3GPP TSG RAN WG1 #109-e R1-220xxxxx

**e-Meeting, May 9th – 20th, 2022**

**Agenda item: 9.9.2**

**Title: Feature lead summary #1 on UE support for two overlapping CRS rate matching patterns**

**Source: Moderator (ZTE Corporation)**

**Document for:** **Discussion and Decision**

# Introduction

In RAN#94e meeting, a new WID about NR DSS was approved for Rel-18, with the following objectives.

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| The following objectives shall be included for improvement of NR spectrum efficiency for LTE-NR co-existence (RAN1):   * Study and if needed specify NR PDCCH reception in symbols with LTE CRS REs. [RAN1]   + Investigate enabling LTE CRS to puncture NR PDCCH, including the impact to NR PDCCH DMRS if there is the performance gain from the additional PDCCH resources. * **Allow a UE to support, and be configured with, two overlapping CRS rate matching patterns regardless of support or configuration of multi-TRP [RAN1, RAN2]** |

This contribution provides a summary of remaining issues on UE support for two overlapping CRS rate matching patterns proposed in contributions submitted under AI 9.9.2. The discussion is conducted under the following email discussion.

[109-e-R18-DSS-02] Email discussion on UE support for two overlapping CRS rate matching patterns by May 20 – Xianghui (ZTE)

* Check points: May 18

# Summary of Tdocs

## [Open] Indication of two overlapping CRS rate matching patterns

In Rel-16, up to 2 overlapping LTE CRS patterns can be configured for multi-DCI based PDSCH transmission in an M-TRP NR cell. In Rel-18, the intention of this WID is to extend support of 2 overlapping LTE CRS patterns regardless of support or configuration of multi-TRP.

Companies’ views on indication of the two overlapping LTE CRS patterns in Rel-18 are summarized below.

All companies agree that the two overlapping LTE CRS patterns should be RRC configured. Additionally, [14, Qualcomm] and [16, Ericsson] think dynamic indication of the two patterns could be also considered.

==> FL’s understanding: dynamic indication is out of the scope according to previous RAN discussion and current WID description. Therefore, no further discussion on this direction is pursued.

For RRC configuration, three options are proposed among companies.

* Option 1: Reuse the existing RRC parameters *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig.* 
  + [1, Huawei, HiSilicon], [2, ZTE], [4, vivo], [5, InterDigital], [7, Samsung], [8, OPPO], [10, NTT DOCOMO], [11, MediaTek], [12, Nokia, Nokia Shanghai Bell], [14, Qualcomm]
  + ~~[8, OPPO] and~~ [14, Qualcomm]: the following legacy configuration restriction in TS 38.331 is applied in Rel-18 DSS.
    - “The first LTE CRS pattern in this list shall be fully overlapping in frequency with the first LTE CRS pattern in lte-CRS-PatternList1, The second LTE CRS pattern in this list shall be fully overlapping in frequency with the second LTE CRS pattern in lte-CRS-PatternList1, and so on.”
* Option 2: Reuse the existing RRC parameter *lte-CRS-PatternList1-r16* and introduce a new Rel-18 RRC parameter *lte-CRS-PatternList3-r18* in *ServingCellConfig.* The new RRC parameter can be configured only if the existing parameter *lte-CRS-PatternList1* is also configured.
  + [3, Spreadtrum], [13, Ericsson], [8, OPPO]

Option 3: Introduce two new Rel-18 RRC parameters *lte-CRS-PatternList1-r18* and *lte-CRS-PatternList2-r18*in *ServingCellConfig.*

* + [4, vivo], [9, Apple]

In addition, [4, vivo] proposes to clarify that the two overlapping CRS rate matching patterns are only applicable to PDSCH with 15kHz SCS scheduled by PDCCH with DCI format 1\_1 or DCI format 1\_2 with CRC scrambled with dedicated RNTI in non-MTRP case in FR1.

### First Round

During the GTW session, it was raised a scenario of Rel-18 UEs in a cell with legacy gNB. FL’s understanding is, as long as it is a legacy gNB, two overlapping LTE CRS patterns can only be configured when if *CORESETPoolIndex* configured with 1. When a Rel-18 UEs receives *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16*, it would do rate matching only for multi-DCI M-TRP based PDSCH. In such case, it seems no issues for reusing legacy parameters in the concerned scenario with also considering the following analysis.

* From FL perspective, only up to two overlapping LTE CRS patterns can be configured simultaneously no matter for single TRP or M-TRP with or without considering neighbour LTE cells. In other words, support of configuring three or four overlapping LTE CRS patterns is out of scope according to the WID. In this sense, it seems no functional difference among above options. It is just a matter of fact that whether to use the legacy or new parameters for configuring the LTE CRS patterns from the two LTE cells with strongest interference.

Regarding the clarification from [4, vivo], FL only finds the following restrictions on support of two overlapping LTE CRS patterns, i.e., no restriction on the PDCCH format.

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| When receiving PDSCH scheduled by PDCCH with CRC scrambled by C-RNTI, MCS-C-RNTI, CS-RNTI, or PDSCHs with SPS, the REs corresponding to the configured or dynamically indicated resources in Clauses 5.1.4.1, 5.1.4.2 are not available for PDSCH. Furthermore, the UE assumes SS/PBCH block transmission according to *ssb-PositionsInBurst* if the PDSCH resource allocation overlaps with PRBs containing SS/PBCH block transmission resources, the UE shall assume that the PRBs containing SS/PBCH block transmission resources are not available for PDSCH in the OFDM symbols where SS/PBCH block is transmitted. |
| - If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:  - if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';  - otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*. |

Based on the summary above, FL would like to check companies’ views on the following proposal.

**Proposal #1:**

* **If the UE is NOT configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet,* up to two overlapping LTE CRS patterns can be configured simultaneously by RRC for PDSCH scheduled by PDCCH with CRC scrambled by C-RNTI, MCS-C-RNTI, CS-RNTI, or PDSCHs with SPS.** 
  + **Reuse the existing RRC parameter *lte-CRS-PatternList1-r16* in *ServingCellConfig.***
  + **FFS reuse the existing RRC parameter *lte-CRS-PatternList2-r16* in *ServingCellConfig.***
  + **The following legacy configuration restriction in TS 38.331 is applied in Rel-18 DSS.** 
    - **“The first LTE CRS pattern in this list shall be fully overlapping in frequency with the first LTE CRS pattern in lte-CRS-PatternList1, The second LTE CRS pattern in this list shall be fully overlapping in frequency with the second LTE CRS pattern in lte-CRS-PatternList1, and so on.”**

Companies are encouraged to provide your views on 1) whether or not support the proposal 2) what’s your views on the FFS points. Depending on the input, I would then revise the FFS point.

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| **Company** | **Comments** |
| OPPO | * For the last sub-bullet (the legacy configuration restriction), we think it needs a discussion for clarification. As mentioned in our contribution [R1-2204025], we see two different understanding for the wording “fully overlapping in frequency”, in short:   1. Interpretation#1: RE level fully-overlapping;   2. Interpretation#2: frequency range level fully-overlapping.   If it is interpretation#1, this 38.331 restriction may not be applicable to Rel-18 DSS; if it is interpretation#2, then it still deserve a discussion about the applicability to Rel-18 DSS.   * The clarification of this 38.331 restriction and the decision of its applicability to Rel-18 DSS also impact the decision on the FFS bullet. If the 38.331 restriction is applicable to Rel-18 DSS, the existing RRC parameter can be reused; if not, a new parameter is needed, and in such a case there would be totally 3 CRS rate matching pattern lists. * PS. The FL summary in section 2.1 misinterprets our position on the 38.331 restriction. Correction is made there. |

## [Open] UE capability

For legacy LTE CRS rate matching, the following FGs are introduced. More details on the FGs are summarized in the Annex.

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| 14-1 | | Multiple LTE-CRS rate matching patterns | | | 1) Maximum number of LTE-CRS rate matching patterns in total within a NR carrier using 15 kHz SCS  2) Maximum number of LTE-CRS non-overlapping rate matching patterns within a NR carrier using 15 kHz SCS | | 5-28 (Rate-matching around LTE CRS) | multipleRateMatchingEUTRA-CRS-r16 {  maxNumberPatterns-r16,  maxNumberNon-OverlapPatterns-r16} |
| 14-1a | | Two LTE-CRS overlapping rate matching patterns within a part of NR carrier using 15 kHz overlapping with a LTE carrier | | | 1. Support of two LTE-CRS overlapping rate matching patterns within a part of NR carrier using 15 kHz SCS overlapping with a LTE carrier | | 14-1 | overlapRateMatchingEUTRA-CRS-r16 |
| 16-2a | Multi-DCI based multi-TRP | | | 1. The maximum number of CORESETs configured per BWP per cell in addition to CORESET 0  2. The maximum number of CORESETs configured per CORESETPoolIndex ( if CORESETPoolIndex is not configured, it is assumed CORESETPoolIndex = 0) per BWP per cell in addition to CORESET 0  3. Support fully/partially overlapping PDSCHs in time and non-overlapping in frequency  4. Maximum number of unicast PDSCHs per CORESETPoolIndex per slot | | |  | *multiDCI-MultiTRP-r16* |
| 16-2a-5 | | | Separate CRS rate matching | | | 1. Whether the UE can rate match around configured CRS patterns which is associated with CORESETPoolIndex (if configured) and are applied to the PDSCH scheduled with a DCI detected on a CORESET with the same value of CORESETPoolIndex | 16-2a and 14-1a | *separateCRS-RateMatching-r16* |

[2, ZTE]: For PDSCH transmission other than multi-DCI based MTRP, a new UE capability similar as FG 14-1a should be introduced to support two overlapping CRS rate matching patterns.

[3, Spreadtrum]: Introduce a new UE capability report for two LTE CRS overlapping rate matching patterns without mTRP, and the number of the additional CRS rate matching patterns is accounted in the total number of rate matching pattern reported by the UE.

[4, vivo]: A new UE capability should be introduced to indicate the support of two overlapping CRS patterns. Only when the new capability is reported to gNB, can gNB configure two overlapping CRS patterns to UE for PDSCH rate matching for non-MTRP case.

[14, Qualcomm]:

* Introduce corresponding new UE capability
  + NW can configure *lte-CRS-PatternList1* and *lte-CRS-PatternList2* without *coresetPoolIndex* only if the UE indicates support of this capability
* Clarify that the Rel-16 UE capability *overlapRateMatchingEUTRA-CRS-r16* is subject to support of *multiDCI-Multi-TRP-r16* and the UE indicating this Rel-16 UE capability can be configured with *lte-CRS-PatternList2* only if there is at least one *ControlResourceSet* in one DL BWP of this serving cell with *coresetPoolIndex* set to 1

### First Round

Based on the summary above, FL would like to check companies’ views on the following proposal.

**Proposal #2:**

* **Introduce a new UE capability for support of two overlapping LTE CRS patterns if the UE is NOT configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet.*** 
  + **NW can configure *lte-CRS-PatternList1* and *lte-CRS-PatternList2* without *coresetPoolIndex* only if the UE indicates support of this capability.**
* **Clarify that the Rel-16 UE capability *overlapRateMatchingEUTRA-CRS-r16* is subject to support of *multiDCI-Multi-TRP-r16*.**
* **Maximum number of LTE-CRS rate matching patterns supported by a UE (i.e., *maxNumberPatterns-r16* and *maxNumberNon-OverlapPatterns-r16*) is kept unchanged.**

Companies are encouraged to provide your views below.

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| **Company** | **Comments** |
| OPPO | Our understanding is that Proposal #2 may depend on outcome of Proposal #1, since Proposal #1 may end up with a ***lte-CRS-PatternList3***. |

## [Closed] Proposed TPs

Many companies provide the TPs for support of two overlapping CRS patterns for Rel-18 DSS. Below are the summary of the TPs and views on the spec impacts.

[1, Huawei, HiSilicon]: Adopt the following TP in TS 38.214

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| **5.1.4.2 PDSCH resource mapping with RE level granularity**  The procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_2, by applying the parameters of *aperiodicZP-CSI-RS-ResourceSetsToAddModListDCI-1-2* instead of *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList*.  A UE may be configured with any of the following higher layer parameters:  *-* REs indicated by the '*RateMatchPatternLTE-CRS*'in *lte-CRS-ToMatchAround* in *ServingCellConfig* or *ServingCellConfigCommon* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.  *-* REs indicated by *'RateMatchPatternLTE-CRS'* in *lte-CRS-PatternList1-r16* in *ServingCellConfig* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.  - Each *RateMatchPatternLTE-CRS* configuration contains *v-Shift* consisting of LTE-CRS-vshift(s), *nrofCRS-Ports* consisting of LTE-CRS antenna ports 1, 2 or 4 ports, *carrierFreqDL* representing the offset in units of 15 kHz subcarriers from (reference) point A to the LTE carrier centre subcarrier location, *carrierBandwidthDL* representing the LTE carrier bandwidth, and may also configure *mbsfn-SubframeConfigList* representing MBSFN subframe configuration. A UE determines the CRS position within the slot according to Clause 6.10.1.2 in [15, TS 36.211], where slot corresponds to LTE subframe.  - If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:  - if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';  - otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.  - If the UE is not configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet*, and the UE is configured by higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, and the UE is configured by higher layer parameter *crs-RateMatch-enable-R18*, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig* are declared as not available for PDSCH.  […] |

[2, ZTE]: A text proposal for 38.214 is suggested as follows.

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| A UE may be configured with any of the following higher layer parameters:  *-* REs indicated by the '*RateMatchPatternLTE-CRS*'in *lte-CRS-ToMatchAround* in *ServingCellConfig* or *ServingCellConfigCommon* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.  *-* REs indicated by *'RateMatchPatternLTE-CRS'* in *lte-CRS-PatternList1-r16 and lte-CRS-PatternList2-r16 if provided* in *ServingCellConfig* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.  - Each *RateMatchPatternLTE-CRS* configuration contains *v-Shift* consisting of LTE-CRS-vshift(s), *nrofCRS-Ports* consisting of LTE-CRS antenna ports 1, 2 or 4 ports, *carrierFreqDL* representing the offset in units of 15 kHz subcarriers from (reference) point A to the LTE carrier centre subcarrier location, *carrierBandwidthDL* representing the LTE carrier bandwidth, and may also configure *mbsfn-SubframeConfigList* representing MBSFN subframe configuration. A UE determines the CRS position within the slot according to Clause 6.10.1.2 in [15, TS 36.211], where slot corresponds to LTE subframe.  - If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:  - if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';  - otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*. |

[5, InterDigital]: Text proposal to 38.214

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| 5.1.4.2 PDSCH resource mapping with RE level granularity  <omitted text>  A UE may be configured with any of the following higher layer parameters:  <omitted text>  - If the UE is configured by higher layer parameter [*twoOverlapping-LTE-CRS-r18*] or by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:  - if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';  - otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.  <omitted text> |

[6, xiaomi]: The mechanisms of allowing a single TRP UE to support, and be configured with, two overlapping CRS-RM patterns can be realized by current specification already.

[8, OPPO]: Adopt the following TS 38.214 text for Rel-18 DSS.

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| - If the UE is configured ~~by higher layer parameter~~ *~~PDCCH-Config~~* ~~with two different values of~~ *~~coresetPoolIndex~~* ~~in~~ *~~ControlResourceSet~~* ~~and is also configured~~ by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:  - if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';  - otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*. |

* Suggest RAN2 with following TS 38.331 text (relating to RRC parameter) for Rel-18 DSS.

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| ***lte-CRS-PatternList2***  A list of LTE CRS patterns around which the UE shall do rate matching for PDSCH scheduled with a DCI detected on a CORESET with CORESETPoolIndex configured with 1. ~~This list is configured only if CORESETPoolIndex configured with 1.~~ The first LTE CRS pattern in this list shall be fully overlapping in frequency with the first LTE CRS pattern in lte-CRS-PatternList1, The second LTE CRS pattern in this list shall be fully overlapping in frequency with the second LTE CRS pattern in lte-CRS-PatternList1, and so on. Network configures this field only if the field *lte-CRS-ToMatchAround* is not configured ~~and there is at least one ControlResourceSet in one DL BWP of this serving cell with~~ *~~coresetPoolIndex~~* ~~set to 1.~~ |

[9, Apple]: Agree on the proposed TP for UE supporting for two overlapping CRS rate matching patterns.

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| 5.1.4.2 PDSCH resource mapping with RE level granularity  …..  -   If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:  -    if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';  -    otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.  -   If the UE is configured by higher layer parameter *lte-CRS-PatternList1-r18* and/or *lte-CRS-PatternList2-r18* in *ServingCellConfig*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r18* and/or *lte-CRS-PatternList2-r18* are declared as not available for PDSCH.  …… |

[11, MediaTek]: Adopt following text proposal to support two overlapping CRS rate matching patterns regardless of support or configuration of multi-TRP

-------------------------------------------Start of TP for TS 38.214 Clause 5.1.4.2-------------------------------

5.1.4.2 PDSCH resource mapping with RE level granularity

-If the UE is configured ~~by higher layer parameter~~ *~~PDCCH-Config~~* ~~with two different values of~~ *~~coresetPoolIndex~~* ~~in~~ *~~ControlResourceSet~~* ~~and is also configured~~ by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:

- if the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';

- otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.

- Within a BWP, the UE can be configured with one or more ZP CSI-RS resource set configuration(s) for aperiodic, semi-persistent and periodic time-domain behaviours (higher layer parameters *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList,*  *sp-ZP-CSI-RS-ResourceSetsToAddModList* and *p-ZP-CSI-RS-ResourceSet* respectively comprised in *PDSCH-Config*), with each ZP CSI-RS resource set consisting of at most 16 ZP CSI-RS resources (higher layer parameter *ZP-CSI-RS-Resource*) in numerology of the BWP. The REs indicated by *p*

------------------------------------------------------------End of TP-------------------------------------------------------

--------------------------------------- start TP1 to 38.214 sub-clause 5.1.4.2 ----------------------------------

5.1.4.2 PDSCH resource mapping with RE level granularity

The procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_2, by applying the parameters of *aperiodicZP-CSI-RS-ResourceSetsToAddModListDCI-1-2* instead of *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList*. The procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_2, by applying the parameters of *aperiodicZP-CSI-RS-ResourceSetsToAddModList in PDSCH-Config-Multicast* instead of *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList in PDSCH-Config*.

A UE may be configured with any of the following higher layer parameters:

*-* REs indicated by the '*RateMatchPatternLTE-CRS*'in *lte-CRS-ToMatchAround* in *ServingCellConfig* or *ServingCellConfigCommon* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

*-* REs indicated by *'RateMatchPatternLTE-CRS'* in *lte-CRS-PatternList1-r16* in *ServingCellConfig* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

- For the UE in RRC\_IDLE and RRC\_INACTIVE modes for broadcast reception, REs indicated by *'RateMatchPatternLTE-CRS'* in *PDSCH-Config-MCCH* or *PDSCH-Config-MCCH* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

- Each *RateMatchPatternLTE-CRS* configuration contains *v-Shift* consisting of LTE-CRS-vshift(s), *nrofCRS-Ports* consisting of LTE-CRS antenna ports 1, 2 or 4 ports, *carrierFreqDL* representing the offset in units of 15 kHz subcarriers from (reference) point A to the LTE carrier centre subcarrier location, *carrierBandwidthDL* representing the LTE carrier bandwidth, and may also configure *mbsfn-SubframeConfigList* representing MBSFN subframe configuration. A UE determines the CRS position within the slot according to Clause 6.10.1.2 in [15, TS 36.211], where slot corresponds to LTE subframe.

- If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:

- if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';

- otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.

- If the UE is configured by higher layer parameter *lte-CRS-PatternList3-r18* in *ServingCellConfig*, REs indicated by *lte-CRS-PatternList3-r16* are declared as not available for PDSCH.

- Within a BWP, the UE can be configured with one or more ZP CSI-RS resource set configuration(s) for aperiodic, semi-persistent and periodic time-domain behaviours (higher layer parameters *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList,*  *sp-ZP-CSI-RS-ResourceSetsToAddModList* and *p-ZP-CSI-RS-ResourceSet* respectively comprised in *PDSCH-Config*), with each ZP CSI-RS resource set consisting of at most 16 ZP CSI-RS resources (higher layer parameter *ZP-CSI-RS-Resource*) in numerology of the BWP. The REs indicated by *p-ZP-CSI-RS-ResourceSet* are declared as not available for PDSCH. The REs indicated by *sp-ZP-CSI-RS-ResourceSetsToAddModList* and aperiodic-ZP-CSI-RS-ResourceSetsToAddModList are declared as not available for PDSCH when their triggering and activation are applied, respectively. The following parameters are configured via higher layer signaling for each ZP CSI-RS resource configuration:

- *zp-CSI-RS-ResourceId* in *ZP-CSI-RS-Resource* determines ZP CSI-RS resource configuration identity.

- *nrofPorts* in *CSI-RS-ResourceMapping* defines the number of CSI-RS ports, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

- *cdm-Type* in *CSI-RS-ResourceMapping* defines CDM values and pattern, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

- *resourceMapping* in *ZP-CSI-RS-Resource* defines the OFDM symbol and subcarrier occupancy of the ZP CSI-RS resource within a slot that are given in Clause 7.4.1.5 of [4, TS 38.211].

- *periodicityAndOffset* in*ZP-CSI-RS-Resource* defines the ZP-CSI-RS periodicity and slot offset for periodic/semi-persistent ZP CSI-RS.

<unchanged text omitted>

------------------------------------ end TP1 to 38.214 sub-clause 5.1.4.2 ----------------------------

Example field description to be included in 38.331 for the parameter *lte-CRS-PatternList3-r18* is shown below

|  |
| --- |
| *ServingCellConfig* field descriptions |
| <unchanged text omitted> |
| ***lte-CRS-PatternList1***  A list of LTE CRS patterns around which the UE shall do rate matching for PDSCH. The LTE CRS patterns in this list shall be non-overlapping in frequency. The network does not configure this field and *lte-CRS-ToMatchAround* simultaneously. |
| ***lte-CRS-PatternList2***  A list of LTE CRS patterns around which the UE shall do rate matching for PDSCH scheduled with a DCI detected on a CORESET with *CORESETPoolIndex* configured with 1. This list is configured only if *CORESETPoolIndex* configured with 1. The first LTE CRS pattern in this list shall be fully overlapping in frequency with the first LTE CRS pattern in *lte-CRS-PatternList1*, The second LTE CRS pattern in this list shall be fully overlapping in frequency with the second LTE CRS pattern in *lte-CRS-PatternList1*, and so on. Network configures this field only if the field *lte-CRS-ToMatchAround* is not configured and there is at least one *ControlResourceSet* in one DL BWP of this serving cell with *coresetPoolIndex* set to 1. |
| ***lte-CRS-PatternList3***  A list of LTE CRS patterns around which the UE shall do rate matching for PDSCH. The first LTE CRS pattern in this list shall be fully overlapping in frequency with the first LTE CRS pattern in lte-CRS-PatternList1, The second LTE CRS pattern in this list shall be fully overlapping in frequency with the second LTE CRS pattern in lte-CRS-PatternList1, and so on. Network configures this field only if the field *lte-CRS-PatternList1* is configured. |
| <unchanged text omitted> |

### First Round

==> FL suggests to discuss the TPs after concluding on the issues in Section 2.1 and Section 2.2.

## [Closed] Conjunction of the two objectives of the WID

[6, xiaomi] and [15, ZTE] provide their views on the conjunction of the two objectives of the WID under AI 9.9.2 and AI 9.9.3 respectively.

|  |
| --- |
| [6, xiaomi]: The behavior of NR PDCCH with two CRS-RM patterns needs to be clarified. |
| [15, ZTE]: If RAN1 would support PDCCH reception in symbols with LTE CRS REs when configured with two overlapping CRS rate matching patterns, the puncturing rules should be discussed.   * FFS whether the same puncturing rule is applied for all cases, i.e., single TRP, single-DCI based multi-TRP and multi-DCI based multi-TRP. |

==> FL suggests to discuss this after there is clear conclusion on support of PDCCH reception in symbols with LTE CRS REs. In addition, it seems more appropriate to be discussed under AI 9.9.1.

# Reference

1. R1-2203138 Discussion on UE support for two overlapping CRS rate matching patterns Huawei, HiSilicon
2. R1-2203211 Discussion on support of two overlapping CRS patterns for DSS ZTE
3. R1-2203345 Discussion on UE support for two overlapping CRS rate matching patterns Spreadtrum Communications
4. R1-2203582 Discussion on two overlapping CRS rate matching patterns vivo
5. R1-2203649 Supporting two overlapping CRS rate matching pattern InterDigital, Inc.
6. R1-2203835 Discussion on UE support for two overlapping CRS rate matching patterns xiaomi
7. R1-2203924 Two overlapping CRS rate matching patterns Samsung
8. R1-2204025 Discussion on UE support for two overlapping CRS rate matching patterns OPPO
9. R1-2204261 Disucssion on UE supporting for two overlapping CRS rate matching patterns Apple
10. R1-2204396 Discussion on LTE CRS rate matching pattern NTT DOCOMO, INC.
11. R1-2204710 Discussion on supporting two overlapping CRS rate matching pattern MediaTek Inc.
12. R1-2204824 Support for 2 overlapping CRS patterns Nokia, Nokia Shanghai Bell
13. R1-2204886 UE support for overlapping CRS rate matching patterns Ericsson
14. R1-2205050 UE support for two overlapping CRS rate-matching patterns Qualcomm Incorporated
15. R1-2204332 Discussion on PDCCH reception with two overlapping CRS patterns for DSS ZTE
16. R1-2204887 Other aspects related to DSS enhancements Ericsson

# Annex - Legacy specification and UE capability

---------------------------------------- TS 38.214 Clause 5.1.4.2 [3] start ----------------------------------------------------------

A UE may be configured with any of the following higher layer parameters:

*-* REs indicated by the '*RateMatchPatternLTE-CRS*'in *lte-CRS-ToMatchAround* in *ServingCellConfig* or *ServingCellConfigCommon* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

*-* REs indicated by *'RateMatchPatternLTE-CRS'* in *lte-CRS-PatternList1-r16* in *ServingCellConfig* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

- Each *RateMatchPatternLTE-CRS* configuration contains *v-Shift* consisting of LTE-CRS-vshift(s), *nrofCRS-Ports* consisting of LTE-CRS antenna ports 1, 2 or 4 ports, *carrierFreqDL* representing the offset in units of 15 kHz subcarriers from (reference) point A to the LTE carrier centre subcarrier location, *carrierBandwidthDL* representing the LTE carrier bandwidth, and may also configure *mbsfn-SubframeConfigList* representing MBSFN subframe configuration. A UE determines the CRS position within the slot according to Clause 6.10.1.2 in [15, TS 36.211], where slot corresponds to LTE subframe.

- If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:

- if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';

- otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.

-----------------------------------------TS 38.214 Clause 5.1.4.2 [3] end -----------------------------------------------------------

--------------------------------------------------TS 38.331 [4] start-------------------------------------------------------------------

ServingCellConfig ::= SEQUENCE {

…

lte-CRS-PatternList1-r16 SetupRelease { LTE-CRS-PatternList-r16 } OPTIONAL, -- Need M

lte-CRS-PatternList2-r16 SetupRelease { LTE-CRS-PatternList-r16 } OPTIONAL, -- Need M

…

|  |
| --- |
| ***lte-CRS-PatternList1***  A list of LTE CRS patterns around which the UE shall do rate matching for PDSCH. The LTE CRS patterns in this list shall be non-overlapping in frequency. The network does not configure this field and *lte-CRS-ToMatchAround* simultaneously. |
| ***lte-CRS-PatternList2***  A list of LTE CRS patterns around which the UE shall do rate matching for PDSCH scheduled with a DCI detected on a CORESET with CORESETPoolIndex configured with 1. This list is configured only if *CORESETPoolIndex* configured with 1. The first LTE CRS pattern in this list shall be fully overlapping in frequency with the first LTE CRS pattern in lte-CRS-PatternList1, The second LTE CRS pattern in this list shall be fully overlapping in frequency with the second LTE CRS pattern in lte-CRS-PatternList1, and so on. Network configures this field only if the field *lte-CRS-ToMatchAround* is not configured and there is at least one ControlResourceSet in one DL BWP of this serving cell with *coresetPoolIndex* set to 1. |

--------------------------------------------------TS 38.331 [4] end -------------------------------------------------------------------

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| 14-1 | Multiple LTE-CRS rate matching patterns | 1) Maximum number of LTE-CRS rate matching patterns in total within a NR carrier using 15 kHz SCS  2) Maximum number of LTE-CRS non-overlapping rate matching patterns within a NR carrier using 15 kHz SCS | 5-28 (Rate-matching around LTE CRS) | multipleRateMatchingEUTRA-CRS-r16 {  maxNumberPatterns-r16,  maxNumberNon-OverlapPatterns-r16} | BandNR | n/a | n/a (FR1 only) | For DSS  The number of the additional CRS rate matching patterns reported in Rel-16 is accounted in the total number of rate matching pattern reported by the UE for Rel-15 by using pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot and pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot  UE reporting component 1 for 14-1 also reports component 2.  Reporting of values of Component 1 larger than two is only applicable when reporting values of Component 2 larger than one. | Optional with capability signalling  Component 1:{2, 3, 4, 5, 6}  Component 2: {1, 2, 3} |
| 14-1a | Two LTE-CRS overlapping rate matching patterns within a part of NR carrier using 15 kHz overlapping with a LTE carrier | 1. Support of two LTE-CRS overlapping rate matching patterns within a part of NR carrier using 15 kHz SCS overlapping with a LTE carrier | 14-1 | overlapRateMatchingEUTRA-CRS-r16 | BandNR | n/a | n/a (FR1 only) | For DSS  The number of the additional CRS rate matching patterns reported in Rel-16 is accounted in the total number of rate matching pattern reported by the UE for Rel-15 by using pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot and pdsch-RE-MappingFR1-PerSymbol/pdsch-RE-MappingFR1-PerSlot | Optional with capability signaling |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 16-2a | Multi-DCI based multi-TRP | 1. The maximum number of CORESETs configured per BWP per cell in addition to CORESET 0  2. The maximum number of CORESETs configured per CORESETPoolIndex ( if CORESETPoolIndex is not configured, it is assumed CORESETPoolIndex = 0) per BWP per cell in addition to CORESET 0  3. Support fully/partially overlapping PDSCHs in time and non-overlapping in frequency  4. Maximum number of unicast PDSCHs per CORESETPoolIndex per slot |  | *multiDCI-MultiTRP-r16* | *FeatureSetDownlinkPerCC-v1620* | No | No | Note: A UE may assume that its maximum receive timing difference between the DL transmissions from two TRPs is within a CP  Note: Processing capability 2 is not supported in any CC if at least one CC is configured with two values of CORESETPoolIndex  Component 1: Candidate values {2,3,4,5} Note: 1. If UE reports value N1 for component 1, that means UE supports up to min (N1+1, 5) CORESETs in total (including CORESET#0) if there is CORESET#0, and supports maximal N1 CORESETs if there is no CORESET#0.  Component 2: Candidate values {1,2,3}  Note: If UE reports value N2 for component 2, that means UE supports up to min (N2+1, 3) CORESETs in total (including CORESET#0) for a TRP if there is CORESET#0, and supports maximal N2 CORESETs for another TRP if there is no CORESET#0.  Component 4: Candidate values {1,2,3,4,7}  Note: per SCS, similar with Rel-15 | Optional with capability signaling |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 16-2a-5 | Separate CRS rate matching | 1. Whether the UE can rate match around configured CRS patterns which is associated with CORESETPoolIndex (if configured) and are applied to the PDSCH scheduled with a DCI detected on a CORESET with the same value of CORESETPoolIndex | 16-2a and 14-1a | *separateCRS-RateMatching-r16* | *MIMO-ParametersPerBand* | No | FR1 only | Note: only applicable for 15kHz SCS | Optional with capability signalling |