**3GPP TSG RAN WG1 #106-e R1-210xxxx**

**e-Meeting, August 16th – 27th, 2021**

**Agenda item:** 7.1

**Source:** Moderator (Samsung)

**Title:** Summary of [106-e-NR-7.1CRs-10]

**Document for:** Discussion and decision

# Introduction

This considers possible interpretations of the specifications [1] for the search space set overbooking/dropping procedure when a search space set is associated with multiple DCI format sizes, and intends to collect views on this issue and, if necessary, decide on a correction to [1]. The following discussion is based on analysis in [2].

# Round 1: Discussion

In Rel-15, it is possible that a CSS set or a USS set is associated with DCI formats having more than one size.

The following is captured in clause 10.1 of [1]. However, although monitoring of a PDCCH candidate implies decoding according to corresponding DCI formats in the search space set, that is not captured in the counting of PDCCH candidates.

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| 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.  |

A UE capability for PDCCH monitoring relates to a number of decoding operations the UE can perform within a time period such as a slot or a span. However, a PDCCH candidate can be related with different number of decoding operations depending on the search space set associated with the PDCCH candidate. Therefore, the definition of $\sum\_{L}^{}M\_{S\_{css(i)}}^{(L)}$ as counting PDCCH candidates for CSS set $S\_{css(i)}$, or $\sum\_{L}^{}M\_{S\_{uss(j)}}^{(L)}$ for USS set $S\_{uss(j)}$, in the UE procedure for determining/resolving search space set overbooking needs to be clarified.

A first interpretation is that the above summations are for PDCCH candidates per search space set, as is currently defined in [1]. A second interpretation is that the above summations are for the number of decoding operations per PDCCH candidate per search space set.

Based on second interpretation, the number of sizes of DCI formats for a search space set needs to also be considered in the overbooking procedure. Basically, if for USS set $S\_{uss(j1)}$ there is one DCI format size and for USS set $S\_{uss(j2)}$ there are two DCI format sizes, using $\sum\_{L}^{}M\_{S\_{uss(j1)}}^{(L)}$ is correct but $\sum\_{L}^{}M\_{S\_{uss(j2)}}^{(L)}$ needs to be replaced by $2∙\sum\_{L}^{}M\_{S\_{uss(j2)}}^{(L)}$ as $\sum\_{L}^{}M\_{S\_{uss(j2)}}^{(L)}$ is the total number of PDCCH candidates for $S\_{uss(j2)}$, not the total number of decoding operations. Consequently, the search space set overbooking procedure in clause 10.1 of [1] needs to be amended.

**Question 1: Companies are requested to provide views on the two interpretations, and any other input, for the counted variable in the UE procedure for search space set overbooking/dropping.**

* **Interpretation 1: the PDCCH candidates for each search space set are counted, or**
* **Interpretation 2: the decoding operations for DCI formats per PDCCH candidate are counted.**

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| Company | Comments |
| Samsung | Interpretation 2 |
| Qualcomm | According to the RAN1 #94 agreements, BD/CCE counting is based on PDCCH configuration before dropping of any candidate. The TS 38.213 complies with the agreements and hence no change is needed.Agreements:* PDCCH BD/CCE counting is only based on the configured PDCCH decoding candidates (i.e., irrespective of whether or not a PDCCH decoding candidate is dropped, e.g., due to collision with other channels/signals)
	+ Check further offline on potential spec impact
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| Huawei, HiSilicon | Interpretation 2.The current specification is clear since the "counting variable" are defined as "PDCCH candidates for monitoring".*Denote by , , the number of counted PDCCH candidates for monitoring for CSS set  and by , , the number of counted PDCCH candidates for monitoring for USS set .*According to the definition in Section 10, "monitoring implies decoding each PDCCH candidate according to the monitored DCI formats". It is clear that the counting procedure has already taken the decoding operations for DCI formats into account. |
| Spreadtrum | Interpretation 2.It is common understanding that PDCCH BD/CCE counting includes DCI format. TS 38213 also gives the description as following. A PDCCH candidate with index  for a search space set  using a set of CCEs in a CORESET  on the active DL BWP for serving cell  is not counted for monitoring if there is a PDCCH candidate with index  for a search space set , or if there is a PDCCH candidate with index  and , in the CORESET  on the active DL BWP for serving cell  using a same set of CCEs, the PDCCH candidates have identical scrambling, and the corresponding DCI formats for the PDCCH candidates have a same size; otherwise, the PDCCH candidate with index  is counted for monitoring.  |
| OPPO | Interpretation 2. It is a common understanding the counting is related to the decoding operations. |
| vivo | Interpretation 2 |
| Intel | Interpretation 2. |
| DOCOMO | Interpretation 2. |
| ZTE | Interpretation 2. |

If RAN1 concludes on Interpretation 2 above, companies are requested to provide input for why a TP, such as the following from [3], is needed or is not needed.

**Question 2: If Interpretation 2 is concluded, please explain why a TP to [1] is or is not needed.**

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| Company | Comments |
| Samsung | A TP is needed because [1] captures “the number of counted PDCCH candidates for monitoring for a CSS/USS set” (the “counted” does not relate to this discussion) while [1] also captures that “monitoring implies decoding each PDCCH candidate according to the monitored DCI formats” (implying Interpretation 2). Therefore, the number of DCI format sizes needs to scale “the number of counted PDCCH candidates for monitoring for the CSS/USS set” but there is currently no association between the number of sizes of DCI formats and “the number of counted PDCCH candidates for monitoring for a CSS/USS set”.  |
| Qualcomm | A TP to [1] is not needed. |
| Huawei, HiSilicon | As explained above, the current specification is clear and no TP is needed. |
| Spreadtrum | Not needed.As comments for Question 1. We think it is clear in spec. However, we are fine for a conclusion if needed. |
| OPPO | Considering the explanations of Huawei and spreadtrum, we think the TP is not needed  |
| vivo | Not needed. The common understanding is the counting is toward the number of blind decoding attempts. If there is ambiguity, a conclusion for clarification would be enough. |
| Intel | Agree with Huawei and others that the use of “counted PDCCH candidates…” in the following along with the spec-text quoted by Spreadtrum (also copied below) already implements as per Interpretation 2. *Denote by , , the number of counted PDCCH candidates for monitoring for CSS set  and by , , the number of counted PDCCH candidates for monitoring for USS set .*In fact, the TP in reference [1] would lead to incorrect overbooking behavior since the proposed scaling of candidates per DCI format size independently on a per-SS set basis would lead to over-counting (e.g., overcount candidates from two SS sets mapped to the same CORESET and same DCI format size) on the one hand, and also conflict with the counting behavior described below on the other. *A PDCCH candidate with index  for a search space set  using a set of CCEs in a CORESET  on the active DL BWP for serving cell  is not counted for monitoring if there is a PDCCH candidate with index  for a search space set , or if there is a PDCCH candidate with index  and , in the CORESET  on the active DL BWP for serving cell  using a same set of CCEs, the PDCCH candidates have identical scrambling, and the corresponding DCI formats for the PDCCH candidates have a same size; otherwise, the PDCCH candidate with index  is counted for monitoring.* If a clarification is really deemed essential, we suggest to capture something simple like the following to avoid any ambiguity:*Denote by , , the number of counted PDCCH candidates for different sizes of DCI formats for monitoring for CSS set  and by , , the number of counted PDCCH candidates for different sizes of DCI formats for monitoring for USS set .* |
| DOCOMO | The TP is not needed as explained by Huawei and other companies. |
| ZTE | Not needed.The current spec is clear based on the spec texts copied by other companies.  |

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| 10.1 UE procedure for determining physical downlink control channel assignment < unchanged text is omitted>Denote by , , the number of counted PDCCH candidates for monitoring for CSS set  and by , , the number of counted PDCCH candidates for monitoring for USS set , for CCE aggregation level $$. For the CSS sets, a UE monitors $\_{}^{}\sum\_{}^{\_{}}\sum\_{}^{}\_{\_{}}^{}$PDCCH candidates requiring a total of $C\_{PDCCH}^{css}$ non-overlapping CCEs in a slot or in a span, where $$ is a number of sizes for DCI formats for CSS set $$ after alignment of DCI format sizes [5, 38.212]. < unchanged text is omitted>Set  Set Set $$ to a number of sizes for DCI formats for USS set $$ after alignment of DCI format sizesSet while $$ AND allocate $$ PDCCH candidates for monitoring to USS set  $\_{}^{}\_{}^{}\sum\_{}^{}\_{\_{}}^{}$;; ;end while |

# References:

1. TS 38.213, v16.6.0 “NR; Physical layer procedures for control”
2. R1-2106856, “Discussion on counting PDCCH candidates in overbooking procedure,” Samsung
3. R1-2106857, “Correction on counting PDCCH candidates in overbooking procedure,” Samsung.