**3GPP TSG-RAN WG4 Meeting # 108-bis R4-23XXXXX**

**Xiamen, China, October 09 – October 13, 2023**

**Agenda item:** 5.36.3

**Source:** Moderator (Ericsson)

**Title:** Topic summary for [108bis][328] NR\_DSS\_enh

**Document for:** Information

# Introduction

This topic summary lists the open issues on the UE demodulation performance part in Rel-18 WI Enhancement of NR Dynamic spectrum sharing (DSS).

# Topic #1: Work plan

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2315849 | Ericsson | Work plan proposal. |

## Open issues summary

### Sub-topic 1-1 Work plan for Rel-18 eDSS demodulation performance part

**Issue 1-1-1: Work plan proposal by rapporteur**

* Proposal (Rapporteur)

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| --- |
| **Target completion date:** June 2024.**RAN4#108bis (Oct 2023):*** Discussion on test scope, simulation assumptions and test parameters.

**RAN4#109 (Nov 2023):*** Finalize the test scope.
* Agree on part of baseline assumptions, test parameters and test metrics.

**RAN4#110 (Feb 2024):*** Agree on baseline assumptions, test parameters and test metrics.
* Collection of initial simulation results.
* CR work split (if necessary).

**RAN4#110bis (Apr 2024):*** Collection of updated & additional simulation results if any.
* Review draft CRs.

**RAN4#111 (May 2024):*** Agreement on the test requirement value.
* Endorse draft CRs.
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* Recommended WF
	+ Discuss the proposed work plan is agreeable or not.

# Topic #2: NR PDCCH reception in symbols with LTE CRS REs

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2315347 | Qualcomm Inc. | **Observation 1:** Performance of option 2 would be much worse compared to option 1.**Proposal 1:** Define NR PDCCH performance requirement for option 1 only with PDCCH channel estimation on the clean DMRS symbol.**Proposal 2:** Assume 2-symbol coreset for NR PDCCH configuration with option 1.**Proposal 3:** Do not define NR PDSCH performance requirement in Rel-18 DSS. |
| R4-2315488 | Apple | **Observation 1:** With legacy channel estimation there would be performance degradation with using the punctured DMRS REs.**Observation 2:** RAN1 has agreed to introduce candidate option (b) only if RAN4 doesn’t define requirements with legacy channel estimation.**Proposal 1:** Do not introduce PDCCH performance requirement with legacy channel estimation with one or more symbols of NR PDCCH overlapping with LTE CRS.**Proposal 2:** Further evaluate NR PDCCH performance for eDSS for NR PDCCH overlapping with LTE CRS, with PDCCH channel estimation on non-overlapped symbol.**Proposal 3:** Use configuration with LTE CRS on only 1 symbol - the 2nd symbol of the slot. NR PDCCH is transmitted on 2 symbols – the 2nd and 3rd symbol of the slot.**Observation 3:** It is not critical to verify UE performance with additional rate matching patterns.**Proposal 4:** Do not introduce PDSCH or PDCCH demodulation requirements with overlapping rate matching patterns configured. |
| R4-2315711 | ZTE Corporation | **Observation 1:** For LTE CRS with 2 CRS antenna ports doesn’t lead to any CRS collisions with the NR PDCCH. LTE CRS with 4 CRS antenna ports will lead to CRS collisions with the NR PDCCH for 1symbol or 2symbols.**Observation 2:** In order to make sure NR PDCCH in DSS scenario has a better performance, the following candidate options can be considered.* Option 1: Advanced receiver
* Option 2: Puncturing
* Option 3: Rate matching

**Proposal 1:** Considering following typical scenarios for RAN4 perspective,* 4-port LTE CRS
* LTE PDCCH/ PCFICH occupied symbol #0
* NR PDCCH occupied symbol#1 or symbol#1 and symbol#2

**Proposal 2:** From RAN4 perspective, following scenarios can be considered for DSS.* Scenario 1: On the OFDM symbol (i.e. symbol#1) colliding with LTE-CRS, only one PDCCH DMRS RE and three PDCCH resource REs colliding with LTE-CRS.
* Scenario 2: On the OFDM symbols (i.e. symbol#1, symbol#2) colliding with LTE-CRS, only one PDCCH DMRS RE and four DMRS RE colliding with LTE-CRS, additional PDCCH symbol#2 not colliding with LTE-RS.
 |
| R4-2315850 | Ericsson | **Observation 1:** More resource available for NR PDCCH in this 2-symbol CORESET scenario, compared to 1-symbol scenario.**Proposal 1:** Introduce NR PDCCH demodulation requirements for 2-symbol CORESET with multiple non-overlapping rate matching patterns scenario.**Observation 2:** UE can report its capability on the support of the reception of 2 overlapping rate matching patterns regardless of support or configuration of multi-TRP in Rel-18**Proposal 2:** Introduce PDSCH demodulation requirements for two overlapping LTE CRS rate matching patterns scenario.**Proposal 3:** Consider table 2.3-1 for PDCCH parameter assumptions.**Proposal 4:** Consider table 2.3-2 for PDCCH test cases.**Proposal 5:** Consider table 2.3-3 for PDSCH parameter assumptions.**Proposal 6:** Consider table 2.3-4 for PDSCH test cases. |
| R4-2315989 | Huawei, HiSilicon | **Proposal 1:** RAN4 to define following demodulation requirements:* PDCCH overlapping with LTE CRS
* PDSCH with two overlapping CRS rate-matching patterns configured

**Proposal 2:** RAN4 to define following test setup and receiver assumption:* Transmission side: TE puncture the PDCCH data and DMRS REs overlapped with LTE CRS
* Receiver side: UE set the LLR corresponding to CRS REs to zero

**Proposal 3:** RAN4 to evaluate performance of following scenarios* Scenario a): At least one PDCCH symbol is not overlapped with LTE CRS.
* Scenario b): All PDCCH symbols are overlapped with LTE CRS

**Proposal 4:** RAN4 to define the performance requirements at least for scenario a). Regarding scenario b):* If the performance difference between scenario a) and scenario b) is acceptable, RAN4 will not define the requirements of b) and inform RAN1 that such capability is suggested to be introduced, otherwise, RAN4 to inform RAN1 that performance of value b) is unacceptable and such capability is suggested to be dropped.

**Proposal 5:** RAN4 to consider following channel estimation methods* Scenario a): Time domain: Use clean symbol; Frequency domain: regular DMRS pattern
* Scenario b): Time domain: Legacy channel estimation ; Frequency domain: regular DMRS pattern

**Proposal 6:** Don’t define requirements for NR PDCCH overlapping with multiple non-overlapping CRS rate matching patterns**Proposal 7:** Don’t consider the scenario that PDCCH and CRS are overlapped on the 1st symbol.**Proposal 8:** Consider following CORESET configuration:* Scenario a): CORESET: 2nd and 3rd symbols, LTE: 4 CRS Ports
* Scenario b): CORESET: 2nd symbol, LTE: 4 CRS Ports

**Proposal 9:** RAN4 to cover all PDCCH Aggregation levels for evaluation purpose. (Not for requirements definition purpose)**Observation 1:** For scenario b), the target SNR can’t be achieved for AL1 and 2, for AL4,6,8, there 1.9dB~3.3dB performance degradation compared to scenario a)**Proposal 10:** Take parameters listed in Table 5-1 as baseline for evaluation.**Proposal 11:** Use test parameters listed in Table 2-2 to 2-4 to define PDSCH requirements |
| R4-2316470 | MediaTek Inc. | **Observation 1:** There are some other existing methods enabling NR PDCCH capacity for DSS:* UE supporting FG 3-2, or FG22-12 to support monitoring PDCCH within the first 4 symbols
* Rel-17 SCell PDCCH scheduling P(S)Cell PDSCH/PUSCH

**Observation 2:** The new feature for NR PDCCH reception in symbols with LTE CRS REs is introduced in Rel-18. It is doubtful that there is a demand for DSS when Rel-18 UE can be widely adopted.**Proposal 1:** Do not introduce requirements for NR PDCCH reception in symbols with LTE CRS REs.**Observation 3:** According to RAN1’s agreements on PDCCH-DMRS channel estimation, RAN4 should not define requirements with “legacy CE assumption” when PDCCH candidates overlap with LTE CRS REs.**Observation 4:** For both 52-1a and 52-1b, there are more than one prerequisite feature groups.**Proposal 2:** If RAN4 agrees to define requirements for NR PDCCH reception in symbols with LTE CRS REs, do not introduce requirements for UE supporting FG 52-1a or FG 52-1b. **Observation 5:** RAN4 should not define requirements when UE supports “b) when some or all of symbols of NR PDCCH candidate overlap with LTE CRS” in component 2 of FG52-1.**Observation 6:** Based on observation 3 and 5, RAN4 can only consider “a) when at least one symbol of the NR PDCCH candidate is not overlapped with LTE CRS” when discussing whether to introduce requirements for NR PDCCH reception in symbols with LTE CRS REs.**Observation 7:** LTE PHICH/PCFICH and LTE-PDCCH are typical transmitted in the 1st symbol and therefore it would not be able to accommodate NR PDCCH. Therefore, support of NR PDCCH overlapping LTE CRS only on 2nd symbol is the most likely scenario. **Proposal 3:** If RAN4 agrees to define requirements for NR PDCCH reception in symbols with LTE CRS REs, RAN4 should only consider the scenario where one clean NR PDCCH symbol on symbol#2 and one NR PDCCH overlapping with LTE CRS on symbol#1.**Observation 8:** There is no other new UE behaviour except rate matching for UE supporting two overlapping CRS rate matching patterns regardless of support or configuration of multi-TRP. **Proposal 4:** Do not introduce UE demodulation requirements for UE supporting two overlapping CRS rate matching patterns. |
| R4-2316639 | Nokia, Nokia Shanghai Bell | **Proposal 1:** RAN4 to limit the scope of UE demodulation performance part to only cover PDCCH.**Proposal 2:** RAN4 to discuss and select UE channel estimation scheme and gNB Tx scheme to be used in defining the requirements.**Proposal 3:** RAN4 to discuss whether to have requirements for either puncturing or superpositioning, or both, under the selected UE channel estimation scheme and gNB Tx scheme.**Proposal 4:** RAN4 to prioritize defining requirements with an assumption of no interference from neighboring LTE cells, hence, no consideration on two overlapping CRS rate matching. |
| R4-2316640 | Nokia, Nokia Shanghai Bell | **Proposal 1:** For NR eDSS, RAN4 do not need to define UE demodulation requirements for PDSCH and PBCH, and CSI requirements.**Observation 1:** Realistic scenario is needed to evaluate PDCCH demodulation performance in NR eDSS.**Proposal 2:** RAN4 to define realistic scenario for evaluation with 4-port LTE CRS, 2-symbol CORESET and SS start in symbol#1 can be considered as a baseline scenario. |

## Open issues summary

### Sub-topic 2-1 PDCCH demodulation requirements

**Issue 2-1-1: Whether to define PDCCH demodulation requirements for Rel-18 eDSS feature**

* Proposals
	+ Option 1 (Qualcomm, ZTE, Ericsson, Huawei, Nokia): Define PDCCH demodulation requirements for eDSS
	+ Option 2 (Apple): Further evaluate PDCCH demodulation performance for eDSS
	+ Option 3 (MediaTek): Not define PDCCH demodulation requirements for eDSS
* Recommended WF
	+ In the high level, most companies agree to define/evaluate PDCCH demodulation requirements for Rel-18 eDSS.
	+ Moderator recommend defining/evaluating PDCCH demodulation requirements for Rel-18 eDSS feature. The detailed test setup will be discussed in the following issues.

**Issue 2-1-2: Evaluation scenario**

* Proposals
	+ Option 1 (ZTE, Huawei): 1-symbol CORESET

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| --- |
| **Symbol #0:** LTE PDCCH/PCFICH**Symbol #1:** NR PDCCH overlapping with LTE CRS |

* + Option 2 (Qualcomm, Apple, ZTE, Ericsson, Huawei, MediaTek, Nokia): 2-symbol CORESET
		- Option 2a (Huawei): If performance difference between Option 1 and Option 2 is acceptable, RAN4 will not define the requirements of Option 1 and inform RAN1 that such capability is suggested to be introduced, otherwise, RAN4 to inform RAN1 that performance of value Option 1 is unacceptable and such capability is suggested to be dropped.

|  |
| --- |
| **Symbol #0:** LTE PDCCH/PCFICH**Symbol #1:** NR PDCCH overlapping with LTE CRS**Symbol #2:** NR PDCCH |

* + Common assumption
		- Single non-overlapping CRS rate matching patterns for PDCCH demodulation.
		- 4 CRS ports for LTE
		- LTE PDCCH/PCFICH is transmitted in symbol #0

|  |  |
| --- | --- |
|  |  |
| Option 1 - 1-symbol CORESET (Ref: R4-2315711) | Option 2 - 2-symbol CORESET (Ref: R4-2315711) |

* Recommended WF
	+ All the companies propose to define/evaluate PDCCH demodulation performance with scenario Option 2 (2-symbol CORESET). Some companies are also interested in scenario Option 1 (1-symbol CORESET) addressing the Note in FG 52-1
	+ Moderator recommends defining/evaluating PDCCH demodulation performance with scenario Option 2 at least and discussing whether to define/evaluate PDCCH demodulation performance with scenario Option 1.

**Issue 2-1-3: gNB assumption for PDCCH symbols overlapped with LTE CRS**

* Proposals
	+ Option 1 (Huawei):
		- PDCCH data is punctured.
		- PDCCH DMRS REs overlapped with LTE CRS
	+ Option 2 (Nokia):
		- Discuss whether to have requirements for either puncturing or superpositioning, or both, under the selected UE channel estimation scheme and gNB Tx scheme.
* Recommended WF
	+ PDCCH symbols overlapped with LTE CRS are punctured.
	+ Discuss further PDCCH-DMRS symbols are punctured and/or overlapped.

**Issue 2-1-4: UE receiver assumption (e.g., channel estimation)**

* Proposals
	+ Option 1 (Qualcomm): Define NR PDCCH performance requirement for option 1 only with PDCCH channel estimation on the clean DMRS symbol.
	+ Option 2 (Apple): Further evaluate NR PDCCH performance for eDSS for NR PDCCH overlapping with LTE CRS, with PDCCH channel estimation on non-overlapped symbol.
	+ Option 3 (Huawei): UE set the LLR corresponding to CRS REs to zero
		- For scenario Option 2: Time domain: Use clean symbol; Frequency domain: regular DMRS pattern
		- For scenario Option 1: Time domain: Legacy channel estimation; Frequency domain: regular DMRS pattern
	+ Option 4 (Nokia): Discuss and select UE channel estimation scheme
* Recommended WF
	+ Discuss options.

**Issue 2-1-5: Simulation assumption for evaluation**

* Proposals
	+ Option 1 (Ericsson):

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| --- | --- |
| Parameters | Values |
| Carrier frequency | 2 GHz |
| SCS | 15 kHz  |
| Bandwidth  | 10 MHz |
| Channel model | TDLC300-100 |
| Antenna configuration | 1x2, 1x4; 2x2, 2x4 |
| CRS  | 4 port CRS without power boosted |
| DCI payload (excluding CRC) | 60 bits |
| Interleaving | Non-interleaved |
| Precoding | Precoder cycling per REG bundle |
| REG bundle size | 6 REGs |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Test number | Bandwidth (MHz) | Symbols with PDCCH | Aggregation level | Propagation Condition | Antenna configuration and correlation Matrix | Reference value |
| Pm-dsg (%) | SNR (dB) |
| 1 | 10 | 2 | 4 | TDLA30-10 | 1x2, 1x4 Low | 1 |  |
| 2 | 10 | 2 | 8 | TDLC300-100 | 2x2, 2x4 Low | 1 |  |

* + Option 2 (Huawei):
		- Cover all PDCCH Aggregation levels for evaluation purpose. (Not for requirements definition purpose)

|  |  |
| --- | --- |
| Parameters | Values |
| Carrier frequency | 2 GHz |
| SCS | 15 kHz  |
| Bandwidth  | 20MHz |
| LTE Bandwidth  | 20MHz |
| Channel model | TDL-C 300-100 |
| Correlation | Low |
| Number of BS antennas | 4Tx |
| Number of UE antennas | 2 Rx |
| DCI payload (excluding CRC) | 60 bits |
| Interleaving | Non-Interleaved |
| Precoding | Precoder cycling per REG bundle |
| REG bundle size | 6 PRBs |
| CRS | single 4 port CRS pattern |
| Aggregation level | 1,2,4,8,16 |
| CORESET  | Scenario a): CORESET: 2nd and 3rd symbols, LTE: 4 CRS PortsScenario b): CORESET: 2nd symbol, LTE: 4 CRS Ports |
| Channel estimation | Scenario a): Use clean symbolScenario b): Use legacy channel estimation |
| Transmitter | DMRS REs and data REs overlapped with CRS are punctured |
| Receiver | Puncture the CRS REs |
| Power ratio of LTE-CRS RE/NR PDCCH-DMRS RE | 3dB |

* Recommended WF
	+ Discuss further considering the conclusion on Issues 2-1-1 to 2-1-4.

# Topic #3: PDSCH demodulation requirements with two overlapping CRS rate matching patterns

## Companies’ contributions summary

See 2.1.

## Open issues summary

### Sub-topic 3-1 PDSCH demodulation requirements

**Issue 3-1-1: Whether to define the PDSCH demodulation requirements with two overlapping CRS rate matching patterns**

* Proposals
	+ Option 1 (Ericsson, Huawei): Define the PDSCH requirements.
	+ Option 2 (Qualcomm, Apple, MediaTek, Nokia): Not define PDSCH demodulation requirements.
		- Option 2a (Nokia): Not define BPCH and CSI requirements also.
		- RAN4 has already defined PDSCH demodulation requirements with one CRS rate matching pattern. No additional UE behaviors even by adding one more pattern.
* Recommended WF
	+ Discuss whether to define PDSCH demodulation requirements with two overlapping CRS rate matching patterns.

**Issue 3-1-2: Test parameters for PDSCH demodulation requirements (if agreed).**

* Proposals
	+ Option 1 (Ericsson):

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| --- | --- | --- | --- | --- | --- | --- |
| Test num. | Reference channel | Bandwidth (MHz) / Subcarrier spacing (kHz) | Modulation format and code rate | Propagation condition | Correlation matrix and antenna configuration | Reference value |
|  |  |  |  |  |  | Fraction of maximum throughput (%) | SNR (dB) |
| Rank 2 |
| 1 | R.PDSCH.1-3.1 FDD | 10 / 15 | 64QAM, 0.50 | TDLA30-10 | 2x2, 2x4, ULA Low | 70 |  |

* + Option 2 (Huawei):
		- Table 2-3: Proposed test cases for PDSCH TDD requirements

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **TDD UL-DL pattern** | **Propagation condition**  | **Correlation matrix and antenna configuration** | **Reference value** |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-1.1 TDD | 10 / 15 | QPSK, 0.30 | FR1.15-1 | TDLA30-10 | 4x2, ULA Low | 70 | TBD |
| 1-2 | R.PDSCH.1-1.2 TDD | 10 / 15 | QPSK, 0.30 | FR1.15-1 | TDLA30-10 | 4x2, ULA Low | 70 | TBD |

* + - Table 2-4: Proposed test cases for PDSCH FDD requirements

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| --- | --- | --- | --- | --- | --- | --- |
| **Test num.** | **Reference channel** | **Bandwidth (MHz) / Subcarrier spacing (kHz)** | **Modulation format and code rate** | **Propagation condition**  | **Correlation matrix and antenna configuration** | **Reference value** |
| **Fraction of maximum throughput (%)** | **SNR (dB)** |
| 1-1 | R.PDSCH.1-7.1 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 4x2, ULA Low | 70 | TBD |
| 1-2 | R.PDSCH.1-7.2 FDD | 10 / 15 | QPSK, 0.30 | TDLA30-10 | 4x2, ULA Low | 70 | TBD |

* Recommended WF
	+ Depends on the conclusion of Issue 3-1-1.

# Appendix

## RAN1 feature list on Rel-18 eDSS (R4-2315006)

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Features | Index | Feature group | Components | Prerequisite feature groups | Need for the gNB to know if the feature is supported | Applicable to the capability signalling exchange between UEs (Sidelink WI only)”. | Consequence if the feature is not supported by the UE | Type(the ‘type’ definition from UE features should be based on the granularity of 1) Per UE or 2) Per Band or 3) Per BC or 4) Per FS or 5) Per FSPC) | Need of FDD/TDD differentiation | Need of FR1/FR2 differentiation | Capability interpretation for mixture of FDD/TDD and/or FR1/FR2 | Note | Mandatory/Optional |
| 52. NR\_DSS\_enh | 52-1 | Reception of NR PDCCH candidates overlapping with LTE CRS REs | Reception of NR PDCCH candidates that overlap with LTE CRS REs within a NR carrier using 15 kHz SCS1) Reception of NR PDCCH candidates in REs that overlap with LTE CRS when UE is provided with LTE CRS RM pattern by configuration of one CRS rate matching pattern via lte-CRS-ToMatchAround2) Reception of a NR PDCCH candidate in REs that overlap with LTE CRS: candidate value set {a) when at least one symbol of the NR PDCCH candidate is not overlapped with LTE CRS, b) when some or all of symbols of NR PDCCH candidate overlap with LTE CRS}3) Reception of NR PDCCH candidates that overlap with LTE CRS REs on the X-th symbols of an NR slot. Candidate values for X: {only 2nd symbol, 1st and 2nd symbols}4) NR PDCCH that overlaps with LTE CRS REs is in Type-1 CSS with dedicated RRC configuration, Type-3 CSS, and/or USS that are monitored within the first 3 OFDM symbols of a slot | 5-28 | Yes | N/A | UE is not required to support reception of NR PDCCH candidates overlapping with LTE CRS REs when it is provided with LTE CRS RM pattern by higher layers  | Per Band | N/A | N/A | N/A | For component 2, RAN1 considers support value b) in component 2 only if RAN4 performance requirements for value b) are not definedNote: it is RAN1 understanding that the feature is supported by UE performing channel estimation with a regular legacy DMRS pattern in frequency dimension, i.e., no change to UE assumption on PDCCH DMRS RE positions/pattern in a symbol that are used for the purpose of channel estimation. | Optional with capability signaling |
| 52. NR\_DSS\_enh | 52-1a | Reception of NR PDCCH candidates overlapping with LTE CRS REs with multiple non-overlapping CRS rate matching patterns | 1) Reception of NR PDCCH candidates in REs that overlap with LTE CRS when UE is provided with LTE CRS RM patterns by configuration of one or multiple non-overlapping CRS rate matching patterns via lte-CRS-PatternList1-r16 if the UE supports FG 14-1 or lte-CRS-PatternList3-r18 if the UE supports FG 52-2 | 52-1, at least one of {14-1, 52-2} | Yes | N/A |  | Per Band | N/A | N/A | N/A | Note: it is RAN1 understanding that the feature is supported by UE performing channel estimation with a regular legacy DMRS pattern in frequency dimension, i.e., no change to UE assumption on PDCCH DMRS RE positions/pattern in a symbol that are used for the purpose of channel estimation. | Optional with capability signaling |
| 52. NR\_DSS\_enh | 52-1b | NR PDCCH reception that overlaps with LTE CRS within a single span of 3 consecutive OFDM symbols that is within the first 4 OFDM symbols in a slot | 1) NR PDCCH that overlaps with LTE CRS REs is in Type-1 CSS with dedicated RRC configuration, Type-3 CSS, and/or USS that are monitored within a single span of 3 consecutive OFDM symbols that is within the first 4 OFDM symbols in a slot | 52-1, 22-12 | Yes | N/A |  | Per Band | N/A | N/A | N/A |  | Optional with capability signaling |
| 52. NR\_DSS\_enh | 52-2 | Two LTE-CRS overlapping rate matching patterns within a part of NR carrier using 15 kHz overlapping with a LTE carrier (regardless of support or configuration of multi-TRP) | 1) Support of two LTE-CRS overlapping rate matching patterns configured by lte-CRS-PatternList3-r18 and lte-CRS-PatternList4-r18 within a part of NR carrier using 15 kHz overlapping with a LTE carrier (regardless of support or configuration of multi-TRP) for the case when crs-RateMatchPerCoresetPoolIndex is not configured2) Maximum number of LTE-CRS rate matching patterns in total within a NR carrier using 15 kHz SCS: {2,3,4,5,6}3) Maximum number of LTE-CRS non-overlapping rate matching patterns within a NR carrier using 15 kHz SCS: {1,2,3} | 5-28 | Yes | N/A |  UE does not support two LTE-CRS overlapping rate matching patterns configured by lte-CRS-PatternList3-r18 and lte-CRS-PatternList4-r18 within a part of NR carrier using 15 kHz overlapping with a LTE carrier | Per Band | N/A | FR1 only | N/A |  If a UE supports FG52-2 and FG14-1, FG14-1 is reported for list1/2 and FG52-2 is reported for list3/4 | Optional with capability singaling |
| 52. NR\_DSS\_enh | 52-2a | Two LTE-CRS overlapping rate matching patterns with two different values of coresetPoolIndex within a part of NR carrier using 15 kHz overlapping with a LTE carrier | Support of two LTE-CRS overlapping rate matching patterns configured by lte-CRS-PatternList3-r18 and lte-CRS-PatternList4-r18 with two different values of coresetPoolIndex within a part of NR carrier using 15 kHz overlapping with a LTE carrier for the case when crs-RateMatchPerCoresetPoolIndex is configured | 52-2, 16-2a | Yes | N/A |  | Per Band | N/A | FR1 only | N/A |  | Optional with capability singaling |