**3GPP TSG RAN WG1 Meeting #107-e R1-21xxxxxx**

**E-meeting, November 11-19, 2021**

**Agenda Item: 7.2.5**

**Source: Moderator (Huawei)**

**Title: Summary of email discussion [107-e-NR-L1enh-URLLC-01] Discussion on LS from RAN2 on blind detection in CA**

**Document for: Discussion and Decision**

# Introduction

The email discussion is to discuss and to decide the Reply LS to RAN2 as response to the received LS R1-2110757(R2-2109168) “LS on PDCCH Blind Detection in CA” [1]:

[107-e-NR-L1enh-URLLC-01] Discussion on LS from RAN2 on blind detection in CA by November 18 – Chengyan (Huawei)

This document summarizes the issues raised in the LS and the views in [2][3][4][5][6][7], and further provides initial questions and proposals for discussion in section 4.

Companies are encouraged to provide the first round views by 11/12, 23:59pm UTC, then we can adjust the proposals and draft the reply LS in the next step of discussion.

# Background from RAN1, RAN2 and Incoming LS R1-2110757

The following agreement was achieved in RAN1#100bis-e for case 3 in Rel-16 URLLC, i.e. when at least one CC is configured for PDCCH monitoring according to Rel-15 and at least one CC is configured for PDCCH monitoring according to Rel-16.

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| Agreements:For the case with Rel-15 monitoring capability and Rel-16 monitoring capability on different serving cells (i.e. case 3), UE will report one or more combination of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16) as UE capability.* If UE reports more than one combination of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16),
	+ gNB configure which combination for UE to use for scaling PDCCH monitoring capability if the number of CCs configured is larger than the reported capability
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According to the above mentioned agreement, the UE can report one or more combinations of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16). However, this has not been captured correctly in TS 38.331 [8] and a CR [9] was handled in RAN2 to align the specification with the agreements. During the discussion in RAN2, it became clear that RAN2 needs more information and the LS was sent to RAN1 [1]. The following questions are raised in the received LS:

**Questions asked in LS R1-2110757 [1]**

To support more than one combination in RAN2 signaling for FG 11-2c and FG 11-2g, RAN2 respectfully asks RAN1 to provide the feedback for the following questions:

1. How many combinations for FG 11-2c and FG 11-2g can be reported at most from RAN1 perspective?

2. Whether the “supported span arrangement for CA” should be reported for each of the combinations or reported only once for FG 11-2c?

Besides, RAN2 wonders whether more than one combination should be supported for FG 11-2e as well? If the answer is yes, how many combinations for FG 11-2e can be reported at most from RAN1 perspective?

# Summary of company views in submitted papers

Companies have provided their views in [2] – [7] on the questions asked by RAN2.

### LS Question #1 – How many combinations for FG 11-2c and FG 11-2g can be reported at most from RAN1 perspective?

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| *Company* | *View* |
| ZTE [2] | It’s RAN1 understanding that reporting one or more combinations for FG 11-2c and FG 11-2g has been supportedRAN1 thinks supporting 4 combinations could be sufficient while it’s up to RAN2 for final decision. |
| Vivo [3] | According to RAN 1 discussion and agreements below, more than one combination is supported for UE supporting mix Rel-15 and Rel-16 CA. 16 combinations for FG 11-2c and FG 11-2g can be reported at most from RAN1 perspective. |
| Samsung [4] | We think up to eight combination would suffice. |
| Huawei, HiSilicon [5], [7] | Considering a trade-off between the signaling overhead and scheduling flexibility, at most 4 combinations are sufficient to be reported by a UE for mixed Rel-16 and Rel-15 PDCCH monitoring capabilities among different serving cells.* FG 11-2c and FG 11-2g, at most 4 combinations are reported by a UE for mixed Rel-16 and Rel-15 PDCCH monitoring capabilities among different serving cells.
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| Nokia, Nokia Shanghai Bell [6] | Confirm that it must be possible to report different combinations of Rel-15 and Rel-16 blind detection capabilities in FG 11-2c, 11-2g. The exact number of combinations is FFS.Indeed, it is clear from the descriptions of FG 11-2c, 11-2g and 11-2e that it must be possible to report combinations of Rel-15 and Rel-16 blind detection capabilities. However, it is not defined in UE feature group list or in specifications how many such combinations are possible,… |

### LS Question #2 – Whether the “supported span arrangement for CA” should be reported for each of the combinations or reported only once for FG 11-2c?

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| ZTE [2] | RAN1 thinks the “supported span arrangement for CA” should be reported for each of the combinations for FG 11-2c. |
| Vivo [3] | The “supported span arrangement for CA” should be reported only once and applied to all combinations given FG 11-2c is per BC. |
| Samsung [4] | We don’t see the necessity of reporting the support for each of the combinations. Unless such a necessity is justified, one reporting for the support of the span arrangement seems to be sufficient. |
| Huawei, HiSilicon [5], [7] | It is simple and provides more flexibility to report the span arrangement for each reported combination. The additional RRC signaling overhead is low.* For 11-2c, the span arrangement is reported for each combination
 |
| Nokia, Nokia Shanghai Bell [6] | Confirm that “supported span arrangement for CA” is reported only once for FG 11-2c. |

### LS Question #3 – RAN2 wonders whether more than one combination should be supported for FG 11-2e as well? If the answer is yes, how many combinations for FG 11-2e can be reported at most from RAN1 perspective?

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| ZTE [2] | Similar to FG 11-2c and FG 11-2g, reporting at most 4 combinations for FG 11-2e is sufficient from RAN1 perspective. |
| Vivo [3] | More than one combination should be supported for FG 11-2e. Similar as for Question1, from RAN1 perspective, 16 combinations are sufficient. |
| Samsung [4] | There were also a third question about FG 11-2e on whether multiple reporting should be supported. Based on the aforementioned agreements, multiple combinations are allowed for reporting, and there is a specific one-to-one relationship between 11-2c and 11-2e. In order to make the current specification consistent with the agreements, one way is to capture the following note in TS 38.331 or 38.306.

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| * UE reports one or more combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16)
	+ One combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) corresponds to one combination of (pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16) reported by a UE for CA operation
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***Proposal 1: Request RAN2 to capture the above note in TS38.331 or 38.306 to make it consistent with the agreements describing relationship between 11-2c and 11-2e.*** |
| Huawei, HiSilicon [5], [7] |

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| **Agreement**For NR-DC operation with at least one downlink cell using Rel-16 PDCCH monitoring capability and at least one downlink cell using Rel-15 PDCCH monitoring capability, and if a UE reports the capability of CC limits for NR-DC operation separately from CA operation, * UE reports one or more combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16)
	+ One combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) corresponds to one combination of (pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16) reported by a UE for CA operation
		- pdcch-BlindDetectionMCG-UE-r16 + pdcch-BlindDetectionSCG-UE-r16 >= pdcch-BlindDetectionCA-r16
		- pdcch-BlindDetectionMCG-UE-r15 + pdcch-BlindDetectionSCG-UE-r15>= pdcch-BlindDetectionCA-r15
		- 3<= The minimum of pdcch-BlindDetectionMCG-UE-r16 +  pdcch-BlindDetectionSCG-UE-r16 + pdcch-BlindDetectionMCG-UE-r15 + pdcch-BlindDetectionSCG-UE-r15 <=16
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For the second part, in order to keep the signaling overhead and implementation complexity on the same level, at most the same number of combinations as answered for Question 1 should be supported. This is also evident from the UE feature description for FG 11-2e [5], where it is said that one combination for NR-DC corresponds to one combination for CA. Thus, whatever number RAN1 is going to decide for Question 1, the same number should also be applied for NR-DC.From 38.822 on FG 11-2e [5]:

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| One combination of (*pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16*) corresponds to one combination of (*pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16*) |

RAN1 has made the necessary agreements to answer the last question in the LS from RAN2 about NR-DC.* For FG 11-2e, multiple combinations should be supported. The same maximum number as agreed for 11-2c should be supported.
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| Nokia, Nokia Shanghai Bell [6] | Confirm that it must be possible to report different combinations of Rel-15 and Rel-16 blind detection capabilities 11-2e. The exact number of combinations is FFS. |

# Discussion on the questions in the LS on blind detection in CA

Companies have provided their views on the questions asked by RAN2 as summarized in section 3. This section provides a set of questions and/or proposals for further discussion.

## LS Question #1 – How many combinations for FG 11-2c and FG 11-2g can be reported at most from RAN1 perspective?

FL observations: All companies confirm that multiple combinations are supported to be reported. But there are different views on the maximum number of combinations to report.

* Max 4 combinations: HW/HiSi, ZTE (where ZTE thinks the final decision should be up to RAN2)
* Max 8 combinations: Samsung
* Max 16 combinations: vivo
* Max number FFS: Nokia

The advantage with supporting more combinations is to provide better flexibility in CA with mixed Rel-15/16 PDCCH monitoring. The gNB can then choose among more combinations and can select one option that better matches the characteristics of the given use case. The drawback is a larger required RRC signaling overhead. From the performance perspective, it does not really seem to be needed to provide extremely high numbers of combinations. Given the proposals provided in the papers, it seems an agreeable middle ground could be to support at most 8 combinations. But, if feasible from the RRC signaling perspective, there is no harm in supporting even more combinations. The final decision could be left to RAN2, as it also has been mentioned by ZTE.

### First round email discussion

Given the overall situation, the following Proposal 4.1.1-1 is made for the first round email discussion.

***Proposal 4.1.1-1: RAN1 provides the following answer to RAN2 for Question #1:***

***RAN1 confirms that multiple combinations of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16) for FG 11-2c and FG 11-2g can be reported.***

* ***The maximum number of reported combinations is a trade-off between configuration flexibility and signaling overhead. From RAN1 perspective, reporting a maximum number of 8 combinations is sufficient but RAN1 leaves it to RAN2’s decision if more combinations should be supported.***

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## LS Question #2 - Whether the “supported span arrangement for CA” should be reported for each of the combinations or reported only once for FG 11-2c?

FL observations: 2 companies (ZTE, Huawei) prefer to report the span arrangement separately for each combination, while 3 companies (vivo, Samsung, Nokia) prefer to report it only once.

A drawback of reporting the span arrangement for each combination is the increased RRC signaling overhead. The advantage, on the other hand, would be more flexibility. It could be possible that for some combinations (e.g. with a small number of Rel-16 CCs) the UE is capable to perform PDCCH monitoring with aligned and unaligned Rel-16 span arrangements whereas for other combinations (e.g. with large number of Rel-16 CCs) PDCCH monitoring can only be performed for aligned Rel-16 CCs. In such case, if the span arrangement would only be reported once for all combinations, the UE would need to report “aligned spans”, which prevents the network from configuring unaligned span arrangement, even if certain combinations at the UE would allow for that. However, it is true that during RAN1 discussion, somehow the unaligned span arrangement case is deprioritized, and thus may work also to only allow reporting once.

### First round email discussion

Since only a few papers submitted, maybe better to check the views from other companies also before making any proposal.

***Question 4.2.1-1: Which option do you prefer for reporting “supported span arrangement”? Please provide your reasons for your choice also.***

* ***Option 1: Report the “supported span arrangement for CA” for each reported combination of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)***
* ***Option 2: Report the “supported span arrangement for CA” once for all reported combination(s) of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16)***

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## LS Question #3 - RAN2 wonders whether more than one combination should be supported for FG 11-2e as well? If the answer is yes, how many combinations for FG 11-2e can be reported at most from RAN1 perspective?

FL observations: All companies confirm that more than one combination shall be supported. Also, it has been pointed out by Samsung [4] and Huawei [7] that there is a one-to-one relationship between 11-2c and 11-2e. Furthermore, all companies provided the same number of supported combinations for 11-2e as they suggested for 11-2c in their respective papers.

### First round email discussion

The tentative proposal below is made for further discussion.

***Proposal 4.3.1-1: Provide the following answer for Question #3 to RAN2:***

***RAN1 confirms that multiple combinations of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) for FG 11-2e can be reported.***

* ***The maximum number of reported combinations is the same as that for combinations of (pdcch-BlindDetectionCA-R15, pdcch-BlindDetectionCA-R16) for FG 11 2-c.***

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## Whether to request RAN2 to capture a note in TS38.331 or 38.306 to make it consistent with the agreements describing relationship between 11-2c and 11-2e

FL observation: In [4] Samsung proposed to request RAN2 to add the following note in 38.331 or 38.306 to make it consistent with the agreements describing relationship between 11-2c and 11-e.

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| * UE reports one or more combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16)
	+ One combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) corresponds to one combination of (pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16) reported by a UE for CA operation
 |

It seems clearer if 38.331 or 38.306 can capture some note for this. However, let’s hear more views from other companies.

### First round email discussion

The following question is set for check the views from companies.

***Question 4.4.1-1: Shall the reply LS also contain a request to RAN2 to capture the following note in 38.331 or 38.306 to make it consistent with the agreements describing the relationship between 11-2c and 11-2e?***

* ***UE reports one or more combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16)***
	+ ***One combination of (pdcch-BlindDetectionMCG-UE-r15, pdcch-BlindDetectionSCG-UE-r15, pdcch-BlindDetectionMCG-UE-r16, pdcch-BlindDetectionSCG-UE-r16) corresponds to one combination of (pdcch-BlindDetectionCA-r15, pdcch-BlindDetectionCA-r16) reported by a UE for CA operation***

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## Other issues

If there is any other issue to discuss, please provide it here.

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# Draft Reply LS

TBD – This section will completed after the proposals in section 2.3 are complete and stable

# Outcome

TBD

# References

[1] R1-2110757, “LS on PDCCH Blind Detection in CA”, RAN2, Huawei

[2] R1-2110906, “[Draft] Reply LS on PDCCH Blind Detection in CA”, ZTE

[3] R1-2110971, “Discussion on RAN2 LS on PDCCH Blind Detection in CA”, vivo

[4] R1-2111709, “Discussion on RAN2 LS on blind detection in CA”, Samsung

[5] R1-2112407, “Draft reply LS on PDCCH Blind Detection in CA”, Huawei, HiSilicon

[6] R1-2111168, “On UE features for PDCCH Blind Detection in CA”, Nokia, Nokia Shanghai Bell

[7] R1-2110813, “Discussion on PDCCH Blind Detection in CA”, Huawei, HiSilicon

[8] TS 38.331-g60

[9] R2-2108585, “Correction on PDCCH Blind Detection in CA”, RAN2##115-e, August 9 – 27, 2021.