**3GPP TSG RAN WG1 #110bis-e R1-220xxxx**

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

**Source: Moderator (Intel Corporation)**

**Title: Moderator Summary for Rel. 18 NR DSS (Round 0)**

**Agenda item: 9.17**

**Document for: Discussion and Decision**

# Introduction

A moderator summary of maintenance issues related to Rel-18 DSS based on contributions submitted to RAN1#110b-e AI 9.17 is provided below. In the following, the alternatives are not meant to be mutually exclusive options, please consider that one or more alternatives could be feasible.

# Maintenance Issues

* 1. NW indication of CE or Tx scheme

The following is proposed in tdocs from Spreadrum, vivo, DOCOMO, Nokia/NSB

* + 1. Round 0

Table 1: Summary of Issue 1

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| **Issue#** | **Description** | **Company position** |
| 1 | Alt 1: Specify NW indication of channel estimation method for NR PDCCH candidates that overlap with LTE CRS REs  Alt 2: Specify NW indication of transmission scheme for NR-PDCCH candidates that overlap with LTE-CRS REs (e.g. puncture or superposition) | * **Support:** * **Alt1:** Vivo, Spreadtrum, DOCOMO, Xiaomi, * **Alt2:** Nokia/NSB, DOCOMO * **Not Support:** * **Alt1:** Samsung, OPPO, ZTE, MTK, LGE * **Alt2:** Samsung, OPPO, ZTE, Vivo, MTK, Huawei/HiSi, LGE |

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| **Company Name** | **Company inputs** |
| Samsung | Not support either Alt-1 or Alt-2.  First, no need for any discussion at this time as “legacy CE” requires RAN4 confirmation.  Second, RAN1 introduced “legacy CE” for the case of 1-symbol CORESET - no need for any NW indication for a CE method. If supported, “legacy CE” is default if the CORESET has 1 symbol; else, it is CE based on the “clean” symbol.  Also, an indication of puncture or superposition would imply additional CE methods, additional RAN4 performance requirements, and then that would also not preclude non-uniform DM-RS pattern.  There is no need for any specification impact. RAN4 will define performance requirements at least for a CORESET with clean symbol and that would be the CE method (UE is always free to use another CE method if it can meet requirements). If operation with no clean symbol is supported in the end, there is no other choice but “legacy CE”. |
| OPPO | We have strong concern on network decision/indication of how UE performs channel estimation, which is a UE implementation choice by nature. For example, although RAN1 #110 raised two examples of CE: legacy CE vs. CE on clean symbols, the UE is not prevented from running CE on an optimal CE which uses all DMRS REs except the ones overlapping with CRS REs, i.e., some of the “clean” DMRS REs in “non-clean” symbol may also be used for CE. So it does not seem a good idea to set up indication to direct specific CE method, and we do not support Alt-1.  Meanwhile, Alt-2 (which suggests a variation of transmission scheme of NR-PDCCH) seems to conflict with following RAN1 #110 agreement: “*PDCCH candidates and PDCCH-DMRS RE mapping are based on that of R15 from UE side.*” According to 38.211 section 7.3.1.5, the power allocation (relating to puncture/superposition) is part of PDSCH resource mapping.    In summary, we do not support either Alt-1 or Alt-2. |
| ZTE | We don’t see much necessity to support either Alt 1 or Alt 2.   * Alt 1:   In case of 1-symbol CORESET or if a UE only reports to support legacy CE, such NW indication is not needed because only legacy CE can be used.  In case 2 or 3 symbol CORESET and if a UE reports to support both legacy CE and CE on clean symbol, it could be up to implementation. In practice, a UE has no reason to apply a CE method that has worse performance, i.e., NW could assume CE on clean symbol is applied in most cases when it could provide better performance.   * Alt 2:   Firstly, we are not sure how much gain it could provide by such indication. In addition, if Alt 2 is adopted, it may cause a UE to report different capabilities to support different transmission schemes, and then cause unnecessary fragmentation in the market. |
| Vivo | We support alt1 but we do not support alt2.  In our understanding, ‘legacy CE’ is default for any CORESET on CRS symbol, while ‘clean symbol-based CE’ requires additional UE capability. An advance UE may support both legacy CE and ‘clean symbol-based CE’ methods. As the performance of these two methods can be quite different, it is desirable for NW to indicate the CE method to adapt to NW configuration. NW can by its implementation to adjust the EPRE of signals on CRS REs. When CRS power is high, it can indicate ‘clean symbol-based CE’ to UE to avoid the strong interference from LTE. if it lowers the CRS power, it can indicate ‘legacy CE’ as legacy CE may have better performance in this case. Regarding Samsung's comments on RAN4 confirmation, legacy CE will be dropped only if RAN4 defines new requirements for legacy CE, RAN1 can discuss alt.1 first as usual, and this alternative can be revised once RAN4 has defined the new requirements  For option2, RAN1 have studied performance of multiple receiver types based on certain assumptions of NW transmissions but RAN1 have not achieved any agreements on how the NW should transmit on the CRS symbol in the end, which means NW transmission scheme is up to gNB. Moreover, NW indication of transmission scheme implies additional CE method or PDCCH processing method at UE side. |
| Qualcomm | Regarding Alt-1, it should be clear that the discussion here is for a UE supporting both CE options. For a UE supporting one of the CE options, RRC indication is not necessary. In this sense, we prefer to discuss whether a UE can inform to the NW whether it supports either or both CE options.  Regarding Alt-2, it would be beneficial for a UE to know how the PDCCH is transmitted (punctured or super-positioned). The indication of super-position is useful only if the UE can make use of the information. In this sense, another UE capability is necessary to accommodate super-positioned PDCCH/LTE-CRS, if this is agreed. |
| Spreadtrum | Support Alt-1. Network can have full knowledge about the situation of LTE deployment and its interference level to NR side. Thus, it is suitable for network to control the whole DSS transmission including UE channel estimation method, which will potentially achieve the best NR-PDCCH performance. |
| Nokia, NSB | Alt 1: We don’t see the necessity for the network to configure the UE with a particular channel estimation methodology explicitly, but rather think that the UE can do what it sees is the best in a given environment. That said, we are not diametrically opposed to Alt 1 either. E.g. in the level “the PDCCH DMRS of the CRS-overlapping symbol is-allowed / is-not-allowed to be used in channel estimation” could be a way to go as it would not directly tie the configuration to UE implementation.  Alt 2: support  What we think would be useful is for the network to know what the UE is capable of, so that the network can then pick between transmitting or not transmitting some PDCCH ALs or selecting between puncturing and non-puncturing depending on what the UE is capable of and configuring the UE with what the gNB will do so that it can exploit this information. But even if the capability indication part is not agreed, the gNB indicating the UE what it will do would still allow the UE implementation to take this into account if it was able to do so, even if the gNB could not adapt its behaviour to the UE capability. |
| MediaTek | Alt1: Such NW indication should be discussed after introducing the UE capabilities on CE. Otherwise, for UE supporting only one of CE implementations, there is no point to have such indication, similar to Qualcomm’s comment. On the other hand, the benefit of such indication is not clear to us, i.e., for UE supporting both CEs, what is the benefit of such indication?  Alt2: we understand the intention is to avoid UE detection on whether the PDCCH candidate is transmitted or not. However, it might be more useful to introduce a UE capability on whether UE can support puncture or not on the overlapped REs. On the other hand, if such indication is introduced, does it also apply to PDSCH rate-matching? This aspect should also be considered. Last, we don’t think superposition is a feasible indication option since we never agree on having such feature (even though NW can still implement it). Also, the signaling might not be easy to be implemented without details of information, such as transmitted power ratio LTE CRS and NR PDCCH/DMRS. Therefore, at this stage, we don’t prefer to have such indication. |
| NTT DOCOMO | We are fine with either Alt1 or Alt2. As agreed at the last meeting, there are two channel estimation schemes. Information for UE to know which scheme is appropriate would be useful. |
| Xiaomi | Support Alt-1.  The performance of PDCCH highly depends on the channel estimation (CE). Introducing NW indication for CE helps the gNB to determine the configuration of PDCCH candidates, as different CE methods may correspond to different PDCCH performance. Furthermore, if no NW indication is introduced, gNB has to configure the PDCCH candidates based on the worst case, e.g., configuring a larger aggregation level (AL). More resource resources may be occupied by Rel-18 UEs without NW indication.  Alt-2 is not clear to us. If superposition transmission is indicated, how will the UE receive the PDCCH? Does the UE have to perform advanced decoding reception, e.g., interference cancelation? If that is the correct understanding, we prefer not to support Alt-2. More clarification would be appreciated. |
| Ericsson1 | We agree the discussion is linked to UE capabilities (which is to be discussed later). Then on the proposal, our understanding is that the system can be operated even without such indications. |
| Huawei/HiSi | For Alt-1, it can be postponed till the UE feature is determined.  For Alt-2, we have a strong concern on adopting superposition since it will degrade the incumbent LTE performance, so we do not support Alt-2. |
| LGE | Not support either Alt-1 or Alt-2.  We also think any spec impact is not needed on top of RAN4 requirement, UE capability and revising on current RAN1 spec restriction. |
| Mod | I have added company positions that seem quite clear/strong and who seem to be able to make decisions without UE capability discussions. pls. feel free to further add in the support/not support column.  @QC, @Ericsson, @Huawei: If you think that this can be discussed as part of UE capability then my interpretation is you are in “Not support” camp at this time but open to future discussion  Given current situation, I think we can keep discussing it (in this table) – I don’t think we have actionable output at this point |

* 1. Restriction on LTE CRS pattern lists

The following is proposed in tdocs from Spreadrum, vivo, DOCOMO

* + 1. Round 0

Table 2: Summary of Issue 2

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| **Issue#** | **Description** | **Company position** |
| 2 | Reception of NR PDCCH candidates overlapped with LTE CRS REs from 2 LTE CRS pattern lists that overlap in frequency (lte-CRS-PatternList1-r16 and lte-CRS-PatternList2-r16 or lte-CRS-PatternList3-r18 and lte-CRS-PatternList4-r18) is not supported | * **Support:** Samsung, OPPO (gNB cfg. restriction), Spreadtrum, Nokia/NSB,LG * **Not Support:** ZTE, Xiaomi, Ericsson, Huawei/HiSi, |

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| **Company Name** | **Company inputs** |
| Samsung | Support.  We think that has already been discussed, including for the WID, and it should be commonly understood that Rel-17 applies in that case. |
| OPPO | It is not clear to us how to interpret “is not supported”. Is it a restriction for gNB not to create such configuration for UE or it is a UE behavior to skip in real time the reception of NR PDCCH overlapping with two CRS pattern lists? We prefer it is a gNB configuration combination (e.g., PDCCH time symbols + CRS pattern lists) that the UE never expects. |
| ZTE | Prefer not to support.  From UE complexity perspective, we don’t see much difference compared to one LTE CRS pattern no matter applying legacy UE or CE on clean symbol. So, we don’t think such restriction is needed. |
| Vivo | For clarification, does the proposal mean that PDCCH can be overlapped with one list of {lte-CRS-PatternList1, lte-CRS-PatternList2, lte-CRS-PatternList3, lte-CRS-PatternList4}? For example, gNB provides lte-CRS-PatternList3 and lte-CRS-PatternList4, the PDCCH candidate can overlap only with lte-CRS-PatternList3 or only with lte-CRS-PatternList4. If this is the correct understanding, we support the proposal. |
| Qualcomm | Clarification is necessary.  In an LTE-CRS pattern list, there can be multiple LTE-CRS patterns that are not overlapped in frequency. Is it proposed to allow NR PDCCH reception with LTE CRS REs from multiple non-overlapping LTE-CRS patterns in a LTE-CRS pattern list, but to disallow NR PDCCH reception with LTE CRS REs from 2 LTE CRS pattern lists? If so, why support of multiple pattern lists has to be excluded specifically? We prefer to have a consistent approach, i.e., single LTE-CRS pattern in single LTE-CRS pattern list, or multiple LTE-CRS patterns in one or two LTE-CRS pattern lists. |
| Spreadtrum | Support.  There would be limited REs (i.e., 4 RE) besides LTE CRS if two CRS patterns overlapping in frequency can be configured to puncture NR PDCCH, which will have a great impact on decoding performance. Thus, we think only one LTE CRS pattern list is applicable to NR PDCCH candidate. For the number of LTE CRS patterns in single LTE-CRS pattern list, we are open to discuss. |
| Nokia, NSB | Prefer to support. |
| MediaTek | We also have similar clarification questions on the meaning of “not support.” |
| NTT DOCOMO | Support |
| Xiaomi | Prefer not to support.  The number of punctured REs according to the two LTE CES patterns may be same as that of single LTE CRS pattern, e.g., 4-port CRS & 1-port CRS on symbol#1, as shown in following figure. In this case, the NR PDCCH is still available on symbol#1 and symbol#2. |
| Ericsson1 | Not support - we do not see need for such restriction. |
| Huawei/HiSi | Not support. That will increase the UE complexity to receive PDCCH REs due to an additional puncturing pattern with limited gain expected to achieve. |
| LGE | Support. |
| Mod | @Vivo, my understanding is that if NR-PDCCH is overlapping with a LTE-CRS pattern from lte-CRS-PatternList1, it also overlaps with the corresponding pattern from lte-CRS-PatternList2 -  @QC, yes, my understanding is that the proposal is to disallow reception in the case of 2 LTE-CRS patterns from 2 lists because they overlap in frequency (as shown in Xiaomi’s example), then my interpretation is that QC is not supportive  Given current situation and clarifications, I think let us use 2 clear options and check where companies stand |

* + 1. Round 1

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| **Issue#** | **Description** | **Company position** |
| 2 | Alt-1: Reception of NR PDCCH candidates overlapped with LTE CRS REs from only one configured LTE CRS pattern list is supported  Alt-2: Reception of NR PDCCH candidates overlapped with LTE CRS REs from either one or two configured LTE CRS pattern lists is supported | * **Support:** * **Alt-1** * **Alt-2** * **Not support:** * **Alt-1** * **Alt-2** |

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| **Company Name** | **Company inputs** |
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* 1. Restriction on SS sets

The following is proposed in tdocs from Spreadrum, vivo, Xiaomi.

* + 1. Round 0

Table 3: Summary of Issue 3

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| **Issue#** | **Description** | **Company position** |
| 3 | Reception of NR PDCCH candidates in Type 0/0A/1/2 CSS overlapped with LTE CRS Res is not supported | * **Support:** Vivo, Qualcomm, Spreadtrum, MTK, DOCOMO, Xiaomi, Huawei/HiSi, * **Not Support:** Samsung, OPPO, ZTE, Nokia/NSB, Ericsson, LGE |

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| **Company Name** | **Company inputs** |
| Samsung | Not support.  No apparent need for any agreement as it is a gNB implementation issue. UE can follow its specified procedures. |
| OPPO | Not support.  This restriction makes sense from performance perspective, but not quite necessary from functionality specification wise. gNB has to avoid overlapping between CSS and CRS by implementation if there is any non-R18-DSS-capable UE monitoring the CSS, or on the other hand gNB may not even care about this if all Ues in the cell are R18-DSS capable Ues. |
| ZTE | Not support.  Instead of explicitly precluding the case, it’s better to leave some flexibility for NW implementation. For instance, the NW may have a configuration where only few monitoring occasions of a CCS overlap with LTE CRS, so that idle Ues could still use other monitoring occasions to access. With this proposal adopted, NW has to handle CSS and USS configurations differently, which may cause additional complexity for management. |
| Vivo | Support  gNB has no information of UE capability of idle UE, thus CSS used by idle UE should be not overlapped with CRS. |
| Qualcomm | Support. |
| Spreadtrum | Support.  For the CSS such as Type 0/0A/1/2, we think reception of NR PDCCH candidates overlapped with LTE CRS Res should not be supported and the UE is not required to monitor such PDCCH candidate. |
| Nokia, NSB | Not support. Agree with views expressed by Samsung, Oppo and ZTE. Unnecessary spec restriction. |
| MediaTek | Support.  NW should know the UE capability before enabling the Rel-18 DSS PDCCH enhancement. |
| NTT DOCOMO | Support. |
| Xiaomi | Support  No significant motivation is observed to enable the reception of NR PDCCH candidates in CSS overlapped with LTE CRS. If the gNB configures the above PDCCH CSS candidates, the legacy UE has to drop the candidates and fails to receive the CSS information, it is unfair to legacy UE . |
| Ericsson1 | We do not see need for this restriction. |
| Huawei/HiSi | Agree with the proposal. |
| LGE | It doesn’t seem to be necessary. |
| Mod | Given current situation, I think we can keep discussing it (in this table) – I don’t think we have actionable output at this point |

* 1. UE capabilities

The following is proposed in tdocs from vivo, Qualcomm, Nokia/NSB

* + 1. Round 0

Table 3: Summary of Issue 3

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| **Issue#** | **Description** | **Company position** |
| 4 | Introduce UE capabilities to indicate the supported CE methods (details to be discussed during UE capability) | * **Support:** Qualcomm, Vivo, Nokia/NSB, MTK, DOCOMO, Xiaomi, * **Not support:** Samsung, OPPO, Spreadtrum |

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| **Company Name** | **Company inputs** |
| Samsung | Not support.  Is a UE capability to support “legacy CE” really proposed here? |
| OPPO | Not support.  If we understand correctly, the issue 4 intends to differentiate between CE based on clean DMRS symbols only and CE based on all DMRS symbols, in order to tell gNB whether gNB can allocation PDCCH in a way with none or at least one “clean symbol”. However, as we mentioned in 2.1.1, it may not be wise to enumerate the CE methods (e.g., some of DMRS in non-clean symbol can be used in CE), and the clean symbol is just so-far a concept within CE, which is in general a UE implementation issue. Given the chance in reality of making all PDCCH symbols non-clean is quite low anyway, we prefer to make “at least one clean symbol” as a resource allocation requirement that is independent from CE methods. With this requirement or restriction, there is no need to introduce the UE capability in issue 4 and the spec impacts related to issue 7 and issue 8 should be simplified.  So our preference is that: do not support UE capability indication on CE methods; instead, make “at least one clean symbol” as a resource allocation requirement regardless of CE methods. |
| ZTE | We have the same question as Samsung.  Together with the details, it could be discussed during UE capability. |
| Vivo | Yes, we are open to discuss the details during UE capability.  Legacy CE should be supported by all Ues supporting PDCCH reception on CRS symbol. Additionally, some UE may support ‘clean symbol-based CE’, thus there can be two types:  1) PDCCH reception on CRS symbol capability1: UE supports legacy CE for PDCCH reception on CRS symbol  2) PDCCH reception on CRS symbol capability2: UE support legacy CE and ‘clean symbol-based CE’ for PDCCH reception on CRS symbol.  Alternatively, there can be a single UE capability for PDCCH reception on CRS symbol with two candidate values: candidate value1) UE supports legacy CE for PDCCH reception on CRS symbol;  candidate value2) UE support legacy CE and ‘clean symbol-based CE’ for PDCCH reception on CRS symbol. |
| Qualcomm | Support with one step forward (rather than leaving it to UE feature discussion) – a UE should be able to report support of either or both of CE Options. To discuss any other details, we need to clarify this point.  “legacy CE option” does not mean the UE follows the existing spec – in the existing spec, the UE does not monitor a PDCCH candidate if it overlaps with at least one RE with LTE-CRS. For “legacy CE option”, the UE monitors such candidate. |
| Spreadtrum | Not support.  From UE channel estimation perspective, there is no difference for legacy CE or CE on clean symbol(s) only in terms of UE capability and complexity. There is no need to introduce UE capabilities to indicate the supported CE methods. |
| Nokia, NSB | (support), phrasing “supported CE methods” the description is a bit broad in our thinking, but whether the UE can use the PDCCH DMRS in the overlapping symbol, or it can only use the PDCCH CMRS of the clean symbol would be useful for the network to know. |
| MediaTek | Support. We also prefer to capture certain high level description on the two UE capabilities. Otherwise, based on the comments above, companies seem to have different understanding on “legacy CE,” e.g., whether it follows current spec or it is a new behavior. We also have concerns on company interpretation of “legacy CE”. Some companies interpret “legacy CE” as “CE on all DMRS symbols” and some companies interpret as “CE on all DMRS symbols assuming DMRS Res in the symbols are transmitted.” We support the “CE on all DMRS symbols assuming DMRS Res in the symbols are transmitted” and prefer to clarify this aspect before UE feature discussion. |
| NTT DOCOMO | We are open to introduce UE capabilities related to CE methods. Details can be discussed during UE capability. |
| Xiaomi | Support.  And prefer to discuss it in UE feature session. |
| Ericsson1 | This can be left to discussions in UE capability sessions. |
| Huawei/HiSi | Is not the UE capability report already agreed? Why are we still discussing it here? If the gNB is not aware of the different UE capabilities, then how would it expect the PDCCH performance (if configuring half-overlapped PDCCH CORESET) and do the correct AL configurations?   |  | | --- | | **Agreement**  Reception of NR PDCCH candidates that overlap with LTE CRS REs is supported by Rel18 UEs  PDCCH candidates and PDCCH-DMRS RE mapping are based on that of R15 from UE side.  Note: depends on UE capability  Following options can be used for PDCCH-DMRS channel estimation   * legacy CE assumption   + RAN1 consider support this, if no RAN4 performance requirements are defined * CE on clean symbol(s) only (this channel estimation option does not apply for 1 symbol CORESET) | |
| LGE | Agree with Ericsson. |
| Mod | For this issue, there seems to be quite a bit more supporting companies and not too strong negative views, so I try to proceed this one to the next round, pls. provide further comments on Proposal-1 below |

* + 1. Round 1

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| **Issue#** | **Description** | **Company position** |
| 4 | Introduce UE capability to indicate one or more supported channel estimation abilities for the reception of NR PDCCH candidates that overlap with LTE CRS REs  • details to be discussed during UE capability discussions (e.g. CE on all PDCCH-DMRS symbols, CE on clean symbol(s) PDCCH-DMRS only) | * **Support:** * **Not support:** |

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| **Company Name** | **Company inputs** |
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* 1. Restriction on symbols

The following is proposed in tdocs from Xiaomi, DOCOMO, Spreadtrum.

* + 1. Round 0

Table 3: Summary of Issue 3

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| **Issue#** | **Description** | **Company position** |
| 5 | Alt-1: Specify restrictions on certain symbols where reception of NR PDCCH overlapped with LTE CRS Res is not supported e.g. symbol#0  Alt-2: Specify NW indication of location of LTE PDCCH | * **Support:** * **Alt-1: ZTE (only #0), Vivo, Qualcomm, Spreadtrum, MTK, DOCOMO (only #0), Xiaomi (only #0)** * **Alt-2:** * **Not Support** * **Alt-1: Nokia/NSB, HW/HiSi, LG** * **Alt-2: Samsung, OPPO, ZTE, Vivo, Qualcomm, Nokia/NSB, HW/HiSi, LG** |

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| **Company Name** | **Company inputs** |
| Samsung | Not support.  It is a gNB implementation issue – gNB can always choose to transmit a PDCCH either according to a first search space set mapping to a CORESET with X symbols (e.g. 2nd and 3rd symbols) or according to a second search space set mapping to a CORESET of Y symbols (e.g. 3rd symbol only) – no need to indicate LTE PDCCH.  Also, why does a UE care if its PDCCH is interfered by PCFICH/PHICH? |
| OPPO | Not support.  Alt-1 does not seem necessary, since the gNB configuration/scheduling can avoid the issue completely.  Alt-2 is a new feature (not even in WID), and should not be opened in maintenance phase. |
| ZTE | Alt 1: Fine with no restrictions or only precluding symbol#0.  Alt 2: More clarification on the necessity is needed. |
| Vivo | We are open to alt1. Not support alt2 as it is a gNB implementation issue. |
| Qualcomm | Support Alt-1. Further discussion is necessary on details.  We are not sure the need of Alt-2. |
| Spreadtrum | Fine to Alt-1.  For Alt-2, we would like to clarify our motivation:  The collision between LTE PDCCH/ PCFICH/PHICH and NR PDCCH can be solved by network scheduling. However, UE cannot obtain the location of the LTE PDCCH/PCFICH/PHICH and whether to collision or not. The UE performs blind detection on the PDCCH candidate only according to the monitoring occasion configured in the search space. If the PDCCH monitoring occasion overlaps with LTE PDCCH/ PCFICH/PHICH, UE will make unnecessary efforts, which is not conducive to power saving of the UE. Thus, The location of the LTE PDCCH needs to be indicated by gNB. If the NR PDCCH candidate collides with the LTE PDCCH/ PCFICH/PHICH, the UE is not required to monitor the NR PDCCH candidate. |
| Nokia, NSB | Alt 1: Not support, not clear to us what the benefit of this restriction is. If there is a clear benefit or implementation simplification we would be open to discuss such a restriction.  Alt 2: Not quite sure what indication the proponents see here (L1/MAC/RRC?), but it would seem difficult for the gNB to provide dynamic information to the UE on what the LTE side is doing within the existing framework. |
| MediaTek | Alt1: Support. RAN1 never evaluated or discussed the overlapped symbol on Symbol#0 and we should not enable such scenario without any analysis. We also like to add the reception of NR PDCCH overlapped with LTE CRS should be within symbol #1 and #2 only. If overlapped symbols are not within the first 3 symbols in a slot, then it means UE can support other PDCCH monitoring capability and we don’t see the clear benefit on having overlapped PDCCH candidates other than the first 3 symbols for such scenarios since PDSCH can use the symbols containing LTE CRS. |
| NTT DOCOMO | Alt1: We support excluding only symbol 0. Other restrictions can be discussed during UE capability if necessary.  Alt2: The need is not clear to us. |
| Xiaomi | Support Alt 1, symbol#0 should be precluded considering that LTE PCFICH and PHICH are also transmitted on symbol#0. |
| Ericsson1 | Below is note from last meeting agreement. This can be left to discussions in UE capability session.  *Note: Restriction on the symbols and/or LTE CRS patterns applicable for above agreements can be considered during UE capability session.* |
| Huawei/HiSi | Not support. It is up to gNB implementation. |
| LGE | Not support. |
| Mod | For Alt-1, there seems to be quite more support than opposition, so we can consider in the next round again to see if opposing companies can be convinced. Pls. provide future input in Round-1 table |

* + 1. Round 1

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| **Issue#** | **Description** | **Company position** |
| 5 | Reception of NR PDCCH overlapped with LTE CRS REs is not supported in symbol#0  • Further restrictions on symbols where reception of NR PDCCH overlapped with LTE CRS REs is not supported can be discussed as part of UE capability discussions | * **Support:** * **Not Support:** |

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| **Company Name** | **Company inputs** |
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* 1. RRC parameters

The following is proposed in tdocs from Huawei/HiSilicon, Nokia/NSB.

* + 1. Round 0

Table 3: Summary of Issue 3

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| **Issue#** | **Description** | **Company position** |
| 6 | Alt-1: A new RRC parameter to enable reception of NR PDCCH candidates overlapped with LTE CRS REs  Alt-2: Specify configuration of PDCCH candidates/aggregation levels of a search space that is to be monitored when overlapped with LTE CRS REs  Alt-3: Specify that PDCCH aggregation levels higher than the aggregation levels employed in the CSS during the transition from RRC Idle to RRC connected state are assumed to be monitored | * **Support** * **Alt-1: Samsung, Vivo, Spreadtrum, Nokia/NSB, HW/HiSi, LGE** * **Alt-2** * **Alt-3** * **Not Support** * **Alt-1: OPPO, ZTE, Xiaomi, Ericsson** * **Alt-2: Samsung, OPPO, ZTE, Vivo, Qualcomm, MTK, DOCOMO, HW/HiSi, LGE** * **Alt-3: Samsung, OPPO, ZTE, Vivo, Qualcomm, MTK, DOCOMO, HW/HiSi, LGE** |

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| **Company Name** | **Company inputs** |
| Samsung | OK for Alt-1.  Alt-2 seems usual operation – no need for any agreement.  No need for Alt-3 – does not impact anything – UE has no shortage of PDCCH candidates at that point and NW can do whatever it wants. |
| OPPO | Not support.  Alt-1: It is not clear to us why NW enabling is needed. Once the PDCCH/CRS allocations are given on air-interface and UE reports its capability for handling, the PDCCH transmission/reception can already take place. It seems the Alt-1 is only to make the UE not to perform as good as its capability allows.  Alt-2/Alt-3: These seem to be optimizations (in case the current spec does not allow) that are not well-discussed in WI phase. We prefer not to introduce them in maintenance. |
| ZTE | Not support.  If a UE reports the feature (i.e., support of PDCCH reception on symbols with LTE CRS), and NW configures PDCCH that overlaps with symbols with CRS for a UE, then the feature is implicitly enabled. Otherwise, it is not enabled. We don’t see much necessity to use an explicit RRC to enable/disable this feature. Similarly, Alt2/3 which requires even finer granularity of signaling is not needed. |
| Vivo | Open to Alt-1. In the LS R2-2002378 from RAN2, RAN2 provides a guideline that “**Avoid defining functionality that has no RRC configuration but is dependent on capability bits.”** gNB should always configure the UE explicitly by DL RRC signalling, respecting the reported capabilities.  We don’t see the motivation of alt2/alt3, the legacy monitoring scheme, where UE monitors SS based on the configured AL and BD numbers, can be reused. |
| Qualcomm | Alt-1 depends on the conclusion on Issue #1.  Regarding Alt-2/3, we do not see the need. |
| Spreadtrum | Open to Alt-1.  For Alt-2/3, we share the similar view with vivo. In addition, we notice that Alt-2/3 will have a lot of impact on the specification. |
| Nokia, NSB | Alt-1: OK, as per the RAN2 instructions in the past.  Alt-2: Support  Alt-3: Support as a possible simplification to Alt-2 if Alt-2 is not agreeable |
| MediaTek | We can support Alt1. However, this can be discussed after the capability discussion in 2.4 and this discussion is related to 2.1.  For Alt-2, not sure we need this level of signaling  For Alt-3, the motivation should be elaborated a little bit more by proponents. |
| NTT DOCOMO | Alt-2/3: Not support. The existing search space configuration can indicate the number of candidates per aggregation level, which should be sufficient. |
| Xiaomi | Not support.  We have the similar concern with OPPO. The PDCCH reception on symbols with LTE CRS depends on the UE capability and gNB configuration. If the gNB does not support transmitting NR PDCCH in symbols containing LTE CRS, the gNB will not configure PDCCH candidates overlapped with LTE CRS. No new RRC parameter is required. |
| Ericsson1 | We think the system can operate without these. That said if need for any additional signaling is identified during UE capability discussions, it can be considered during that stage. |
| Huawei/HiSi | Support Alt-1, because gNB may or may not support configuring R18 DSS – if gNB does not support R18 DSS, the UE should not by default perform the PDCCH blind detection on the overlapping symbols – that will unnecessarily increase the false alarm and power consumption.  Not see the clear motivation for Alt-2 and Alt-3. |
| LGE | Open to Alt-1, but not support Alt-2/3. |
| Mod | Given current situation (many companies also think we can discuss during UE capability), I think we can keep discussing it (in this table) – I don’t think we have actionable output at this point |

* 1. Relaxation for PDCCH-DMRS in REG bundle

The following is proposed in tdocs from Qualcomm.

* + 1. Round 0

Table 3: Summary of Issue 3

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| **Issue#** | **Description** | **Company position** |
| 7 | For a CORESET with precoderGranularity = sameAsREG-bundle and if CE on clean symbol(s) only is applicable for PDCCH-DMRS the UE is not required to monitor a PDCCH candidate if there is no clean symbol(s) for channel estimation within the set of REGs of the PDCCH candidate | * **Support:** * **Not support:** |

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| **Company Name** | **Company inputs** |
| Samsung | Not support.  The described scenario will not occur in Rel-17 DSS; otherwise, it is a NW misconfiguration.  In any case, no apparent need for any agreement as there is no apparent specification impact. |
| OPPO | The technical logic reads straightforward. However, we are a bit hesitated to introduce “clean symbol”, which is a concept in UE implementation-based CE, into spec as a condition to define UE functional behaviors. In contrast, as provided in 2.4.1, we prefer to make the “at least one clean symbol” as a resource allocation requirement/restriction regardless of CE methods. |
| ZTE | Fine with the proposal. No spec impact is expected. |
| Vivo | Not quite sure about the intention of the proposal.  This proposal seems to leave the door open to perform CE on clean symbol in a 1-symbol CORESET with precoderGranularity = sameAsREG-bundle for PDCCH candidate whose REGs do not overlapped with CRS, however, this is contradictory with the following agreement. On the other hand, for these PDCCH candidates not overlapped with CRS, the two CE methods are actually the same.  For PDCCH candidates in multi-symbol CORESET overlapped with CRS, we assume there would be at least one clean symbol, then the proposal is also not needed as there it is no additional spec impact.   * CE on clean symbol(s) only (this channel estimation option does not apply for 1 symbol CORESET) |
| Qualcomm | Support.  1-symbol CORESET overlapping with an LTE-CRS symbol is allowed even today – the UE monitors PDCCH candidates that do not overlap with LTE-CRS (if any), and does not monitor the others. Now the question is, for a UE supporting CE on clean symbol(s) only, whether it is allowed to configure 1-symbol CORESET? We presume it is allowed if the CORESET does not overlap with LTE-CRS BW in frequency-domain, or with LTE-CRS symbol(s) in time-domain. Then what if the CORESET is partially overlapped with LTE-CRS BW in frequency-domain, and some PDCCH candidates in the CORESET do not overlap with LTE-CRS REs? Legacy UE monitors the PDCCH candidates in the CORESET as long as the candidates are not overlapped with LTE-CRS REs.  We need a clear understanding on whether this configuration is allowed. We are open to discuss the above question, but our current assumption is that it is preferred to allow configuring CORESET that partially overlaps with LTE-CRS BW so that some candidates are still available as of today. |
| Spreadtrum | Not support.  We agree with Samsung. We think both legacy UE and R18 DSS UE support legacy CE. No additional UE capabilities are required. Issue 7 will not occur. |
| MediaTek | Support in general. Whether it is an error configuration or it can be configured but UE supporting “clean symbol CE” will skip the detection should be clarified. However, this discussion should occur after the UE capabilities proposed in 2.4 are introduced. |
| NTT DOCOMO | If a UE capability to inform the channel estimation method supported by UE is introduced, we think that this proposed rule is also necessary. |
| Xiaomi | Prefer not to support if the indication discussed in 2.1.1 is confirmed. The situation mentioned above can be solved by adding an NW indication to inform the CE method. In this case, the situation that UE adopts clean symbol CE but no clean symbols for DMRS reception can be avoided. |
| Ericsson1 | We follow the intention, but perhaps this could be handled along with UE capability discussion |
| Huawei/HiSi | Support. If the UE reports the CE based on clean symbols, then it is necessary that UE should skip the monitoring of the no clean symbol PDCCH candidate. |
| Mod | There seems to be a set of companies that believe this is a misconfiguration, then let us try to clarify that in Round-1 below |

* + 1. Round 1

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| **Issue#** | **Description** | **Company position** |
| 7 | Alt1 (same as round-0): For a CORESET with precoderGranularity = sameAsREG-bundle and if CE on clean symbol(s) only is applicable for PDCCH-DMRS the UE is not required to monitor a PDCCH candidate if there is no clean symbol(s) for channel estimation within the set of REGs of the PDCCH candidate  Alt2 (this is a misconfiguration): For a CORESET with precoderGranularity = sameAsREG-bundle and if CE on clean symbol(s) only is applicable for PDCCH-DMRS the UE does not expect to be configured with such a CORESET if there are no clean symbol(s) available for channel estimation within that CORESET | * **Support:** * **Alt-1** * **Alt-2:** * **Not support:** * **Alt-1:** * **Alt-2:** |

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| **Company Name** | **Company inputs** |
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* 1. Relaxation for PDCCH-DMRS WB

The following is proposed in tdocs from vivo, Qualcomm.

* + 1. Round 0

Table 3: Summary of Issue 3

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| **Issue#** | **Description** | **Company position** |
| 8 | For a CORESET with precoderGranularity = allContiguousRBs  Alt1: if CE on clean symbol(s) only is applicable for PDCCH-DMRS the UE does not expect to be configured such that there is no clean symbol(s) for channel estimation within all the REGs of the contiguous RBs in the CORESET where the UE attempts to decode a PDCCH candidate  Alt2: if CE on clean symbol(s) only is applicable for PDCCH-DMRS the UE does not monitor a PDCCH candidate if there is no clean symbol(s) for channel estimation within all the REGs of the contiguous RBs in the CORESET where the UE attempts to decode the PDCCH candidate  Alt3: NR PDCCH candidates is not expected to be overlapped with LTE CRS REs | * **Support** * **Alt-1:** * **Alt-2: Nokia/NSB, Ericsson, HW/HiSi** * **Alt-3: ZTE, Vivo, Qualcomm, Spreadtrum, MTK,** * **Not Support (Alt-1, Alt-2, Alt-3)** |

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| **Company Name** | **Company inputs** |
| Samsung | Not support.  Alt. 1 is based on Rel-17 specifications and may be revisited as a possible conclusion. |
| OPPO | Similar to issue 7, we prefer to make the UE behavior not dependable on a choice on CE. Our suggestion to Issue 7 also applies here.  BTW, both Alt1 and Alt3 seem to read similar: UE does not expect a specific PDCCH+CRS setup for all PDCCH candidates in the CORESET. |
| ZTE | Alt 3  In legacy, PDCCH candidate overlaps with LTE CRS is not allowed in case of precoderGranularity = allContiguousRBs. We prefer to keep it in Rel-18 DSS. |
| vivo | Alt3.  In R15, wideband DMRS CORESTE cannot be overlapped with CRS while narrowband DMRS CORESET can. We think this principle can be maintained in R18 DSS for simplicity, thus we prefer Alt3. |
| Qualcomm | Agree with OPPO that Alt-1 and Alt-3 are similar (or same in reality).  We think Alt-2 is fine while Alt-1 and Alt-3 are restrictive. If we go with Alt-1 or Alt-3, in reality, it is not possible to configure a single wideband RS CORESET commonly for a UE supporting CE on clean symbol(s) only and a UE supporting legacy CE option.  This should be discussed together with the case of precoderGranularity = sameAsREG-Bundle in Issue 7. |
| Spreadtrum | Support Alt3. We think R17 rules should be maintained, i.e., it is not expected to collide with LTE CRS REs for a CORESET with precoderGranularity = allContiguousRBs. |
| Nokia, NSB | Alt-2: The Search Space should be allowed to sometimes overlap with CRS and sometimes not, and if the UE requires a clean symbol to do channel estimate then it can be expected to not be able to decode the PDCCH, and hence the candidate should be dropped. This is more logical than restricting the configuration. |
| MediaTek | Alt-3 is restricted but it is simpler. At this stage, we prefer to have a simple and workable UE behavior. |
| Ericsson1 | We are OK with Alt2. Similar to previous comment, perhaps this could be handled along with UE capability discussion. |
| Huawei/HiSi | Alt.2 is preferred to make is less restrictive for gNB configuration. |
| Mod | There seems to be a need to resolve this, however there is good support for both Alt-2 and Alt-3. Given this is a maintenance issue, I think down-selecting Alt-1 is not going to help much – I think its okay to continue discussion (in this table) and re-visit when we have a significant majority |

* 1. Clean symbol determination

The following is proposed in tdocs from Qualcomm.

* + 1. Round 0

Table 3: Summary of Issue 3

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| **Issue#** | **Description** | **Company position** |
| 9 | if CE on clean symbol(s) only is applicable for PDCCH-DMRS, the UE determines clean symbol(s) based on  Alt1: LTE-CRS pattern(s) of all configured LTE-CRS pattern list(s)  Alt2: LTE-CRS pattern(s) of configured LTE-CRS pattern depending on whether crs-RateMatchPerCoresetPoolIndex is configured | * **Support:** * **Alt-1: Samsung (single LTE-CRS pattern), OPPO, ZTE, Vivo (single LTE-CRS pattern), Xiaomi,** * **Alt-2: Qualcomm, Ericsson** * **Not Support:** * **Alt-1** * **Alt-2** |

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| **Company Name** | **Company inputs** |
| Samsung | Alt1 without the ‘s’ – i.e. “LTE-CRS pattern of the configured LTE-CRS pattern list”  We think it is clear that only a single pattern list is supported – multiple pattern lists (including for different TRPs) are not supported.  This also relates to issue#2. |
| OPPO | First of all, similar to issue 7 and issue 8, we prefer to make the UE behavior not dependable on a choice on CE. Our suggestion to Issue 7 also applies here.  Between Alt-1 and Alt-2, we prefer Alt-1. The current specification relating to PDCCH monitoring in overlapping with CRS does not get crs-RateMatchPerCoresetPoolIndex involved. |
| ZTE | Alt 1. We have similar view as OPPO. In Rel-17, PDCCH monitoring on symbols with CRS doesn’t consider crs-RateMatchPerCoresetPoolIndex no matter only list1 is configured or both list1 and list 2 are configured. |
| vivo | Same view as Samsung, as discussed in issue#2, the case where PDCCH is overlapped with two list in time domain is precluded. |
| Qualcomm | Alt-1 for a UE not configured with crs-RateMatchPerCoresetPoolIndex, and Alt-2 for a UE configured with crs-RateMatchCoresetPoolIndex.  We do not think Alt-1 makes sense when *crs-RateMatchPerCoresetPoolIndex* is configured. It is also not clear what the concern to go with Alt-2. |
| Spreadtrum | We think it is related to issue#2. We think only one LTE CRS pattern list is supported in this feature. There is no need to discuss this issue. |
| MediaTek | Similar view with Qualcomm on the interpretation of Alt1 and Alt2. Also similar view with spreadrum, Alt1 might be related to 2.2 and we prefer to handle these two discussions together. |
| Xiaomi | Support Alt 1. We have similar view with Samsung and OPPO that PDCCH monitoring does not matter with *crs-RateMatchPerCoresetPoolIndex.* |
| Ericsson1 | We follow the intention, and think Alt 1 is appropriate for case without crs-RateMatchPerCoresetPoolIndex configured, and Alt 2 for case with crs-RateMatchPerCoresetPoolIndex configured. |
| Huawei/HiSi | Alt.2 is preferred, with the same logic of Sec. 2.2.1 |
| Mod | It seems that many companies prefer a resolution to Issue#2 before taking this up, so we can re-visit this later. |

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# References

|  |  |  |  |
| --- | --- | --- | --- |
|  | R1-2208491 | Discussion on remaining issues for Rel-18 DSS | ZTE |
|  | R1-2208578 | Maintenance for Rel-18 DSS | Spreadtrum Communications |
|  | R1-2208675 | Remaining issues on NR Dynamic spectrum sharing | vivo |
|  | R1-2208859 | Discussion on remaining issues in Rel-18 eDSS | OPPO |
|  | R1-2209275 | Discussion on NR PDCCH reception in symbols with LTE CRS REs | Xiaomi |
|  | R1-2209814 | Remaining issues on NR PDCCH reception in symbols with LTE CRS REs | Huawei, HiSilicon |
|  | R1-2209929 | Remaining issues on NR PDCCH reception in symbols with LTE CRS REs | NTT DOCOMO, INC. |
|  | R1-2210017 | Maintenance for Rel-18 DSS | Qualcomm Incorporated |
|  | R1-2210193 | [eDSS] RRC configuration and UE capability for PDCCH on CRS | Nokia, Nokia Shanghai Bell |