**3GPP TSG-RAN WG4 Meeting #102-e R4-22xxxxx**

**Electronic Meeting, 21st Feb – 3rd Mar, 2022**

**Title:** WF on demodulation requirement for Enhancement on Multi-TRP

**Source:** Huawei, HiSilicon

**Agenda item:** 10.19.4

**Document for:** Approval

# Introduction

This WF capture all agreements and open issues for the following topics in [102-e][330] NR\_FeMIMO\_Demod.

* Topic #1: Demodulation requirement for Multi-TRP enhancement
  + Sub-topic #1-1 Test Scope
  + Sub-topic #1-2 Test setup for PDCCH requirement
  + Sub-topic #1-3 Test setup for PDSCH requirement

The agreed WFs on demodulation requirement for Enhancement on Multi-TRP in previous meeting is listed as following.

* R4-2203092, RAN4#101bis-e

# Topic #1: Demodulation requirement for Multi-TRP enhancement

## Sub-topic #1-1 Test Scope

**Issue 1-1-1: Whether to define PDCCH requirement for multi-TRP repetition transmission schemes**

*Candidate options:*

* Observations
  + Observation 1(Huawei): There is a great gain by performing soft-combining for non-SFN PDCCH enhancement.
* Proposals
  + Option 1(Ericsson, Samsung, Huawei, Intel): Yes
  + Option 2 (Apple, Qualcomm, MTK): No

*Recommendations for 2nd round:*

* Comments are encouraged if any
* Encourage companies to check whether there is difference receiver processing with PDCCH without repetition
* From performance gain and receiver processing, encourage companies to check can go option 1 to save progress

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| **Company** | **Comments** |
| Huawei | We prefer Option 1. There is different receiver processing comparing to the normal PDCCH, also there is a great gain observed based on our simulation. We don’t think the performance under multi-TRP repetition transmission scheme can be ensured without defining corresponding performance requirements.  This case is different from the enhanced HST scenario. In HST scenario, we can assume PDCCH performance can be ensured by PDSCH since we have PDSCH test cases and PDCCH is configured with same transmission scheme as PDSCH. However, we don’t have such test case to verify PDCCH processing under multi-TRP repetition transmission scheme.  Could proponent of Option 2 clarify how to ensure the PDCCH performance under multi-TRP repetition transmission scheme if we don’t define such cases? |
| Samsung | We support option 1,  Compared with PDCCH without repetition, we have observed that there is different processing, which need repetition combination. Similar with Rel-16, PDSCH with multi-TRP transmission, it is necessary to define the related requirement to verify the PDCCH performance  From performance gain aspect, as mentioned by Huawei, a clear gain can be obtained. We agreed that PDCCH may be not the limited factor for Downlink, while from receiver aspect, we do see the difference |
| Apple | We support option 2. Given the time for completion of performance part, we can de-prioritize this. We agree that there will be gain with this and it is different UE processing to support this feature. PDCCH is not the limiting factor for DL anyway, so its not critical to define these requirements. UE might not support this feature, but support other mTRP schemes with PDSCH, then network would not use this feature, but other methods like higher AL to improve PDCCH reliability |
| Intel | Similar view a Huawei and Samsung. Support Option 1. |
| Ericsson | We support option 1. PDCCH enhancement for multi-TRP is one of the main enhancements for FeMIMO in Rel-17. The way of soft combining of two PDCCH from different TRPs is quite different in comparison to single TRP PDCCH reception. It is worthy to verify and defining requirement. |
| Qualcomm | Option 2. We prefer not to define m-TRP PDCCH requirement.  We agree that repeated PDCCH for m-TRP scheme would provide performance benefit as there are various ways to make use of the repeated PDCCH. However, the operating SNR for PDCCH is already quite low and is known not to be a performance bottleneck. Furthermore, given the limited WI time budget, we think that we should not spend our effort defining PDCCH requirement for m-TRP. |
| Mediatek | We support Option 2. We share similar view to comments from Apple and Qualcomm. |

**Issue 1-1-2: Whether to define PDSCH requirement to verify whether UE is with proper behaviour of rate matching around the two linked PDCCH.**

*Candidate options:*

* Proposals
  + Option 1(Huawei): Yes
  + Option 2 (Apple, Ericsson, Intel, Qualcomm, MTK, Huawei (Compromise), Samsung): No

*Tentative agreements:*

* No PDSCH requirement defined with rate matching around two linked PDCCH

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| **Company** | **Comments** |
| Samsung | We are fine with tentative agreement made in 1st round |
| Apple | Fine with tentative agreements from round1. |
| Intel | Support the tentative agreement. |
| Ericsson | Agree with tentative agreements. |
| Qualcomm | Okay with the tentative agreement |
| Mediatek | We are fine with the tentative agreement. |

**Issue 1-1-3: Whether to define PDSCH requirement for Multi-TRP inter-cell operation**

*Candidate options:*

* Proposals
  + Option 1(Samsung, Huawei): Yes
    - Option 1a(Samsung) : Introduce test applicable rule between existing Multi-DCI intra-cell M-TRP test case and new test case for inter-cell Multi-DCI PDSCH
    - Option 1b (Huawei): Define performance requirement for enhancements on multi-TRP inter-cell operation with full-overlapping resource allocation.
  + Option 2 (Apple, Ericsson, Intel, MTK, Qualcomm): No
    - Option 2a(Intel) : Define applicability for UE that supports “IntCell-Mtrp” feature that if such UE satisfied Rel-16 minimum requirements for PDSCH multi-DCI based transmission scheme, inter-cell operation can be also guaranteed

*Recommendations for 2nd round:*

* Comments are encouraged if any
* Encourage companies to check how can guarantee the test coverage with different deployment scenario, considering UE supported inter-cell multi-TRP and intra-cell multi-TRP belong difference UE capability in Rel-16 and Rel-17?

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| **Company** | **Comments** |
| Huawei | We prefer Option 1b to define inter-cell multi-TRP cases with full-overlapping resource allocation to improve UE performance especially when UE is at the edge of two TRPs. |
| Samsung | We support option 1.  We would like to highlight intra-cell and inter-cell multi-TRP are different deployment scenario. UE support intra-cell or inter-cell multi-TRP are belong to UE feature with optional with capability signaling  We agree that from baseband processing, there is no different foreseen. While from test coverage aspect, how can guarantee the test coverage with different deployment scenario, considering UE supported inter-cell multi-TRP and intra-cell multi-TRP belong difference UE capability in Rel-16 and Rel-17, if UE only supported inter-cell multi-TRP  Our intention is to reuse the test parameters in Rel-16 and apply the existing requirement for UE supported inter-cell multi-TRP, and there is no additional simulation effort. Meanwhile, we can introduce the test applicable rule, if UE supported both intra-cell multi-TRP and inter-cell multi-TRP, to reduce the test effort. |
| Apple | We support option 2. We are not entirely sure if same requirements will apply as existing mDCI mTRP requirements in Rel-16. |
| Intel | For non-overlapped allocation we support Option 2a. We can agree on Option 2 and further discuss necessity of applicability rule. For overlapped allocation, we are fine with Option 1b also due to lack this requirement in Rel-16. However, considering limited time in Rel-17 we are also fine to discuss this in next release. |
| Ericsson | We can consider to compromise to option 2a to have applicability rule and no requirement albeit an first preference on option 2. Since we expect the test setup, e.g. channel model, is same, we don’t think it is needed to add the dedicated requirements and to verify the same baseband processing. |
| Qualcomm | Option 2. We don’t foresee UE demod processing to be different between Rel-16 multi-DCI and Rel-17 m-TRP inter-cell transmission. Therefore, we prefer not to define any PDSCH requirement m-TRP inter-cell transmission. |
| Mediatek | We support Option 2. |

## Sub-topic #1-2 Test setup for PDCCH requirement

**Issue 1-2-1: Multi-TRP repetition transmission schemes for PDCCH requirements if introduced**

*Candidate options:*

* Proposals
  + Option 1(Intel, Ericsson, Apple, Qualcomm, MTK, Samsung): only with FDM repetition in FR1
  + Option 2(Huawei): Both FDM with intra-slot repetition and TDM with intra-slot repetition in FR1

*Recommendations for 2nd round:*

* Encourage the proponent of option 2 to check whether option 1 can be acceptable based on majority view?

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| **Company** | **Comments** |
| Huawei | We can compromise to Option 1. |
| Samsung | Thanks for Huawei compromise |
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**Issue 1-2-2: Simulation Assumption for PDCCH with FDM repetition scheme if introduced**

*Candidate options:*

* Proposals
  + Option 1(WF in last meeting, MTK):

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| Parameter | Value | | |
| FDD 15 kHz SCS | | TDD 30 kHz SCS |
| CBW | 10 MHz | | 40 MHz |
| Antenna configuration | 2x2; 2x4 (2Tx for each TRP) | | |
| CORESET RB | 24 | 48 | |
| CORESET Duration | 2 | | |
| Aggregation level | 4, 8 | | |
| CCE-REG mapping | Non-interleaved | | |
| REG bundle size | 6 | | |
| Propagation conditions | TDLA30-10 | | |
| Test metric | SNR @1% Probability of missed downlink scheduling grant | | |

* + Option 2(Huawei): Permutation and combination can be used to reduce the test efforts, such as FDM for AL2 and TDM for AL8

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| Parameter | Value | |
| Test 1 | Test 2 |
| Repetition transmission schemes | FDM | TDM |
| CBW | 10MHz for FDD15kHz SCS and 40MHz for TDD30kHz SCS | |
| CORESET RB | 24 for FDD15kHz SCS and 48 for TDD15kHz SCS | |
| CORESET duration | 2 | |
| Aggregation level | 2 | 8 |
| Propagation Condition | TDLA30-10 | TDLC300-100 |
| Antenna configuration | 1x2 and 1x4 | 2x2 and 2x4 |
| CCE to REG mapping type | nonInterleaved | |
| REG bundle size | 6 | |
| Test metric | 1% of Pm-dsg (%) | |

* + Option 3(Ericsson): Parameter configurations from previous test cases can be considered as baseline with necessary adaptations (if needed).
  + Option 4(Apple, Ericsson): AL should be chosen based on simulation results and operation SNR>-4Db with 4Rx

*Recommendations for 2nd round:*



* Companies are encouraged to provide the simulation results with different AL as {2, 4, 8} with 2x2, and 2x4 antenna configuration in the next meeting with FDM, down selection one of AL under condition of operation SNR>-4dB with 4Rx for PDCCH requirement.

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| **Parameter** | **Value** | |
| **FDD 15 kHz SCS** | **TDD 30 kHz SCS** |
| Repetition transmission schemes | FDM | |
| CBW | 10 MHz | 40 MHz |
| CORESET RB | 24 | 48 |
| CORESET duration | 2 | |
| Aggregation level | 2/4/8 | |
| Propagation Condition | TDLA30-10 | |
| Antenna configuration | 2x2, 2x4 | |
| CCE to REG mapping type | nonInterleaved | |
| REG bundle size | 6 | |
| Payload bits(without CRC) | 39/52 | 41/53 |
| Test metric | 1% of Pm-dsg (%) | |

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| **Company** | **Comments** |
| Huawei | For the payload size, 39/52 bits for FDD and 41/53 bits for TDD are for Rel-15 PDCCH requirements definition. We prefer to use same payloads for further evaluation. |
| Samsung | Thanks for compromise of Huawei, we can focus on the test parameters of FDM only  Regarding the AL, to reduce the test effort, it seems we can skip AL as 8. Based on current requirement of AL=8, for 4Rx, the SNR is -4.5dB targeting 1% of pm-dsg. And also AL=4, and FDM operation, it is expected the SNR is around -4dB. We can reduce the test effort in the next meeting   * Companies are encouraged to provide the simulation results with different AL as {2, 4, ~~8~~} with 2x2, and 2x4 antenna configuration in the next meeting with FDM, down selection one of AL under condition of operation SNR>-4dB with 4Rx for PDCCH requirement.   Regarding the payload,, we can differentiate it, there is no need to cover the possible payload, since the test purpose is to verify the combination  For FDD with 24 COREST RB , payload is 39 for AL=2/4  For TDD with 48 COREST RB, payload is 41 for AL=2/4 |
| Apple | Propose to limit to AL 2 and include AL 4 if necessary.  Don’t see the need for more than 1 payload size. 1 should be sufficient. |
| Intel | We tend to agree with Apple that one payload is enough to verify this feature considering that UE should also pass normal PDCCH requirements. |
| Qualcomm | We think this legacy way of PDCCH testing does not capture the use case where m-TRP PDCCH can reap performance benefit compared to that of the single TRP transmission. One of the important use cases for m-TRP PDCCH is that it could provide performance benefit (over single TRP scheme) in a scenario when one of the TRPs is blocked. In such a scenario, a different test design is needed, e.g., having one of the TRPs is blocked with certain probability. |
| Mediatek | If it is agreed to introduce requirement, we would prefer to help testing efforts by keeping configurations simple, like Apple is proposing to use only AL 2 and 1 payload size. To our understanding, it should be enough for feature verification. |

## Sub-topic #1-3 Test setup for PDSCH requirement

**Issue 1-3-1: Simulation Assumption for PDSCH requirment for inter-cell operation if introudced**

*Candidate options:*

* Proposals
  + Option 1(Samsung, Apple, MTK): Reusing test parameters of existing Rel-16 multi-DCI based on TRP transmission test case (Table 5.2.2.1.12-2) with different PCI for TP1 and TP2 i.e.
    - Time offset/frequency offset: -0.5us /200Hz for FR1 FDD 15kHz SCS; -0.25us/300Hz for FR1 TDD 30kHz SCS
    - RB allocation: frequency non-overlapping
    - MCS: 64QAM 1/2
    - PCI ID: [0] for TP1, [3] for TP2
    - SSB transmission: SSB 1 for TP1, SSB 2 for TP2
  + Option 2 (Huawei): Reuse test parameters of existing Rel-16 multi-DCI based on TRP transmission test case (Table 5.2.2.1.12-2) with different PCI for TP1 and TP2
    - RB allocation: frequency overlapping

*Recommendations for 2nd round:*

* Reusing test parameters of existing Rel-16 multi-DCI based on TRP transmission test case (Table 5.2.2.1.12-2) with different PCI for TP1 and TP2 i.e.
  + Time offset/frequency offset: -0.5us /200Hz for FR1 FDD 15kHz SCS; -0.25us/300Hz for FR1 TDD 30kHz SCS
  + MCS: 64QAM 1/2
  + PCI ID: [0] for TP1, [3] for TP2
  + SSB transmission: SSB 1 for TP1, SSB 2 for TP2
* Option 1:
  + RB allocation: frequency non-overlapping
  + Reuse the same requirement of Rel-16 Multi-DCI non-overlapped resource allocation for PDSCH requirement with multi-TRP inter-cell operation
  + Introduce test applicability rule between Rel-16 Multi-DCI with non-overlapped Tx schemes and Rel-17 Multi-TRP inter-cell Tx schemes
* Option 2:
  + RB allocation: frequency full-overlapping

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| **Company** | **Comments** |
| Huawei | We still prefer to define inter-cell multi-TRP cases with full-overlapping resource allocation to improve UE performance especially when UE is at the edge of two TRPs. |
| Samsung | We support option 1, we are open to check the performance with frequency full-overlapping. While considering there is no requirement of full-overlapping for Rel-16 eMIMO and the baseline receiver is MMSE-IRC, where is IC receiver introduced to handle intra-cell or inter-layer interference. Our intention is to reuse the test parameters in Rel-16 and apply the existing requirement for UE supported inter-cell multi-TRP, and there is no additional simulation effort. Meanwhile, we can introduce the test applicable rule, if UE supported both intra-cell multi-TRP and inter-cell multi-TRP, to reduce the test effort. |
| Apple | If requirements are introduced, new simulation effort is needed in our understanding. We don’t support fully overlapping and prefer to have same assumptions as Rel-16 to be able to define any applicability rule if necessary. |
| Mediatek | If it is agreed to introduce requirement, we still would support Option 1 of frequency non-overlapping configuration. |

# Reference

1. R4-2207177, Email discussion summary for [102-e][330] NR\_FeMIMO\_Demod, RAN4#102-e, Samsung
2. R4-2203092, WF on demodulation requirement for Enhancement on Multi-TRP, RAN4#101bis-e, Huawei, HiSilicon