3GPP TSG-RAN WG1 Meeting #109-e Tdoc R1-2205466

e-Meeting, 9th – 20th May, 2022

Agenda Item: 8.2.2

Source: Ericsson

Title: Correction to BD/CCE budget allocation over multiple serving cells for multi-DCI multi-TRP for FR2-2

Document for: Discussion, Decision

# 1 Introduction

This document contains a proposed correction to BD/CCE budget allocation over multiple serving cells for multi-DCI multi-TRP for FR2-2.

# 2 Discussion

One aspect that has not been fully captured in specifications yet is multi-DCI multi-TRP support for the case of per-slot group monitoring with multiple serving cells. Support for multi-TRP for FR2-2 has already been agreed in AI 8.2.4 (Beam Management), and for multi-TRP to be fully functional there is an impact on per-slot group PDCCH monitoring that is analogous to the impact on per-slot monitoring. For the case of per-slot monitoring with multi-DCI multi-TRP in Rel-16, 38.213 contains the following text:

According to this text, serving cells are partitioned into two mutually exclusive sets with in the first set and in the second set. The first set corresponds to serving cells that can schedule PDSCH from only a single TRP (single value of *coresetPoolIndex*), and the 2nd set corresponds to serving cells that can schedule PDSCH from two TRPs (two values of *coresetPoolIndex*). Then for the purposes of reporting the blind decode capabilities (*pdcch-BlindDetectionCA*) the UE computes a number of serving cells as where is a value reported by the UE capability parameter *blindDetectFactor-r16* [4] (corresponds to FG 16-2a-10 [5]). Reporting R = 2 allows the UE to use its full BD/CCE budget for monitoring DCIs from two TRPs.

**38.213 Section 10**

If a UE can support

- a first set of serving cells where the UE is either not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a single value for all CORESETs on all DL BWPs of each scheduling cell from the first set of serving cells, and

- a second set of serving cells where the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value 0 for a first CORESET, and with a value 1 for a second CORESET on any DL BWP of each scheduling cell from the second set of serving cells

the UE determines, for the purpose of reporting *pdcch-BlindDetectionCA*, a number of serving cells as where is a value reported by the UE.

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than 4 serving cells and the UE is not provided *monitoringCapabilityConfig* for any downlink cell or if the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and for a maximum number of non-overlapped CCEs the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells. When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot that corresponds to downlink cells, where

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

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

Then, if the total number of configured serving cells over all SCS configurations exceeds the computed value , the aggregated BD/CCE budget over is divided amongst the configured serving cells as follows (see 38.213 Section 10.1):

where the parameter is configured as 1 or *R*. This applies to serving cells configured with Rel-15 per-slot monitoring.

In the spec review process after RAN1#108-e, it was pointed out that the BD/CCE budget allocation to serving cells did not capture this multi-TRP aspect for the case of Rel-17 per slot group monitoring, i.e., for 480/960 kHz SCS. The spec editor acknowledged this, and provided the following response. In the end there was not time to finish, and the RAN1 chairman recommended to do this in RAN1#109-e.

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| --- | --- | --- |
| Comment #5 | If possible, with the remaining time this week, we think it would be good to capture mTRP impact on PDCCH monitoring as commented by the editor:  [Aris] I am fine to assume applicability of M-TRP for PDCCH in 480/960 kHz – no issue with capturing it.  The only question is whether to do so now or leave for May. Should be possible to do now as the other draft CRs are getting close to stable.  [Aris2]: I will request the chairman to extend the approval of this draft CR. Can then update for M-TRP and consider the update for approval together with the URLLC/SL draft CRs. |  |

The issue is that the expressions for computing the BD/CCE budget per serving cell for per-slot group monitoring for 480/960 kHz are currently not written as a function of like above; the existing expressions effectively assume R = 1. This means that a UE reporting R = 2 cannot take advantage of its full BD/CCE budget for PDCCH monitoring for multi-DCI mTRP.

To correct this we propose that the following TP is recommended to the spec editor.

1. Update the formulas in 38.213 Section 10.1 that provide the allocation of the BD/CCE budget over multiple-serving cells ( and ) for the case of per-slot group monitoring to account for the reported capability parameter *blindDetectFactor-r16*  for multi-DCI-based multi-TRP (variable R in 38.213). Note: The candidate values of *blindDetectFactor-r16* are R = {1,2} and correspond to FG 16-2a-10.
   * Recommend TP#1 to the spec editor

Reason for change

For UEs reporting candidate value R = 2 for the capability parameter *blindDetectFactor-r16* (corresponds to FG 16-2a-10) and for operation with multi-DCI multi-TRP, the BD/CCE capability allocation over multiple serving cells does not scale with R. Effectively, it defaults to R = 1 in which case the network and UE cannot take advantage of the full BD/CCE budget reported by the UE for PDCCH monitoring for multi-DCI mTRP.

Summary of change

Update the formulas and supporting procedure text in 38.213 Section 10 that provide the allocation of BD/CCE budget ( and ) over multiple serving cells

Consequences if not approved

The network and UE cannot take advantage of the full BD/CCE budget reported by a UE reporting candidate value R = 2 for the capability parameter *blindDetectFactor-r16*.

>>> Begin TP#1 for Section 10 of 38.213 >>>

10 UE procedure for receiving control information

\*\*\* Unchanged text is omitted \*\*\*

If a UE can support

- a first set of serving cells where the UE is either not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a single value for all CORESETs on all DL BWPs of each scheduling cell from the first set of serving cells, and

- a second set of serving cells where the UE is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value 0 for a first CORESET, and with a value 1 for a second CORESET on any DL BWP of each scheduling cell from the second set of serving cells

the UE determines, for the purpose of reporting *pdcch-BlindDetectionCA*, *pdcch-BlindDetectionCA-r17*, *pdcch-BlindDetectionCAr15*, and *pdcch-BlindDetectionCAr15* a number of serving cells as where is a value reported by the UE.

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than 4 serving cells and the UE is not provided *monitoringCapabilityConfig* for any downlink cell or if the UE is provided *monitoringCapabilityConfig* = *r15monitoringcapability* for all downlink cells where the UE monitors PDCCH, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and for a maximum number of non-overlapped CCEs the UE can monitor per slot when the UE is configured for carrier aggregation operation over more than 4 cells. When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot that corresponds to downlink cells, where

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

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

\*\*\* Unchanged text is omitted \*\*\*

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than four downlink cells, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs that the UE can monitor per group of slots when the UE is configured for carrier aggregation operation over more than four downlink cells for which the UE is provided *monitoringCapabilityConfig* = *r17monitoringcapability*. When a UE is not configured for NR-DC operation for all downlink cells where the UE monitors PDCCH, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per group of slots that corresponds to downlink cells, where

- is if the UE does not provide *pdcch-BlindDetectionCA-r17*, where is the number of configured downlink serving cells

- otherwise, is the value of *pdcch-BlindDetectionCA-r17*

When the UE is configured for carrier aggregation operation over more than 4 cells, the UE does not expect to monitor per group of slots a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of .

\*\*\* Unchanged text is omitted \*\*\*

If a UE indicates in *UE-NR-Capability* a carrier aggregation capability larger than one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability* or larger than one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*, the UE includes in *UE-NR-Capability* an indication for a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs the UE can monitor for downlink cells with *monitoringCapabilityConfig* = *r15monitoringcapability* or for downlink cells with *monitoringCapabilityConfig* = *r17monitoringcapability* when the UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability* and at least one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*. When a UE is not configured for NR-DC operation, the UE determines a capability to monitor a maximum number of PDCCH candidates and a maximum number of non-overlapped CCEs per slot or per group of slots that corresponds to downlink cells or to downlink cells, respectively, where

- is if the UE does not provide *pdcch-BlindDetectionCAr15*, where is the number of configured downlink serving cells

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr15*, *pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr15*

- else, is the value of *pdcch-BlindDetectionCAr15* from a combination of (*pdcch-BlindDetectionCAr15, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

and

- is if the UE does not provide *pdcch-BlindDetectionCAr17*, where is the number of configured downlink serving cells

- otherwise,

- if the UE reports only one combination of (*pdcch-BlindDetectionCAr15, pdcch-BlindDetectionCAr17*), is the value of *pdcch-BlindDetectionCAr17*

- else, is the value of *pdcch-BlindDetectionCAr17* from a combination of (*pdcch-BlindDetectionCAr15, pdcch-BlindDetectionCAr17*) that is provided by *pdcch-BlindDetectionCA-CombIndicator-r17*

\*\*\* Unchanged text is omitted \*\*\*

When the UE is configured for carrier aggregation operation over more than two downlink cells with at least one downlink cell with *monitoringCapabilityConfig* = *r15monitoringcapability*, at least one downlink cell with *monitoringCapabilityConfig* = *r17monitoringcapability*, and no downlink cell with *monitoringCapabilityConfig* = *r16monitoringcapability*, the UE does not expect to

- monitor per slot a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of , and

- monitor per group of slots a number of PDCCH candidates or a number of non-overlapped CCEs that is larger than the maximum number as derived from the corresponding value of

\*\*\* Unchanged text is omitted \*\*\*

10.1 UE procedure for determining physical downlink control channel assignment

\*\*\* Unchanged text is omitted \*\*\*

If a UE

- does not report *pdcch-BlindDetectionCA*, *pdcch-BlindDetectionCA-r17*, *pdcch-BlindDetectionCAr15*, or *pdcch-BlindDetectionCAr15* or is not provided *BDFactorR*,

- reports *pdcch-BlindDetectionCA*, *pdcch-BlindDetectionCA-r17*, *pdcch-BlindDetectionCAr15*, or *pdcch-BlindDetectionCAr15*, the UE can be indicated by *BDFactorR* either or

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.*

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*.

For each scheduled cell from the downlink cells, the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell more than PDCCH candidates or more than non-overlapped CCEs per slot.

For each scheduled cell from the downlink cells, the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell

- more than PDCCH candidates or more than non-overlapped CCEs per slot

- more than PDCCH candidates or more than non-overlapped CCEs per slot for CORESETs with same *coresetPoolIndex* value

\*\*\* Unchanged text is omitted \*\*\*

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*, the UE assumes .

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*, the UE assumes .

For each scheduled cell from the downlink cells using any combination for a group of slots, the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell, more than PDCCH candidates or more than non-overlapped CCEs per group of slots.

For each scheduled cell from the downlink cells using any combination for a group of slots, the UE is not required to monitor on the active DL BWP with SCS configuration of the scheduling cell,

* more than PDCCH candidates or more than non-overlapped CCEs per group of slots
* more than more than PDCCH candidates or more than non-overlapped CCEs per group of slots for CORESETs with the same *coresetPoolIndex* value.

\*\*\* Unchanged text is omitted \*\*\*

>>> End TP >>>