based on the first round discussion, the following observations can be made

* Observation 1: The UE always reports its PDCCH blind detection capability if the UE supports more than 4 CCs. This is regardless of the number of CCs configured for the UE.
* Observation 2: The highlighted text in yellowimplies that the PDCCH blind detection capability is used only when the UE is configured for CA operation over more with 4 CCs.
* Observation 3: When a UE reports the capability of supporting more than 4 CCs but is configured with no more than 4 CCs, the condition , always holds no matter is equal to the number of configured CCs or *pdcch-BlindDetectionCA*.
* Observation 4:  in is equal to *pdcch-BlindDetectionCA* according to current specification

For a UE reporting the capability of supporting more than 4 CCs but configured with no more than 4 CCs, there is some inconsistence even though it does not lead to any difference for the UE to determine the upper bound for the monitored PDCCH candidates and non-overlapping CCEs per slot for each DL BWP.

* According to Observation 2, the UE reported PDCCH blind detection capability should NOT be used.
* According to Observation 4,  in is equal to *pdcch-BlindDetectionCA*, i.e. the UE reported PDCCH blind detection capability is used in this case.

Therefore, an alternative TP is proposed. The reasoning behind is to align with Observation 2, i.e. *pdcch-BlindDetectionCA* will be used only when the UE is configured for CA operation over more with 4 CCs

When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates per slot that corresponds to  downlink cells, where

-  is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA* or if the number of configured downlink cells is no more than 4

- otherwise,  is the value of *pdcch-BlindDetectionCA*

**Q1: Do you agree with alternative TP? If not, why?**

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| --- | --- | --- |
| **Company** | **Agree or not** | **Comment** |
| Samsung |  | We believe the existing text in the spec has no problem but if the majority of companies believe otherwise, we are open to take the updated change. |
| Nokia | Agree | We are OK with the clarification |
| Qualcomm | No | Our understanding is that the highlighted yellow spec text means the reported capability does not take real effect when the number of configured cells is <= 4. But the PDCCH BD/CCE limits are correct according to Observation 3. The proposed change in red words should be left to implementation. We do not think an update to the very old spec text is necessary if it is not ambiguous and is not wrong. |
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|  |  |  |

## Second round summary

To be updated based on the discussion

# Conclusions

To be updated based on the discussion

# References

1. R1-2105919, “Correction on PDCCH blind detection capability for CA in TS38.213”, Huawei, HiSilicon

# Appendix: Proposed CR in R1-2105919

10 UE procedure for receiving control information

If the UE is configured with a SCG, the UE shall apply the procedures described in this clause for both MCG and SCG except for PDCCH monitoring in Type0/0A/2-PDCCH CSS sets where the UE is not required to apply the procedures in this clause for the SCG

- When the procedures are applied for MCG, the terms 'secondary cell', 'secondary cells' , 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells, serving cell, serving cells belonging to the MCG respectively.

- When the procedures are applied for SCG, the terms 'secondary cell', 'secondary cells', 'serving cell', 'serving cells' in this clause refer to secondary cell, secondary cells (not including PSCell), serving cell, serving cells belonging to the SCG respectively. The term 'primary cell' in this clause refers to the PSCell of the SCG.

A UE monitors a set of PDCCH candidates in one or more CORESETs on the active DL BWP on each activated serving cell configured with PDCCH monitoring according to corresponding search space sets where monitoring implies decoding each PDCCH candidate according to the monitored DCI formats.

For monitoring of a PDCCH candidate in a slot

- If the UE has received *ssb-PositionsInBurst* in *SIB1* and has not received *ssb-PositionsInBurst* in *ServingCellConfigCommon* for a serving cell and if the UE does not monitor PDCCH candidates in a Type0-PDCCH CSS set and at least one RE for a PDCCH candidate overlaps with at least one RE corresponding to a SS/PBCH block index provided by *ssb-PositionsInBurst* in *SIB1*, the UE is not required to monitor the PDCCH candidate.

- If a UE has received *ssb-PositionsInBurst* in *ServingCellConfigCommon* for a serving cell and if the UE does not monitor PDCCH candidates in a Type0-PDCCH CSS set and at least one RE for a PDCCH candidate overlaps with at least one RE corresponding to a SS/PBCH block index provided by *ssb-PositionsInBurst* in *ServingCellConfigCommon*, the UE is not required to monitor the PDCCH candidate.

- If the UE monitors the PDCCH candidate for a Type0-PDCCH CSS set on the serving cell according to the procedure described in Subclause 13, the UE may assume that no SS/PBCH block is transmitted in REs used for monitoring the PDCCH candidate on the serving cell.

- If at least one RE of a PDCCH candidate on the serving cell overlaps with at least one RE of *lte-CRS-ToMatchAround*, the UE is not required to monitor the PDCCH candidate.

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than 4 serving cells, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates the UE can monitor per slot. When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates per slot that corresponds to  downlink cells, where

-  is the number of configured downlink cells if the UE does not provide *pdcch-BlindDetectionCA*

- otherwise,  is the value of *pdcch-BlindDetectionCA*

When a UE is configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates per slot that corresponds to  downlink cells for the MCG where  is provided by *pdcch-BlindDetection* for the MCG and determines a capability to monitor a maximum number of PDCCH candidates per slot that corresponds to  downlink cells for the SCG where  is provided by *pdcch-BlindDetection* for the SCG. When the UE is configured for carrier aggregation operation over more than 4 cells, or for a cell group when the UE is configured for NR-DC operation, the UE does not expect to monitor per slot a number of PDCCH candidates that is larger than the maximum number as derived from the corresponding value of .

When a UE is configured for NR-DC operation with a total of downlink cells on both the MCG and the SCG, the UE expects to be provided *pdcch-BlindDetection* for the MCG and *pdcch-BlindDetection* for the SCG with values that satisfy

- *pdcch-BlindDetection* for the MCG + *pdcch-BlindDetection* for the SCG <= *pdcch-BlindDetectionCA*, if the UE reports *pdcch-BlindDetectionCA*, or

- *pdcch-BlindDetection* for the MCG + *pdcch-BlindDetection* for the SCG <= , if the UE does not report *pdcch-BlindDetectionCA*.

For NR-DC operation, the UE may indicate, through *pdcch-BlindDetectionMCG-UE* and *pdcch-BlindDetectionSCG-UE*, respective maximum values for *pdcch-BlindDetection* for the MCG and *pdcch-BlindDetection* for the SCG.

If the UE reports *pdcch-BlindDetectionCA*,

- the value range of *pdcch-BlindDetectionMCG-UE* or of *pdcch-BlindDetectionSCG-UE* is [1, …, *pdcch-BlindDetectionCA*-1], and

- *pdcch-BlindDetectionMCG-UE* + *pdcch-BlindDetectionSCG-UE* >= *pdcch-BlindDetectionCA*.

Otherwise, if  is a maximum total number of downlink cells that the UE can be configured on both the MCG and the SCG as described in [10, TS 38.133],

- the value range of *pdcch-BlindDetectionMCG-UE* or of *pdcch-BlindDetectionSCG-UE* is [1, 2, 3],

- *pdcch-BlindDetectionMCG-UE* + *pdcch-BlindDetectionSCG-UE* >= .