**3GPP TSG-RAN WG4 Meeting # 102-e R4-210XXXX**

**Electronic Meeting, 21th Feb– 3rd March, 2022**

**Agenda item:** 10.19.4

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [102-e][330] NR\_FeMIMO\_Demod

**Document for:** Information

# Introduction

Rel-17 NR FeMIMO WI is a RAN1 leading WI with below major enhancement in RAN1 area

* Enhancement on multi-beam operation
* Enhancement on multi-TRP
* Enhancement on SRS
* Enhancement on CSI reporting

In the last meeting, the scope of performance requirement of NR FeMIMO was under discussion and the related agreement was summarized as following table

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Items** | | **BS demodulation** | **UE demodulation** | **CSI** |
| Enhancement on multi-beam operation | | NO | NO | NO |
| Enhancements on multi-TRP | Enhancements on Multi-TRP for PDCCH, PUCCH and PUSCH | NO | FFS for M-TRP PDCCH repetition  FFS for M-TRP PDSCH with rate matching | NO |
| Enhancements on Multi-TRP inter-cell operation | NO | FFS for M-TRP Inter-cell PDSCH | NO |
| Enhancements on beam management for multi-TRP | NO | NO | NO |
| Enhancements on HST-SFN deployment | NO | PDSCH for SFN scheme A  FFS for SFN scheme B  FFS for PDCCH and PDSCH CA case | NO |
| Enhancement on SRS | | NO | NO | NO |
| Enhancement on CSI reporting | M-TRP | NO | NO | CSI for M-TRP |
| FDD reciprocity | NO | NO | FFS PMI for enhanced Type II port selection codebook |

Based on the RAN1 feature and work plan of NR FeMIMO, the scope of this email discussion mainly focuses to identify the test scope of performance requirements of NR FeMIMO, identify the potential impact of the UE demodulation requirements and CSI requirements. Meanwhile, the initial simulation assumption also should be discussed to facilitate the test case setup for requirements

In practical, the scope of this email discussion is indicated as follows agenda:

* UE Demodulation and CSI requirements(6.19.4)
* General (10.19.4.1)
* Demodulation requirement (10.19.4.2)
* Enhancement on HST-SFN scenario (10.19.4.2.1)
* Enhancement on Multi-TRP (10.19.4.2.2)
* CSI requirement (10.19.4.3)
* CSI reporting for multi-TRP (10.19.4.3.1)
* Rel-17 eType II port selection codebook (10.19.4.3.2)
* Others (10.19.4.3.3)

List of candidate target of email discussion for 1st round and 2nd round

* 1st round: Discussion and identify the potential impact on the UE performance requirements based on the RAN1 feature
* 2nd round: Discussion the test setup and agree the initial simulation assumption for UE demodulation and CSI parts test cases

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203778 | Apple | Proposal 1: Given the limited time for performance part for Rel-17 FeMIMO, we don’t introduce requirements for PDCCH enhancements for multi-TRP.  Proposal 2: Do not introduce requirements to verify PDSCH rate matching for 2 linked PDCCH.  Proposal 3: Do not introduce requirements for PDSCH demod for inter-cell mTRP. |
| R4-2204735 | Samsung | Proposal 1: Introduce PDCCH requirements for multi-TRP repetition transmission schemes.  Proposal 2: Introduce PDSCH requirement for Multi-TRP inter-cell operation   * Introduce test applicable rule between existing Multi-DCI intra-cell M-TRP test case and new test case for inter-cell Multi-DCI PDSCH   Proposal 3: 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 |
| R4-2205427 | Ericsson | Proposal 1: Introduce PDCCH requirement for Multi-TRP repetition transmission schemes.  Proposal 2: Not to define PDSCH requirement for verifying the rate-matching behaviour.  Proposal 3: Not to define PDSCH requirement for Multi-TRP inter-cell operation.  Proposal 4: Select FDM transmission scheme for PDCCH requirement (if introduced).  Proposal 5: Parameter configurations from previous test cases can be considered as baseline with necessary adaptations (if needed). |
| R4-2205775 | Huawei | Observation 1: There is a great gain by performing soft-combining for non-SFN PDCCH enhancement.  Proposal 1: Define PDCCH requirement for multi-TRP repetition transmission schemes.  Proposal 2: Define PDSCH performance requirements to verify whether UE is with proper behaviour of rate matching around the two linked PDCCH.  Proposal 3: Define performance requirement for enhancements on multi-TRP inter-cell operation with full-overlapping resource allocation.  Proposal 4: For PDCCH performance requirements for mTRP, consider both FDM and TDM. Permutation and combination can be used to reduce the test efforts, such as FDM for AL2 and TDM for AL8.   |  |  |  | | --- | --- | --- | | **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 | 0 | | | Test metric | 1% of Pm-dsg (%) | |   Proposal 5: 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 and configured full-overlapping resource allocation for PDSCH requirement for inter-cell operation |
| R4-2205919 | Intel | Proposal 1: Define applicability rule 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 (Option 2a Alt1).  Proposal 2: Define demodulation performance requirement for PDCCH FDM repetition scheme only. |

## Open issues summary

Last RAN4 meeting agreeements in the WF R4-2203090/91/92

List of open issues

* Sub-topic 1-1 Test Scope
  + Issue 1-1-1: Whether to define PDCCH requirement for multi-TRP repetition transmission schemes
  + 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.
  + Issue 1-1-3: Whether to define PDSCH requirement for Multi-TRP inter-cell operation
* Sub-topic 1-2 Test setup for PDCCH requirement for Enhancement on Multi-TRP if introduced
  + Issue 1-2-1: Multi-TRP repetition transmission schemes for PDCCH requirements
  + Issue 1-2-2: Simulation Assumption for PDCCH with FDM repetition scheme
* Sub-topic 1-3 Test setup for PDSCH requirement for inter-cell operation if introduced
  + Issue 1-3-1: Simulation Assumption for PDSCH requirement for inter-cell operation

### Sub-topic 1-1: Test Scope

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

* 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): No
* Recommended WF
  + Define PDCCH requirement for multi-TRP repetition transmission scheme

**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.**

* Proposals
  + Option 1(Huawei): Yes
  + Option 2 (Apple, Ericsson): No
* Recommended WF
  + Encourage comments if any.

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

* 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 2 (Apple, Ericsson, Intel): 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
* Recommended WF
  + Encourage comments if any.

### Sub-topic 1-2: Test setup for PDCCH requirement for Enhancement on Multi-TRP if introduced

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

* Proposals
  + Option 1(Intel, Ericsson): only with FDM repetition in FR1
  + Option 2(Huawei): Both FDM with intra-slot repetition and TDM with intra-slot repetition in FR1
* Recommended WF
  + Define demodulation performance requirement for PDCCH with FDM intra-slot repetition in FR1
  + FFS on TDM with intra-slot repetition in FR1

**Issue 1-2-2: Simulation Assumption for PDCCH with FDM repetition scheme**

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

|  |  |  |  |
| --- | --- | --- | --- |
| 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

|  |  |  |
| --- | --- | --- |
| 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).
* Recommended WF
  + Encourage comments if any for following proposals
  + Aggregation level
    - Option 1(WF in previous meeting): 4 and 8 for FDM
    - Option 2 (Huawei): 2 for FDM, 8 for TDM
  + Antenna configuration
    - Option 1 (WF in previous meeting): 2x2, 2x4 for FDM
    - Option 2 (Huawei): 1x2 ,1x4 for FDM and 2x2 ,2x4 for TDM
  + Channel model
    - Option 1 (WF in previous meeting): TDLA30-10 for FDM
    - Option 2 (Huawei): TDLA30-10 for FDM and TDLC300-100 for TDM

### Sub-topic 1-3: Test setup for PDSCH requirement for inter-cell opereation if introdcued

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

* Proposals
  + Option 1(Samsung): 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
* Recommended WF
  + 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
  + RB allocation
    - Option 1(Samsung): frequency non-overlapping
    - Option 2(Huawei): frequency overlapping

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 1-1-1  Issue 1-1-2  Issue 1-1-3 |
| Intel | **Issue 1-1-1: Whether to define PDCCH requirement for multi-TRP repetition transmission schemes**  Support the recommended WF. This feature has impact on UE Rx processing, hence we should define performance test case to verify it. Benefits of this feature should not be discussed in RAN4 since RAN1 has already performed performance analysis and identified benefits. Otherwise, feature would not be defined.  **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.**  We do no think that new UE rate-matching behavior needs to be verified. RAN4 has not defined a dedicated requirement for Rel-16 eMIMO CRS rate-matching pattern. Basicaly, due to limited impact on UE Rx processing. Suggest considering the similar approach. Support Option 2.  **Issue 1-1-3: Whether to define PDSCH requirement for Multi-TRP inter-cell operation**  We should distinguish discussion on overlapped and non-overlapped multi-DCI Tx schemes. As we understood, Huawei suggested to define new Rel-17 requirement with overlapped alocation. We are fine to define such requirements. Same time, there is no difference between inter-cell or intra-cell scenarios from receive processing perpective, assumed propagation conditions and demodulation performance. Therefore, option 2 is valid regradless of multi-DCI Tx scheme configuration.  Support Option 2a. |
| Apple | **Issue 1-1-1: Whether to define PDCCH requirement for multi-TRP repetition transmission schemes**  Option 2. We don’t agree with the recommended WF. We agree there is a gain in PDCCH performance with repetition. Given the limited time for WI completion, we can de-prioritize it.  **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.**  Option 2. We don’t see the need to introduce requirements to validate PDSCH RM at UE.  **Issue 1-1-3: Whether to define PDSCH requirement for Multi-TRP inter-cell operation**  Option 2. Do not introduce new requirements. We don’t think the current requirements from Rel-16 mTRP can directly be used either. |
| Qualcomm | **Issue 1-1-1: Whether to define PDCCH requirement for multi-TRP repetition transmission schemes**  Option 2. We don't foresee a huge benefit from introducing requirements for PDCCH in Rel-17. The operating SNR for PDCCH is already quite low. Furthermore, if UE passes the PDSCH requirement, corresponding PDCCH performance can be implicitly ensured.  **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.**  Option 2. Rate-matching around linked PDCCH is mainly a functional behavior. While RAN4 may choose to define test cases to verify UE’s functional behavior, we think it is not warranted here given limited WI time budget.  **Issue 1-1-3: Whether to define PDSCH requirement for Multi-TRP inter-cell operation**  Option 2. We don’t see a necessity to define requirements for inter-cell m-TRP considering that the UE demod processing is same as that of the Rel-16 m-TRP transmission. |
| Ericsson | **Issue 1-1-1: Whether to define PDCCH requirement for multi-TRP repetition transmission schemes**  We support the recommended WF. PDCCH enhancement is the main study and achievement, which brings changes on UE reception and benefit on the UE demodulation performance. It should be also verified and guaranteed that the PDCCH repetition and reception from two different TRPs.  **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.**  We support option 2.  **Issue 1-1-3: Whether to define PDSCH requirement for Multi-TRP inter-cell operation**  We support option 2. |

Sub topic 1-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 1-2-1  Issue 1-2-2 |
| Apple | Issue 1-2-1  If agreed to introduce requirements, only FDM intra-slot repetition scheme.  Issue 1-2-2  If agreed to introduce requirements, the AL should be chosen based on simulation results and operating SNR > -4dB with 4RX. AL 8 might result in very low SNR. |
| Qualcomm | Issue 1-2-1 Test setup for PDCCH requirement for Enhancement on Multi-TRP if introduced  We don’t support defining requirements for m-TRP PDCCH.  Option 1, if only requirement is introduced |
| Ericsson | Issue 1-2-1  Support FDM only.  Issue 1-2-2  Share similar view with Apple. |

Sub topic 1-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 1-3-1 |
| Apple | Issue 1-3-1  If requirements are introduced, we introduce requirements with the same simulation assumptions for mDCI mTRP requirements. |
| Qualcomm | Issue 1-3-1: Simulation Assumption for PDSCH requirment for inter-cell operation  We don’t support defining PDSCH requirements for inter-cell operation. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Topic #2: Demodulation requirement for Enhancement on HST-SFN scenario

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203777 | Apple | Proposal 1: Do not introduce demodulation requirements for SFN scheme B.  Proposal 2: Define test case when both channels (PDSCH/PDCCH) are transmitted using SFN scheme A and define performance requirements for PDSCH only.  Proposal 3: Only define single carrier requirements for HST SFN enhancements in Rel-17.  Proposal 4: Use the following assumptions as baseline for SFN Scheme A   * Reuse the Rel-16 HST SFN test setup as baseline. UE receives from 2 nearest RRHs at any given time. * Rank 2, MCS17 * Max Doppler shift: 870 Hz for 15Khz; 1667 Hz for 30KHz * Channel model: For PDCCH and PDCCH HST-SFN channel model with 2 nearest RRH – time varying path power and path delay. For TRS from each RRH single tap with time varying path power and path delay.   Proposal 5: Evaluate performance improvement of HST SFN scheme A over Rel-16 HST SFN. |
| R4-2204163 | NTT DoCoMo | Proposal 1: Reuse existing Rel-16 HST-SFN test set-up as a baseline (i.e. Option1)   * PDCCH/PDSCH/ SFN transmitted from two RRHs * TCI state 1 and TCI state 2 applied for TRP/RRH #2n, #2n+1 separately; TRS 1 and TRS 2 transmitted from TRP#2n, and #2n+1 separately  |  |  |  | | --- | --- | --- | | Parameter | Value | | | **FDD 15 kHz SCS** | **TDD 30 kHz SCS** | | CBW | **10 MHz** | **40 MHz** | | Antenna configuration | **2x2; 2x4** | | | DMRS type | **Type 1** | | | Number of DMRS symbols | **1+1+1** | | | TDD pattern |  | **7D1S2U, S: 6D 4G 4U** | | TRS configuration | **10ms, 2 slot pattern** | | | PDSCH mapping | **Type A, Start symbol 2, Duration 12** | | | Ds and Dmin | **Ds =700m; Dmin=150m** | | | Test metric | **SNR @70% of maximum throughput** | |   Proposal 2: Define the following maximum Doppler shift   * 15 kHz SCS:   + Option 1: 972 Hz * 30 kHz SCS:   + Option 1: 1667 Hz   Observation 1: As for Maximum Doppler shift of Rel-17 HST-SFN scheme B, we would like to clarify how to treat the pre-compensation first. (If RAN4 agrees to introduce the requirement of HST-SFN scheme B) |
| R4-2204268 | CMCC | Proposal 1: for scheme B, we prefer following two options:   * Option 1: introduce PDSCH requirements for SFN for scheme B * Option 2: do not introduce PDSCH requirements for SFN scheme B and define the following test applicability rule to guarantee performance with this scheme:   + If UE passes the existing test cases (demodulation requirement for HST-SFN with high Doppler shift), the performance of SFN scheme B is guaranteed   Proposal 2: it is proposed to define PDCCH requirements for HST SFN scenario.  Proposal 3: for HST-SFN, define single carrier requirement firstly. If time allowed, PDSCH CA requirements for HST SFN scenario can be considered later.  Proposal 4: for 15KHz SCS, the maximum Doppler shift is 870Hz; for 30KHz SCS, the maximum Doppler shift is 1667Hz.  Proposal 5: for Rel-17 HST-SFN test cases, the test parameters are proposed as following:   |  |  | | --- | --- | | Parameter | Value | | MCS | MCS17 | | Rank | 2 | | Antenna configuration | 2\*2; 2\*4 | | Ds and Dmin | Ds = 700 m, Dmin =150m | |
| R4-2204735 | Samsung | Proposal 4: Introduce PDSCH requirements for HST SFN scenario with SFN scheme A and scheme B with following test applicability rules:   * If UE pass HST-SFN scheme A test cases, UE can skip HST-SFN scheme B test cases   Proposal 5: No dedicated PDCCH test case for SFN transmission schemes; Define test case when both channels (PDSCH/PDCCH) are transmitted using SFN scheme A and verify performance of PDSCH only (option 3).  Proposal 6: Do not define PDSCH CA requirements for HST SFN scenario (option 2).  Proposal 7: Reusing existing Rel-16 HST-SFN test set-up as baseline to introduce enhanced SFN scheme A and SFN scheme B PDSCH test cases with below update:   * SFN scheme A (UE based solution): two TCI states with QCL A type information included   + PDCCH/PDSCH/PBCH SFN transmitted from two RRHs   + TCI state 1 and TCI state 2 applied for for TRP/RRH #2n, #2n+1 separately; TRS 1 and TRS 2 transmitted from TRP#2n, and #2n+1 separately   + HST SFN channel model specified in B.3.2 of TS 38.101-4 reused * SFN scheme B (TRP based pre-compensation solution): two TCI states with one configured QCL type A information, and another one configured QCL Type B information’   + PDCCH/PDSCH/PBCH SFN transmitted from two RRHs   + TCI state 1 and TCI state 2 applied for for TRP/RRH #2n, #2n+1 separately; TRS 1 and TRS 2 transmitted from TRP#2n, and #2n+1 separately   + HST SFN channel model specified in B.3.2 of TS 38.101-4 reused without modelling Doppler shift |
| R4-2205428 | Ericsson | Proposal 1: Option 2: Introduce only PDSCH requirements for SFN scheme A.  Proposal 2: Option 2: Do not define PDSCH CA requirements for HST-SFN scenario.  Proposal 3: If the PDCCH requirement for non-HST SFN scenario is excluded then consider the necessity of introducing PDCCH requirement for HST-SFN scenario.  Proposal 4: For PDSCH demodulation requirements with HST-SFN Scheme A, set 870Hz for SCS=15kHz and 1660Hz for SCS=30kHz.  Proposal 5: For PDSCH demodulation requirements with HST-SFN Scheme A, set MCS13 Rank 2.  Proposal 6: For HST-SFN Scheme A, reusing the existing Rel-16 HST-SFN channel model (Ds=700m, Dmin=150m, v=500km/h) with removing the two furthest paths corresponding to the two furthest TRP.  Proposal 7: Confirm the assumption that the HST-SFN advanced receiver is the baseline receiver for defining scheme A requirement.  Proposal 8: The PDSCH demodulation requirements for HST-SFN Scheme A is applicable for UE capable of ‘SFN Scheme A’. |
| R4-2205774 | Huawei | Observation 1: Better performance can be achieved for Scheme B comparing to the normal SFN.  Observation 2: There is large UE performance difference for Scheme B between different BS implementation of frequency offset between two TRP.  Proposal 1: Define PDSCH performance requirements for Scheme B for HST scenario.  Proposal 2: For Scheme B, BS behaviour can be modeled into channel model so that TE implementation of pre-compensation has no impact on the UE performance during the test.  Proposal 3: Do not define any PDCCH requirements for HST scenario but define PDCCH requirements for Scheme A for non-HST scenario.  Proposal 4: Do not consider CA requirements for HST SFN scenario.  Proposal 5: For Scheme A, transmit TRS#i from RRH#4k+i that i = 0, 1, 2, 3 and k = 0, 1, 2, … .  Proposal 6: For the maximum Doppler shift for Scheme A, reuse the value from Rel-16 HST-SFN, i.e. 870Hz for 15kHz, 1667Hz for 30kHz.  Proposal 7: Select MCS17 with Rank 2 for Scheme A performance requirements definition.  Proposal 8: For the channel model for Scheme A, reusing the existing Rel-16 HST-SFN channel model (Ds=700m, Dmin=150m) with removing the two furthest paths corresponding to the two furthest TRP.  Proposal 9: Select MCS17 with Rank 2 for Scheme B performance requirements definition.  Proposal 10: For Scheme A, transmit TRS#i from RRH#4k+i that i = 0, 1, 2, 3 and k = 0, 1, 2, … .  Proposal 11: Configure the following four TCI codepoint during the test:   * Codepoint#0 active when UE receiving PDSCH from RRH#4k and RRH#4k+1 : TCI#0, TCI#1 * Codepoint#1 active when UE receiving PDSCH from RRH#4k+1 and RRH#4k+2: TCI#1, TCI#2 * Codepoint#2 active when UE receiving PDSCH from RRH#4k+2 and RRH#4k+3: TCI#2, TCI#3 * Codepoint#3 active when UE receiving PDSCH from RRH#4k+3 and RRH#4(k+1): TCI#3, TCI#0   Proposal 12: For the channel model for Scheme B, reusing the existing Rel-16 HST-SFN channel model (Ds=700m, Dmin=150m) with removing the two furthest paths corresponding to the two furthest TRP. |
| R4-2205920 | Intel | Proposal 1: Define demodulation performance requirements for SFN Scheme A only for FR1  Proposal 2: Define demodulation performance requirements for SFN Scheme A for CA.  Proposal 3: Do not define demodulation performance requirements for SFN Scheme B. |
| R4-2206100 | Qualcomm | Proposal 1: The difference between the estimated Dopplers for TRP#1 (i.e., estimated from TRS1) and TRP#2 (i.e., estimated from TRS2) should be within the TRS-based tracking pull-in range with some margin.  Proposal 2: The resultant maximum delay spread estimated at the UE side from two TRSs should be within the length of the cyclic prefix.  Proposal 3: Rel-17 HST model should include path-loss for TRS of each TRP separately and apply the same scaling as PDSCH for each TRP  Proposal 4: Rel-17 HST model should assume delay for TRS of each TRP separately and apply the same delay as PDSCH for each TRP  Proposal 5: Rel-17 HST should assume only two RRHs (representing TRP#1 and TRP#2) transmitting simultaneously.  Proposal 6: The simulation assumptions for HST scheme A should not assume SFN transmission for PBCH/SSB. |

## Open issues summary

Last RAN4 meeting agreeements in the WF R4-2203090/91/92

List of open issues

* Sub-topic 2-1 Test Scope
  + Issue 2-1-1: Whether to define PDCCH requirement for HST SFN scenario
  + Issue 2-1-2: Whether to define PDSCH requirement with HST-SFN scheme B
  + Issue 2-1-3: Whether to define PDSCH CA requirement for Enhancement on HST SFN scenario
* Sub-topic 2-2 Test setup for PDCCH requirement for Enhancement on Multi-TRP if introduced
  + Issue 2-2-1: Multi-TRP repetition transmission schemes for PDCCH requirements
  + Issue 2-2-2: Number of TCI code point for Test
  + Issue 2-2-3: Maximum Doppler shift
  + Issue 2-2-4: MCS and Rank
  + Issue 2-2-5: Channel Model
  + Issue 2-2-6: Baseline receiver for defining scheme A requirement
  + Issue 2-2-7: UE capability
  + Issue 2-2-8: Performance evaluation
* Sub-topic 2-3 Test setup for PDSCH requirement for SFN scheme B with Single Carrier If introduced
  + Issue 2-3-1: Common setup for PDSCH requirement
  + Issue 2-3-2: Number of TCI code point for Test
  + Issue 2-3-3: Maximum Doppler shift
  + Issue 2-3-4: MCS and Rank
  + Issue 2-3-5: Channel Model

### Sub-topic 2-1: Test Scope

**Issue 2-1-1: Whether to define PDCCH requirement for HST SFN scenario**

* Proposals
  + Option 1 (Huawei): Do not define any PDCCH requirements for HST scenario but define PDCCH requirements for Scheme A for non-HST scenario.
  + Option 2(Apple, Samsung): Define test case when both channels (PDSCH/PDCCH) are transmitted using SFN scheme A and verify performance of PDSCH only
  + Option 3(Ericsson): If the PDCCH requirement for non-HST SFN scenario is excluded then consider the necessity of introducing PDCCH requirement for HST-SFN scenario.
* Recommended WF
  + No PDCCH requirement for Enhancement on HST-SFN scenario.
  + Define test case where both channels (PDSCH/PDCCH) are transmitted using SFN scheme and verify performance of PDSCH only

**Issue 2-1-2: Whether to define PDSCH requireemnt with HST-SFN scheme B**

* Observations
  + Observation 1(NTTDoCoMO):
    - As for Maximum Doppler shift of Rel-17 HST-SFN scheme B, we would like to clarify how to treat the pre-compensation first. (If RAN4 agrees to introduce the requirement of HST-SFN scheme B)
  + Observation 2(Huawei):
    - Better performance can be achieved for Scheme B comparing to the normal SFN.
    - There is large UE performance difference for Scheme B between different BS implementation of frequency offset between two TRP
  + Observation 3 (Intel):
    - Conventional receiver leads to 2 dB and 1.1 dB performance degradation with 0 and 752Hz residual frequency error compared to HST-SFN receiver.
* Proposals
  + Option 1(Samsung, Huawei, CMCC): Yes
  + Option 2 (Apple, Intel, Ericsson): No
  + Option 3 (CMCC): do not introduce PDSCH requirements for SFN scheme B and define the following test applicability rule to guarantee performance with this scheme:
    - If UE passes the existing test cases (demodulation requirement for HST-SFN with high Doppler shift), the performance of SFN scheme B is guaranteed
* Recommended WF
  + Encourage comments if any.

**Issue 2-1-3: Whether to define PDSCH CA requirement for Enhancement on HST SFN scnearion**

* Proposals
  + Option 1(Apple, Huawei, Samsung, Ericsson): Only define PDSCH requirements for HST SFN scenario with single carrier requirement in Rel-17
  + Option 2 (Intel): Define PDSCH CA requirements for HST SFN scenario
  + Option 3 (CMCC): For HST-SFN, define single carrier requirement firstly. If time allowed, PDSCH CA requirements for HST SFN scenario can be considered later.
* Recommended WF
  + No PDSCH CA requirement for Enhancement on HST SFN scenario in Rel-17 FeMIMO WI.

### Sub-topic 2-2: Test setup for PDSCH requirement for SFN scheme A with Single Carrier

**Issue 2-2-1: Comment setup for PDSCH requirement**

* Proposals
  + Option 1 (Samsung, NTT DoCoMo, Apple, Ericsson, CMCC): Reuse existing Rel-16 HST-SFN test set-up as a baseline
    - PDCCH/PDSCH SFN transmitted from two RRHs
    - TCI state 1 and TCI state 2 applied for TRP/RRH #2n, #2n+1 separately; TRS 1 and TRS 2 transmitted from TRP#2n, and #2n+1 separately

|  |  |  |
| --- | --- | --- |
| Parameter | Value | |
| FDD 15 kHz SCS | TDD 30 kHz SCS |
| CBW | 10 MHz | 40 MHz |
| Antenna configuration | 2x2; 2x4 | |
| DMRS type | Type 1 | |
| Number of DMRS symbols | 1+1+1 | |
| TDD pattern |  | 7D1S2U, S: 6D 4G 4U |
| TRS configuration | 10ms, 2 slot pattern | |
| PDSCH mapping | Type A, Start symbol 2, Duration 12 | |
| Ds and Dmin | Ds =700m; Dmin=150m | |
| Test metric | SNR @70% of maximum throughput | |

* + Option 2 (Qualcomm): The simulation assumption for HST scheme A should not assume SFN transmission for PBCH/SSB
* Recommended WF
  + Reuse existing Rel-16 HST-SFN test set-up as a baseline
    - PDCCH/PDSCH SFN transmitted from two RRHs.

|  |  |  |
| --- | --- | --- |
| Parameter | Value | |
| FDD 15 kHz SCS | TDD 30 kHz SCS |
| CBW | 10 MHz | 40 MHz |
| Antenna configuration | 2x2; 2x4 | |
| DMRS type | Type 1 | |
| Number of DMRS symbols | 1+1+1 | |
| TDD pattern |  | 7D1S2U, S: 6D 4G 4U |
| TRS configuration | 10ms, 2 slot pattern | |
| PDSCH mapping | Type A, Start symbol 2, Duration 12 | |
| Ds and Dmin | Ds =700m; Dmin=150m | |
| Test metric | SNR @70% of maximum throughput | |

**Issue 2-2-2: Number of TCI codepoint for Test**

* Proposals
  + Option 1 (Samsung): TCI state 1 and TCI state 2 applied for TRP/RRH #2n, #2n+1 separately; TRS 1 and TRS 2 transmitted from TRP#2n, and #2n+1 separately
  + Option 2 (Huawei): Configure 4 TCI code point during test, transmit TRS#i from RRH#4k+i that i = 0, 1, 2, 3 and k = 0, 1, 2, … .
    - Codepoint#0 active when UE receiving PDSCH from RRH#4k and RRH#4k+1 : TCI#0, TCI#1
    - Codepoint#1 active when UE receiving PDSCH from RRH#4k+1 and RRH#4k+2: TCI#1, TCI#2
    - Codepoint#2 active when UE receiving PDSCH from RRH#4k+2 and RRH#4k+3: TCI#2, TCI#3
    - Codepoint#3 active when UE receiving PDSCH from RRH#4k+3 and RRH#4(k+1): TCI#3, TCI#0
* Recommended WF
  + Encourage comments if any.

**Issue 2-2-3: Maximum Doppler shift**

* Proposals for 15 KHz SCS:
  + Option 1 (Samsung, Apple, CMCC, Intel, Ericsson. Huawei): 870 Hz
  + Option 2 (NTTDoCoMO): 972 Hz
  + Option 3 (Qualcomm): The difference between the estimated Dopplers for TRP#1 (i.e., estimated from TRS1) and TRP#2 (i.e., estimated from TRS2) should be within the TRS-based tracking pull-in range with some margin.
* Proposals for 30KHz SCS
  + Option 1(Samsung, Apple, CMCC, Intel, Ericsson. Huawei, NTTDoCoMO ): 1667 Hz
  + Option 2(Qualcomm): The difference between the estimated Dopplers for TRP#1 (i.e., estimated from TRS1) and TRP#2 (i.e., estimated from TRS2) should be within the TRS-based tracking pull-in range with some margin.
* Recommended WF
  + Define PDSCH requirement with HST-SFN scheme A with Maximum Doppler shift
    - 15KHz: 870Hz
    - 30KHz: 1667Hz

**Issue 2-2-4: MCS and Rank**

* Proposals
  + Option 1 (Samsung, Apple, NTT DoCoMo, CMCC, Intel, Huawei): MCS 17 with Rank 2
  + Option 2 (Ericsson): MCS 13 with Rank 2
* Recommended WF
  + Define PDSCH requirement with HST-SFN scheme A with MCS 17 and Rank 2 from MCS Table 1

**Issue 2-2-5: Channel Model**

* Proposals
  + Option 1 (Samsung, Apple, Huawei, Ericsson, Qualcomm ): Reusing the existing Rel-16 HST-SFN channel model (Ds=700m, Dmin=150m) with removing the two furthest paths corresponding to the two furthest TRP
    - Option 1a (Apple): For PDCCH and PDCCH HST-SFN channel model with 2 nearest RRH – time varying path power and path delay. For TRS from each RRH single tap with time varying path power and path delay
    - Option 1b(Qualcomm):
* The resultant maximum delay spread estimated at the UE side from two TRSs should be within the length of the cyclic prefix.
* Rel-17 HST model should include path-loss for TRS of each TRP separately and apply the same scaling as PDSCH for each TRP
* Rel-17 HST model should assume delay for TRS of each TRP separately and apply the same delay as PDSCH for each TRP
* Recommended WF
  + Reusing the existing Rel-16 HST-SFN channel model (Ds=700m, Dmin=150m) with removing the two furthest paths corresponding to the two furthest TRP as baseline
  + For PDCCH and PDSCH HST-SFN with 2 nearest RRH, including time varying path power and path delay
  + For TRS, single tap from each RRH, including time varying path power and path delay, apply the same scaling as PDSCH for each TRP for path power, and apply the same same delay as PDSCH for each TRP for path delay

**Issue 2-2-6: Baseline receiver for defining scheme A requirement**

* Proposals
  + Option 1 (Ericsson): Confirm the assumption that the HST-SFN advanced receiver is the baseline receiver for defining scheme A requirement
* Recommended WF
  + Encourage comments if any.

**Issue 2-2-7: UE capabilty**

* Proposals
  + Option 1 (Ericsson): The PDSCH demodulation requirements for HST-SFN Scheme A is applicable for UE capable of ‘SFN Scheme A’.
* Recommended WF
  + The PDSCH demodulation requirements for HST-SFN scheme A is applicable of “SFN scheme A”. No additional UE capability was introduced in RAN4 for PDSCH demodulation requirement for HST-SFN

**Issue 2-2-8: Performance evalution**

* Proposals
  + Option 1 (Apple): Evaluate performance improvement of HST SFN scheme A over Rel-16 HST SFN.
* Recommended WF
  + Please proponents of proposal clarify the intension of performance evaluation for Rel-16 HST SFN in Rel-17 FeMIMO WI, considering different RAN1 design, UE baseband processing and channel model

### Sub-topic 2-3: Test setup for PDSCH requirement for SFN scheme B with Single Carrier If introduced

**Issue 2-3-1: Comment setup for PDSCH requirement**

* Proposals
  + Option 1 (Samsung): Reuse existing Rel-16 HST-SFN test set-up as a baseline
    - two TCI states with one configured QCL type A information, and another one configured QCL Type B information’
    - TCI state 1 and TCI state 2 applied for TRP/RRH #2n, #2n+1 separately; TRS 1 and TRS 2 transmitted from TRP#2n, and #2n+1 separately

|  |  |  |
| --- | --- | --- |
| Parameter | Value | |
| FDD 15 kHz SCS | TDD 30 kHz SCS |
| CBW | 10 MHz | 40 MHz |
| Antenna configuration | 2x2; 2x4 | |
| DMRS type | Type 1 | |
| Number of DMRS symbols | 1+1+1 | |
| TDD pattern |  | 7D1S2U, S: 6D 4G 4U |
| TRS configuration | 10ms, 2 slot pattern | |
| PDSCH mapping | Type A, Start symbol 2, Duration 12 | |
| Ds and Dmin | Ds =700m; Dmin=150m | |
| Test metric | SNR @70% of maximum throughput | |

* Recommended WF
  + Option 1

**Issue 2-3-2: Modeling of TRP pre-compensation**

* Proposals
  + Option 1 (Huawei): For scheme B, BS behaviour can be modeled into channel model so that TE implementation of pre-compensation has no impact on the UE performance during the test.
* Recommended WF
  + Option 1

**Issue 2-3-3: Number of TCI codepoint for Test**

* Proposals
  + Option 1 (Samsung): TCI state 1 and TCI state 2 applied for TRP/RRH #2n, #2n+1 separately; TRS 1 and TRS 2 transmitted from TRP#2n, and #2n+1 separately
  + Option 2 (Huawei): Configure 4 TCI code point during test, transmit TRS#i from RRH#4k+i that i = 0, 1, 2, 3 and k = 0, 1, 2, … .
    - Codepoint#0 active when UE receiving PDSCH from RRH#4k and RRH#4k+1 : TCI#0, TCI#1
    - Codepoint#1 active when UE receiving PDSCH from RRH#4k+1 and RRH#4k+2: TCI#1, TCI#2
    - Codepoint#2 active when UE receiving PDSCH from RRH#4k+2 and RRH#4k+3: TCI#2, TCI#3
    - Codepoint#3 active when UE receiving PDSCH from RRH#4k+3 and RRH#4(k+1): TCI#3, TCI#0
* Recommended WF
  + Encourage comments if any.

**Issue 2-3-4: MCS and Rank**

* Proposals
  + Option 1 (Samsung, Huawei): MCS 17 with Rank 2
* Recommended WF
  + Define PDSCH requirement with HST-SFN scheme B with MCS 17 and Rank 2 from MCS Table 1

**Issue 2-3-5: Channel Model**

* Proposals
  + Option 1 (Samsung, Huawei)
    - Reusing the existing Rel-16 HST-SFN channel model (Ds=700m, Dmin=150m) with removing the two furthest paths corresponding to the two furthest TRP as baseline
    - HST SFN channel model specified in B.3.2 of TS 38.101-4 reused without modelling Doppler shift
* Recommended WF
  + Reusing the existing Rel-16 HST-SFN channel model (Ds=700m, Dmin=150m) with removing the two furthest paths corresponding to the two furthest TRP as baseline
  + For PDCCH and PDSCH HST-SFN with 2 nearest RRH, including time varying path power and path delay, without modelling Doppler shift
  + For TRS, single tap from each RRH, including time varying path power and path delay, apply the same scaling as PDSCH for each TRP for path power, and apply the same delay as PDSCH for each TRP for path delay, without modelling Doppler shift

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 2-1-1  Issue 2-1-2  Issue 2-1-3 |
| Intel | **Issue 2-1-1: Whether to define PDCCH requirement for HST SFN scenario**  Support the recommended WF.  **Issue 2-1-2: Whether to define PDSCH requireemnt with HST-SFN scheme B**  After BS performs frequency pre-compensation, channel model becomes much simplier than HST-SFN. It is two/four tap model when there are no taps with huge Doppler frequency magnitudes and different sign. The Doppler frequency magnitudes are the same or considering Tx frequency error are different on some ceratin value that is in the worst case limited by 0.4 PPM. Considering this channel model, conventioanl UE receiver with Jakes spectrum assumptions + conventional TRS based frequency tracking can be used. According to our evaluations, performance difference between scenarios with HST-SFN receiver and conventional receiver is limited by 2 dB. We expect that some further adjustment can be made for conventional reciever.  Since conventional receiver can be used on UE side, we do not see a big impact on UE implementation. Support option 2.  **Issue 2-1-3: Whether to define PDSCH CA requirement for Enhancement on HST SFN scnearion**  We are fine to compromise to Option 1, hence we support the recomened WF. |
| Apple | **Issue 2-1-1: Whether to define PDCCH requirement for HST SFN scenario**  We are fine with the recommended WF.  **Issue 2-1-2: Whether to define PDSCH requireemnt with HST-SFN scheme B**  We support option 2. With pre-compensation the UE doesn’t need advanced receiver/ processing and should be like single tap HST in our understanding. Hence, we don’t see the need to introduce requirements.  **Issue 2-1-3: Whether to define PDSCH CA requirement for Enhancement on HST SFN scnearion**  We are fine with the recommended WF. |
| Qualcomm | **Issue 2-1-1: Whether to define PDCCH requirement for HST SFN scenario**  We are okay with the recommended WF.  **Issue 2-1-2: Whether to define PDSCH requireemnt with HST-SFN scheme B**  Option 2. Assuming PDSCH is Doppler pre-compensated, our understanding is that it does not impact the UE side processing in a meaningful way, e.g., even in the presence of residual error. Therefore, we don’t think it is necessary to define requirements for Scheme B.  **Issue 2-1-3: Whether to define PDSCH CA requirement for Enhancement on HST SFN scnearion**  We support the recommended WF. |
| Ericsson | **Issue 2-1-1: Whether to define PDCCH requirement for HST SFN scenario**  Ok with recommended WF.  **Issue 2-1-2: Whether to define PDSCH requirement with HST-SFN scheme B**  We are ok to evaluate Scheme B, since the pre-compensation assumed by RAN1 is only for Doppler shift from the 2nd RRH but gNB does not compensate the time difference between two RRHs. As some companies commented, it is like two-tap channel model with almost same Doppler shift. We  believe UE can receive with the Rel-15 receiver as far as the time difference between two taps are within a CP. However we would like to evaluate this scenario (Ds=700m, Dmin=150m) especially for SCS 30kHz.  **Issue 2-1-3: Whether to define PDSCH CA requirement for Enhancement on HST SFN scenario**  We support the recommended WF. |

Sub topic 2-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| SoftBank | Issue 2-2-3: We support Option 2 for 15kHz SCS, proposed by NTT DoCoMo. We are fine with Option 1 for 30kHz SCS. |
| DoCoMo | Issue 2-2-1  We are ok with the recommended WF.  Issue 2-2-3  For 15KHz, our preference is still 972Hz (Option2).  As we describe in our contribution, Rel-17 HST-SFN scheme A can support 972Hz because UE can track the Doppler shift per each RRH and need not track the Doppler shift jump that is observed in Rel-16 HST-SFN. In addition, from the perspective of Japanese operators, it is important to support Band 1 as well as LTE.  For 30KHz, we are ok with 1667Hz (Option1).  Issue 2-2-4  We are basically fine with the recommended WF. But we would like to focus on Issue 2-2-3 first. |
| Apple | **Issue 2-2-1: Comment setup for PDSCH requirement**  We support the recommended WF.  **Issue 2-2-2: Number of TCI codepoint for Test**  Option 2. We agree that we need 4 TCI code points.  **Issue 2-2-3: Maximum Doppler shift**  We support option 1 for both 15KHz SCS and 30KHz SCS. We cannot agree to use high doppler shift without seeing some initial results. Using the same assumptions as HST-SFN is a starting point.  **Issue 2-2-5: Channel Model**  Fine with recommended WF. The time-varying Doppler shift on TRS from each TRP should also match that on PDSCH/PDCCH.  **Issue 2-2-6: Baseline receiver for defining scheme A requirement**  We are not sure what the proposal means. The UE needs different processing that HST-SFN for scheme A. This is very different from HST-SFN. We have PDSCH/PDCCH associated with 2 TCI states now. Could the proponents please explain how same receiver can be assumed?  **Issue 2-2-7: UE capabilty**  We understand that there is a UE feature from RAN1 for this. Its very early to discuss if additional capability is needed or not in our opinion. We cannot preclude this at this stage.  **Issue 2-2-8: Performance evalution**  We understand that its different feature and processing. Since we are just introducing requirements for RAN1 feature/ enh we understand that we need not compare performance. Since its an enhancement we think it would be interesting to see the performance comparison over existing HST transmission scheme. We are not sure if RAN1 used Rel-16 HST\_SFN in their evaluation. |
| Qualcomm | **Issue 2-2-1: Comment setup for PDSCH requirement**  We support the recommended WF as the initial simulation assumptions.  **Issue 2-2-3: Maximum Doppler shift**  We support the recommend WF.  We think that the difference between the estimated Dopplers for TRP#1 (i.e., estimated from TRS1) and TRP#2 (i.e., estimated from TRS2) should be within the TRS-based tracking pull-in range with some margin, therefore option 1 is safer for 15KHz.  **Issue 2-2-4: MCS and Rank**  We support the recommended the WF.  **Issue 2-2-5: Channel Model**  We are okay with recommended WF.  **Issue 2-2-6: Baseline receiver for defining scheme A requirement**  Could the proponent of this proposal clarify which receiver the “HST-SFN advanced receiver” is pointing to? Rel-17 HST-SFN assumes non-SFN TRS and will require very different processing at the UE side compared to that of Rel-16 HST-SFN where TRS is assumed to be transmitted in an SFN fashion. Therefore, our understanding is that Rel-16 receiver can’t be assumed as a baseline if this is what this proposal is referring to.  **Issue 2-2-7: UE capabilty**  As far as we are aware, RAN1 has yet to finalize UE capability for Scheme A Therefore we think that it is too early to discuss this proposal in RAN4.  **Issue 2-2-8: Performance evalution**  Our understanding is that UE processing and channel model are different for Scheme A compared to the implementation of Rel-16 HST-SFN. While companies can do their internal evaluation and compare performance against Rel-16 HST-SFN to gain further insight, we think that performance evaluation and requirement for scheme A should not consider that of Rel-16 HST-SFN. |
| Ericsson | **Issue 2-2-1: Comment setup for PDSCH requirement**  Ok with the recommended WF.  **Issue 2-2-2: Number of TCI codepoint for Test**  It depends on the channel model in Issue 2-2-5. If we agree to specify the channel model based on two RRHs, we think it is sufficient to configure **three** TRS configurations? (Two TRS for two active RRHs and one TRS for the coming RRH).  **Issue 2-2-3: Maximum Doppler shift**  For 15kHz SCS: we support 972Hz.  For 30kHz SCS: we support 1667Hz.  It looks most companies prefer to MCS17 rank 2 for Rel-17 HST-SFN in Issue 2-2-4, which is higher MCS compared with Rel-16 test setup (MCS13 rank 2). We are fine to configure higher MCS. In this case, we also propose to set higher Doppler shift of 972Hz for SCS 15kHz since UE can estimate Doppler shift per RRH.  **Issue 2-2-4: MCS and Rank**  Ok with option 1. Our intention is to reuse the Rel-16 HST-SFN test setup. But we are also fine with higher MCS options.  **Issue 2-2-5: Channel Model**  Ok with the recommended WF.  **Issue 2-2-6: Baseline receiver for defining scheme A requirement**  Support Option 1 with more clarification.  “Confirm the assumption that the **Rel-16** HST-SFN advanced receiver is the baseline receiver for defining **Rel-17 HST-SFN s**cheme A requirement”  **Issue 2-2-7: UE capability**  Support the recommended WF.  **Issue 2-2-8: Performance evaluation**  If RAN4 will evaluate the performance gain of Scheme A from Rel-16, we should set the same MCS condition, i.e., MCS13, rank 2. |

Sub topic 2-3

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 2-3-1  Issue 2-3-2  Issue 2-3-3  Issue 2-3-4  Issue 2-3-5 |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Topic #3: CSI reporting requirement for multi-TRP

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203779 | Apple | **CSI Enhancements for multi-TRP**  Proposal 1: Introduce PMI reporting requirements for single DCI SDM transmission scheme.  Proposal 2: Introduce PMI reporting requirements for CSI enhancements for Mode 1 with X=0.  Proposal 3: Evaluate performance of PMI reporting with enhanced CSI reporting against single PMI reporting for multi-TRP transmission.  Proposal 4: Use the following simulation assumptions as baseline:   * FR: FR1 only * Antenna config: 8x2, 8x4 * Number of layers: 2 (1 MIMO layer per TRP) * NZP CSI-RS resource set with 2 resources: Ks=2   + K1=1; For NZP CSI-RS resource associated with TRP1   + K2=1; For NZP CSI-RS resource associated with TRP2 * CMR pair: N=1 for mTRP hypothesis * CSI Report Mode: Mode 1 with X=0   Proposal 5: Introduce test metric of TP ratio of multi-TRP follow PMI and random PMI. The layers for random PMI per TRP should be orthogonal.  Proposal 6: Do not introduce requirements for CSI reporting for multi-DCI multi-TRP transmission scheme. |
| R4-2204784 | Samsung | Proposal 1: Introduce below test cases for CSI enhancement on NCJT m-TRP transmission schemes   * Test 1a: PMI test for single-DCI based on M-TRP scheme with full overlapped resource allocation * Test 1b: CQI test for multi-DCI based on M-TRP scheme with non-overlapping resource allocation   Proposal 2: General test set-up for CSI reporting   * 2 TPs configured * One CSI-RS resource set with Ks = 2   + TP1 associated with NZP-CSI-RS resource 1   + TP2 associated with NZP CSI-RS resource 2 * CSI reporting: One CSI associated with multi-TRP measurement hypothesis and X=0 CSI associated with single-TRP measurement hypothesis (CSI reporting mode 1 with X=0)   + CMR group 1 {CMR a} corresponding to NZP CSI-RS resource 1, K1=1   + CMR group 2 {CMR b} corresponding to NZP CSI-RS resource 2, K2=1   + CMR pair (N=1) : CMR {a,b} for M-TRP measurement hypothesis * No time/frequency offset between two TPs   Proposal 3: Using 4+ 4 ports for PMI test for M-TRP transmission scheme. |
| R4-2205429 | Ericsson | Proposal 1: Introduce requirements for PMI reporting for single-DCI based multi-TRP scheme.  Proposal 2: Not to introduce requirement for CQI and RI reporting for single-DCI based multi-TRP scheme.  Proposal 3: Not to introduce CSI reporting requirement for multi-DCI based multi-TRP scheme. |
| R4-2205438 | Nokia | Observation 1: For multi-DCI cases with non-overlapping PDSCH resources, the PMI/RI calculations for each TRP are not different from legacy. CQI on the other hand is shared among TRPs, so the legacy algorithm does no longer apply.  Observation 2: For single-DCI cases with overlapping PDSCH resources, the PMI/RI/CQI calculations differ significantly from legacy.  Proposal 1: Single-DCI: Define new CSI reporting requirement for CQI, RI and PMI reporting for Single-DCI based Multi-TRP scheme, with the PMI reporting being the most important one.  Proposal 2: Multi-DCI: Define new CSI reporting requirement for CQI reporting for Multi-DCI based Multi-TRP scheme. |
| R4-2205776 | Huawei | Proposal 1: Only define PMI reporting cases for single-DCI based multi-TRP scheme.  Proposal 2: Configure two resources in a resource pair in the same slot for CSI reporting requirements for mTRP.  Proposal 3: Only consider the first reporting method with X=0 for CSI reporting requirement. Number of antenna port, reporting granularity(WB/SB), CSI-RS resource type (P/AP), CSI-RS reporting type (P/AP), test metric, etc. can be reused from the existing CSI reporting cases, i.e. configuration of 4+4/8+8/16+16 port case is corresponding to that of the existing 8/16/32 port case.  Proposal 4: Reuse from the Rel-15/16 CSI reporting requirements, i.e. 1 layer per TRP.  Proposal 5: Do not consider time/frequency offset between two TRPs.  Proposal 6: Select 4 ports per TRP as starting point for CSI reporting requirements for mTRP. |
| R4-2206108 | Qualcomm | Proposal 1: The propagation channels apply to each of TRP #1 and TRP #2 is TDLA30-5 and are statistically independent.  Proposal 2: Correlation matrix and antenna configuration parameters apply to each of TRP #1 and TRP #2 is high corr and cross-polarized, respectively.  Proposal 3: The same Pc ratios to be considered for TRP #1 and TRP #2 in defining requirements.  Proposal 4: The SNRs for TRP #1 and TRP #2 are assumed to be balanced with a scaling factor of 1/sqrt(2) for the transmitted signal from each TRP.  Proposal 5: Only PMI reporting is considered for defining the requirements for the m-TRP CSI.  Proposal 6: The performance requirement for the m-TRP PMI reporting should not consider single TRP reporting and be defined only within the context of m-TRP reporting.  Proposal 7: The simulation assumption for m-TRP PMI reporting should Wideband PMI reporting for report Option 1 with X=0.  Proposal 8: The number of CSI-RS ports is assumed to be 8 for each TRP for the PMI tests.  Proposal 9: The m-TRP CSI requirements be limited to FR1 and do not define requirements for FR2. |

## Open issues summary

Last RAN4 meeting agreeements in the WF R4-2203090/91/92

List of open issues

* Sub-topic 3-1 Test Scope
  + Issue 3-1-1: Test cases for CSI reporting enhancement for m-TRP transmission
* Sub-topic 3-2: Test setup for CSI reporting requirement for m-TRP transmission
  + Issue 3-2-1: Common simulation assumption
  + Issue 3-2-2: General test set-up for CSI reporting
  + Issue 3-2-3: CSI resource configuration
  + Issue 3-2-4: Number of CSI-RS Ports
  + Issue 3-2-5: Number of layers
  + Issue 3-2-6: Test metric for PMI reporting
  + Issue 3-2-7: Performance evaluation

### Sub-topic 3-1: Test Scope

**Issue 3-1-1: Test cases for CSI reporting enhancement for m-TRP transmission**

* Observations
  + Observation 1(Nokia):
    - For multi-DCI cases with non-overlapping PDSCH resources, the PMI/RI calculations for each TRP are not different from legacy. CQI on the other hand is shared among TRPs, so the legacy algorithm does no longer apply
    - For single-DCI cases with overlapping PDSCH resources, the PMI/RI/CQI calculations differ significantly from legacy.
* Proposals
  + Option 1(Samsung, Nokia): Introduce below test cases for CSI reporting enhancement for m-TRP
    - Test 1a: PMI test for single-DCI based on M-TRP scheme with full overlapped resource allocation
    - Test 1b : CQI test for multi-DCI based on M-TRP scheme with non-overlapping resource allocation
  + Option 2(Huawei, Apple, Qualcomm): Only define PMI reporting cases for single-DCI based on multi-TRP
    - Option 2a (Qualcomm, Apple): The m-TRP CSI requirements be limited to FR1 and do not define requirements for FR2.
  + Option 3(Nokia):
    - Define new CSI reporting requirement for CQI, RI and PMI reporting for Single-DCI based Multi-TRP scheme, with the PMI reporting being the most important one.
    - Define new CSI reporting requirement for CQI reporting for Multi-DCI based Multi-TRP scheme.
  + Option 4(Ericsson)
    - Introduce requirements for PMI reporting for single-DCI based multi-TRP scheme.
    - Not to introduce requirement for CQI and RI reporting for single-DCI based multi-TRP scheme.
    - Not to introduce CSI reporting requirement for multi-DCI based multi-TRP scheme
* Recommended WF
  + Define PMI reporting requirement for single-DCI based Multi-TRP scheme with full overlapped resource allocation only in FR1
  + FFS on CQI reporting requirement for multi-DCI based Multi-TRP scheme
    - Option 1(Samsung, Nokia): Define new CSI reporting requirement for CQI reporting for Multi-DCI based Multi TRP scheme
    - Option 2(Apple, Huawei, Qualcomm, Ericsson): No to define CQI reporting requirement

### Sub-topic 3-2: Test setup for CSI reporting requirement for m-TRP transmission

**Issue 3-2-1: Common simulation assumption**

* Proposals
  + Option 1(Qualcomm)
    - Channel and correlation models: TDLA30-10 with XP High with statistically independent for each TRP
    - Pc setting: Same Pc ratios for each TRP in defining requirement
    - SNR setting: The SNRs for TRP #1 and TRP #2 are assumed to be balanced with a scaling factor of 1/sqrt(2) for the transmitted signal from each TRP
* Recommended WF
  + Option 1

**Issue 3-2-2: General test set-up for CSI reporting**

* Proposals
  + Option 1(Samsung)
    - 2 TPs configured with fully overlapping resource allocation
    - One CSI-RS resource with Ks = 2
* TP1 associated with NZP-CSI-RS resource 1
* TP2 associated with NZP CSI-RS resource 2
  + - CSI reporting: One CSI associated with multi-TRP measurement hypothesis and X=0 CSI associated with single-TRP measurement hypothesis (CSI reporting mode 1 with X=0)
* CMR group 1 {CMR a} corresponding to NZP CSI-RS resource 1, K1=1
* CMR group 2 {CMR b} corresponding to NZP CSI-RS resource 2, K2=1
* CMR pair (N=1) : CMR {a,b} for M-TRP measurement hypothesis
  + - Fix layer combination and precoding during test cases i.e. 1+1 for 2Rx, 2+2 for 4Rx
    - No time/frequency offset between two TP
    - Other test parameters reusing existing Rel-16 PDSCH requirements with single-DCI M-TRP SDM scheme
  + Option 2(Huawei)
    - Configure two resources in a resource pair in the same slot for CSI reporting requirements for mTRP.
    - Number of antenna port, reporting granularity(WB/SB), CSI-RS resource type (P/AP), CSI-RS reporting type (P/AP), test metric, etc. can be reused from the existing CSI reporting cases, i.e. configuration of 4+4/8+8/16+16 port case is corresponding to that of the existing 8/16/32 port case.
    - Reuse from the Rel-15/16 CSI reporting requirements, i.e. 1 layer per TRP.
    - No time/frequency offset between two TP
  + Option 3(Qualcomm)
    - CSI reporting type: WB PMI reporting for mode 1 with X=0
  + Option 4(Apple )
    - FR: FR1 only
    - Antenna config: 8x2, 8x4
    - Number of layers: 2 (1 MIMO layer per TRP)
    - NZP CSI-RS resource set with 2 resources: Ks=2
* K1=1; For NZP CSI-RS resource associated with TRP1
* K2=1; For NZP CSI-RS resource associated with TRP2
  + - CMR pair: N=1 for mTRP hypothesis
    - CSI Report Mode: Mode 1 with X=0
* Recommended WF
  + 2 TPs configured with fully overlapping resource allocation
  + One CSI-RS resource with Ks = 2
    - TP1 associated with NZP-CSI-RS resource 1
    - TP2 associated with NZP CSI-RS resource 2
  + CSI reporting: One CSI associated with multi-TRP measurement hypothesis and X=0 CSI associated with single-TRP measurement hypothesis (CSI reporting mode 1 with X=0)
    - CMR group 1 {CMR a} corresponding to NZP CSI-RS resource 1, K1=1
    - CMR group 2 {CMR b} corresponding to NZP CSI-RS resource 2, K2=1
    - CMR pair (N=1) : CMR {a,b} for M-TRP measurement hypothesis
  + No time/frequency offset between two TP

**Issue 3-2-3: CSI resource configuration**

* Proposals
  + Option 1 (Huawei): Configure two resources in a resource pair in the same slot for CSI reporting requirements for mTRP.
* Recommended WF
  + Option 1

**Issue 3-2-4: Number of CSI-RS Ports**

* Proposals
  + Option 1 (Qualcomm):
    - 8 for each TRP
  + Option 2 (Samsung, Apple, Huawei):
    - 4 for each TRP
* Recommended WF
  + Option 2

**Issue 3-2-5: Number of layers**

* Proposals
  + Option 1 (Apple, Huawei): 2 (1 MIMO layer per TRP)
  + Option 2 (Samsung): 1MIMO layer for each TRP with 2Rx, 2 MIMO layers for each TRP with 4Rx
* Recommended WF
  + Encourage comments if any.

**Issue 3-2-6: Test metric for PMI reporting**

* Proposals
  + Option 1
    - Option 1a (Apple): TP ratio of multi-TRP follow PMI and random PMI. The layers for random PMI per TRP should be orthogonal
    - Option 1b (Qualcomm): The performance requirement for the m-TRP PMI reporting should not consider single TRP reporting and be defined only within the context of m-TRP reporting.
* Recommended WF
  + Apply test metric of TP ratio follow PMI and random PMI with m-TRP reporting. The layer for random PMI per TRP should be orthogonal

**Issue 3-2-7: Performance evaluation**

* Proposals
  + Option 1 (Apple): Evaluate performance of PMI reporting with enhanced CSI reporting against single PMI reporting for multi-TRP transmission.
* Recommended WF
  + Please proponents of proposal clarify the intension of performance evaluation

## Companies views’ collection for 1st round

### Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

Sub topic 3-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 3-1-1 |
| Nokia, Nokia Shanghai Bell | Issue 3-1-1  Single-DCI:  Nokia would prefer CQI, RI and PMI, but can compromise on defining new CSI reporting requirement for PMI only for the single-DCI based Multi-TRP scheme.  Multi-DCI:  For multi-DCI cases with non-overlapping PDSCH resources, the PMI/RI calculations for each TRP are not different from legacy. CQI on the other hand is shared among TRPs, so the legacy algorithm does no longer apply. Therefore, Nokia still prefer CQI reporting if feasible from a work plan perspective |
| Intel | Issue 3-1-1  For multi-TRP Tx scheme RAN1 has designed enhanced CSI feedback that assumes reporting of single CQI, and two PMI and RI values. For single-DCI based Tx scheme, considering reception of overlapped MIMO layers from two different TRPs, calculation of CQI, PMI and RI values are different compared to a single-TRP Tx scenario. Therefore, we see a necessity to define CQI, PMI and RI reporting requirements for single-DCI based Tx scheme.  The same enhanced CSI feedback mechanism is applied for multi-DCI based Tx scheme. For non-overlapped configuration only CQI calculation is different compared to the single-TRP scenario since UE should report single CQI value. Therefore, we recommend also defining requirements for CQI reporting for multi-DCI non-overlapped Tx scheme. Otherwise, system performance cannot be guaranteed for multi-DCI Tx scheme. |
| Apple | **Issue 3-1-1: Test cases for CSI reporting enhancement for m-TRP transmission**  Single DCI SDM – PMI reporting only  Multi-DCI transmission – Do not define CQI reporting requirements. Since there are no CSI enhancements for multi-DCI transmission, we don’t see the need to define such requirements. The NW can always configure different NZP CSI-RS from different TRP and UE reports. Its up to the gNB how the CSI reports are used. Also, how is CQI/CSI reporting different in case NZP CSI-RS are from different TRP or multiple NZP CSI-RS from same TRP. |
| Qualcomm | **Issue 3-1-1: Test cases for CSI reporting enhancement for m-TRP transmission**  Single DCI: Only PMI reporting for SDM transmission  Multi-DCI: We support Option 2  From CQI/CSI processing point of view, we are of the opinion that multi-DCI processing is not different compared to that of single DCI transmission. Hence, we don’t see a need to define such requirement. Also, our understanding is that multi-DCI is not part of the FeMIMO WID for “Enhancement on CSI measurement and reporting” (item 4). |
| Ericsson | **Issue 3-1-1: Test cases for CSI reporting enhancement for m-TRP transmission**  For single DCI: UE will benefit the most from PMI reporting of m-TRP enhancement on CSI. Considering the workload and limited timeslot, we support only define PMI reporting requirement.  For multi-DCI: PMI and RI reporting are the same with legacy processing. CQI reporting is different but with no enhanced algorithm. We don’t support define CSI reporting requirement for multi-DCI transmission. |

Sub topic 3-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 3-2-1  Issue 3-2-2  Issue 3-2-3  Issue 3-2-4  Issue 3-2-5  Issue 3-2-6  Issue 3-2-7 |
| Apple | **Issue 3-2-5: Number of layers**  Option 1. We don’t see the need to introduce 4 layers for 4RX. 2 layers in total is sufficient. Also we try to use the same test setup and simulation assumptions for 2RX and 4RX.  **Issue 3-2-7: Performance evaluation**  Our intention is to evaluate the performance of enhanced CSI processing for mTRP against PMI reports for multi-TRP with different resources configured from each TRP. For enhanced CSI the UE needs advanced processing. With multiple reports the gNB needs to combine appropriately. It would be worth evaluating if enhanced receiver processing is indeed beneficial. |
| Qualcomm | **Issue 3-2-1: Common simulation assumption**  We support the recommended WF  **Issue 3-2-2: General test set-up for CSI reporting**  Could proponent of the WF consider pulling Option 3 into the recommended WF? Then we could support the recommended WF.  **Issue 3-2-3: CSI resource configuration**  We support the recommended WF  **Issue 3-2-4: Number of CSI-RS Ports**  We support option 1. We think precoding gain could be minimal with only 4-port for PMI reporting. Therefore, we suggest going with 8-port configuration as a starting point.  **Issue 3-2-5: Number of layers**  We support Option 1 |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Topic #4: PMI reporting requirement for Rel-17 enhanced Type II PS codebook

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2204784 | Samsung | Proposal 4: Introduce PMI test case for enhanced Type II PS codebook under SU-MIMO set-up  Proposal 5: For BF CSI-RS, two methods can be considered:   * Alt 1: MIMO fading channel as Rel-13 LTE Class B K=1 PMI test cases * Alt 2: Power scaling method similar as Rel-13 LTE Class B K>1 CRI test case |
| R4-2204829 | Nokia | Requirements:  Observation 1: The Rel-17 feTypeIIPS codebook is (for the UE) a lower complexity version of Rel-16 eTypeIIPS style of codebooks, which can be equally well applied to both MU and SU MIMO scenarios.  Observation 2: The Rel-17 further enhanced type II port selection codebook is structurally, computationally, and implementation wise, very distinct from the Rel-16 PS codebook and requirements do not exist for any codebooks with comparable structure.  Proposal 1: Define PMI requirement for Rel-17 feType II port selection, for FDD FR1.  Test setup:  Observation 3: Standardization of a test procedure for feType II PS performance requirements is a complex problem, in particular if the SS/BS algorithm for UL/DL reciprocity based beam selection is to be modelled.  Proposal 2: Include feType II PS performance requirements utilizing CSI-RS transmission with a predetermined beam selection used in the transmission.  Observation 4: TE complexity reduction and UL/DL reciprocity modelling can be achieved with known test setups.  Observation 5: An important use case for the feType II PMI is to enhance MU-MIMO throughput by providing a much more accurate representation of the strongest channel eigenvectors than Type I single panel PMI. This allows the gNB to steer the beams of co-scheduled UEs in each other’s null space with less residual interference.  Observation 6: SU-MIMO throughput is less sensitive than MU-MIMO to PMI inaccuracies because MU-MIMO throughput is limited by interference between co-scheduled UEs.  Observation 7: A DUT could in practice be able to report a feType II PMI that does not represent well the main eigenvectors of the channel and still pass an SU-MIMO test for feType II, because the throughput difference between Type I SP and feType II is not large enough for SU-MIMO transmission.  Proposal 3: RAN4 to evaluate both SU-MIMO and MU-MIMO options for the propagation environment and/or interference setting, when determining the Rel-17 feType II PS performance requirements. |
| R4-2205426 | Ericsson | Proposal 1: Consider defining PMI requirement for Rel-17 eType II port selection only if RAN4 can reach an agreement on a simplified way of testing with SU-MIMO test set-up, otherwise not to define requiremen***t.*** |
| R4-2205777 | Huawei | Proposal 1: Define PMI reporting requirement for Rel-17 FeTypeII port selection codebook based on evaluation on the performance gain over eTypeII codebook.  Proposal 2: Only consider SU-MIMO setup if PMI reporting requirement for FeTypeII port selection is introduced.  Proposal 3: Further discuss the modeling method if PMI reporting requirement for FeTypeII port selection is introduced. |

## Open issues summary

Last RAN4 meeting agreeements in the WF R4-2203090/91/92

List of open issues

* Sub-topic 4-1 Test Scope
  + Issue 4-1-1: Whether to define PMI requirement for Rel-17 FeTye II PS codebook
* Sub-topic 4-2: Test setup of PMI reporting requirement for FeType II PS codebook if introduced
  + Issue 4-2-1: General Test seup of PMI reporting requirement
  + Issue 4-2-2: Modelling BF CSI-RS Port

### Sub-topic 4-1: Test Scope

**Issue 4-1-1: Whether to define PMI requirement for Rel-17 FeTye II PS codebook**

* Observations
  + Observation1(Nokia):
    - The Rel-17 feTypeIIPS codebook is (for the UE) a lower complexity version of Rel-16 eTypeIIPS style of codebooks, which can be equally well applied to both MU and SU MIMO scenarios.
    - The Rel-17 further enhanced type II port selection codebook is structurally, computationally, and implementation wise, very distinct from the Rel-16 PS codebook and requirements do not exist for any codebooks with comparable structure.
* Proposals
  + Option 1 (Samsung, Nokia, Huawei): Yes
    - Option 1a(Huawei): Define PMI reporting requirement for Rel-17 FeTypeII port selection codebook based on evaluation on the performance gain over eTypeII codebook.
    - Option 1b(Ericsson): Consider defining PMI requirement for Rel-17 eType II port selection only if RAN4 can reach an agreement on a simplified way of testing with SU-MIMO test set-up, otherwise not to define requirement**.**
* Recommended WF
  + Encourage comments if any
  + Encourage companies to check whether it is acceptable to define PMI reporting requirement for Rel-17 FeTypeII port selection codebook based on majority view?

### Sub-topic 4-2: Test setup of PMI reporting requirement for FeType II PS codebook if introduced

**Issue 4-2-1: General Test seup of PMI reporting requirement**

* Observations
  + Observation 1 (Nokia):
    - Option 1b(Ericsson): Consider defining PMI requirement for Rel-17 eType II port selection only if RAN4 can reach an agreement on a simplified way of testing with SU-MIMO test set-up, otherwise not to define requirement**.** Standardization of a test procedure for feType II PS performance requirements is a complex problem, in particular if the SS/BS algorithm for UL/DL reciprocity based beam selection is to be modelled.
    - TE complexity reduction and UL/DL reciprocity modelling can be achieved with known test setups.
    - An important use case for the feType II PMI is to enhance MU-MIMO throughput by providing a much more accurate representation of the strongest channel eigenvectors than Type I single panel PMI. This allows the gNB to steer the beams of co-scheduled UEs in each other’s null space with less residual interference.
    - SU-MIMO throughput is less sensitive than MU-MIMO to PMI inaccuracies because MU-MIMO throughput is limited by interference between co-scheduled UEs.
    - A DUT could in practice be able to report a feType II PMI that does not represent well the main eigenvectors of the channel and still pass an SU-MIMO test for feType II, because the throughput difference between Type I SP and feType II is not large enough for SU-MIMO transmission.
* Proposals
  + Option 1 (Nokia): Both SU-MIMO and MU-MIMO
  + Option 2 (Samsung, Huawei, Ericsson): SU-MIMO
* Recommended WF
  + Option 2

**Issue 4-2-2: Modelling BF CSI-RS Port**

* Proposals
  + Option 1 (Samsung)
    - Option 1a: MIMO fading channel as Rel-13 LTE Class B K=1 PMI test cases
    - Option 1b: Power scaling method similar as Rel-13 LTE Class B K>1 CRI test case
  + Option 2(Huawei)
    - Further discuss the modeling method if PMI reporting requirement for FeTypeII port selection is introduced.
  + Option 3(Nokia)
    - Include feType II PS performance requirements utilizing CSI-RS transmission with a predetermined beam selection used in the transmission.
* Recommended WF
  + Encourage comments if any.

## Companies views’ collection for 1st round

### Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

Sub topic 4-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 4-1-1 |
| Nokia, Nokia Shanghai Bell | Issue 4-1-1  Nokia agree with the WF. We would like to agree with option 1b to have PMI as baseline pending acceptance from the Test Equipment vendors for test set-up. |
| Intel | Support to define PMI requirement for Rel-17 FeTye II PS codebook. |
| Apple | We don’t support introducing requirements for FeType II port selection. No requirements for PS have been introduced since Rel-15 because of the complexity to test it. Its not only UE, but also the gNB that needs to have the right processing for PS. How is the gNB processing proposed to be tested? |
| Qualcomm | **Issue 4-1-1: Whether to define PMI requirement for Rel-17 FeTye II PS codebook**  Our understanding is that FeTypeII PS CB would require implementation of the CB at the gNB side (based on the estimated delay/angle from UL reference signal), which is not standardized. Furthermore, requirements were not defined in earlier releases for PS CB, therefore no baseline performance is available. Considering the above limitations, we are not in favor of introducing requirement for FeTypeII PS CB. |
| Ericsson | Issue 4-1-1:  We prefer to discuss the possible test procedure and test metric first and then come back to whether to define such requirement  Regarding to the test metric, if we simply compare the performance with Type I random, then how can we tell the enhancement is really from eType II PS CB? We lack baseline performance for comparison. |

Sub topic 4-2

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 4-2-1  Issue 4-2-2 |
| Nokia, Nokia Shanghai Bell | Issue 4-2-1  Agree on SU-MIMO and FFS for MU-MIMO  Issue 4-2-2  We are currently further evaluating the options suggested by Samsung. |
| Ericsson | Issue 4-2-1:  Support option 2 if it is introduced.  Issue 4-2-2:  Need further check. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Topic #5: Other

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2203779 | Apple | **PMI reporting in ICI**  Proposal 7: RAN4 further evaluates PMI reporting in ICI before deciding to introduce requirements.  Proposal 8: For further evaluation of PMI reporting in ICI use the following simulation assumptions:   * Antenna config: 8x2 XP High * Prop. channel model: TDLA30-5; ensure that channel from target and interference cell are statistically independent and have different beam direction (to ensure PMI are different) * NZP CSI-RS for interference:   + Overlapping with serving cell   + Non-overlapping with serving cell * CSI-IM for interference: non overlapping with CSI-IM for serving cell * Loading for interference cell: PDSCH transmission is enabled in all slots for interference cell   Proposal 9: Evaluate performance based on TP ratio with and with ICI for (1) overlapping NZP CSI-RS (2) non-overlapping NZP CSI-RS.  Proposal 10: The scope of PMI reporting in ICI is approved in FeMIMO WID or part TEI-17 for further discussion in RAN4. |
| R4-2204784 | Samsung | Observation 1: PMI reporting with inter-cell colliding NZP CSI-RS interference belongs to generic network scheduling issues, not related to the objectives/features in FeMIMO WI and which is out of Rel-17 FeMIMO WI scope.  Proposal 6: NO discussion/handling of the topic for PMI reporting under inter-cell interference in Rel-17 FeMIMO WI.   * This issue can be handled under either TEI-17 or Rel-18 specific WI pending on the consensus in RAN4. |
| R4-2205425 | Ericsson | Observation 1: When interfering cell is strong at the cell edge, the corresponding spatial covariance matrix of the interference term of the channel estimate, , does not only deviate from being spatially white, but it also equals to the spatial covariance of the interfering cell.  Observation 2: Due to the current NR CSI-RS design, where CSI-RS sequences of different ports are not randomized but same for multiple ports, leads to that is very far from spatially white which causes false PMI selection.  Observation 3: Network deployments where cell planning is used for CSI-RS can only partially mitigate the problem in the general case, due to strongly interfering stray signals transmitted from cells further away which are commonly observed in e.g., metropolitan deployments.  Observation 4: Network deployment with colliding CSI-RS between all cells have significant benefits to the operator in terms of no need for such network planning, ease of network densification and evolution when adding new sites, lower reference signal overhead and low interference at low load in network. Deploying with non-colliding RS should be avoided due to these reasons.  Proposal 1: RAN4 to first evaluate the impact brought by false PMI reporting solution, then discuss a proper model to reveal this issue, and consider introducing the corresponding PMI reporting requirement to resolve this issue.  Observation 5: Colliding CSI-RS with 3GPP sequence(original) has the worst performance across the whole SNR range. The throughput loss is more than 10%.  Observation 6: Non-colliding or new sequence for CSI-RS improves performance but has other drawbacks as discussed in this contribution  Observation 7: There is an obviously performance degradation when false PMI reporting configured using the ‘wrong W1 model’. |
| R4-2205778 | Huawei | Proposal 1: Firstly focus on the RAN1 feature for FeMIMO demodulation requirements definition considering the limitation TU for RAN4 FeMIMO performance part. |
| R4-2205908 | MTK | Observation 1: There is throughput degradation when UE report wrong PMI under the scenario of inter-cell interference.  Proposal 1: Define PMI requirements for the scenario of inter-cell interference.  Proposal 2: The test metric can be throughput ratio between follow PMI with inter-cell interference and follow PMI without interference. |

## Open issues summary

Last RAN4 meeting agreeements in the WF R4-2203090/91/92

List of open issues

* Sub-topic 5-1 PMI reporting requirement with inter-cell interference
  + Issue 5-1-1: whether to define PMI reporting requirement for inter-cell interference scenario in Rel-17 FeMIMO
  + Issue 5-1-2: PMI reporting with inter-cell interference evaluation assumption
  + Issue 5-1-3: Test metric of PMI reporting with inter-cell interference

### Sub-topic 5-1: PMI reporting requirement with inter-cell interference

**Issue 5-1-1: whether to define PMI reporting requirement for inter-cell interference scenario in Rel-17 FeMIMO**

* Observations
  + Observation 1 (Samsung): PMI reporting with inter-cell colliding NZP CSI-RS interference belongs to generic network scheduling issues, not related to the objectives/features in FeMIMO WI and which is out of Rel-17 FeMIMO WI scope.
  + Observation 2 (Ericsson):
    - Observation 1: When interfering cell is strong at the cell edge, the corresponding spatial covariance matrix of the interference term of the channel estimate, , does not only deviate from being spatially white, but it also equals to the spatial covariance of the interfering cell.
    - Observation 2: Due to the current NR CSI-RS design, where CSI-RS sequences of different ports are not randomized but same for multiple ports, leads to that is very far from spatially white which causes false PMI selection.
    - Observation 3: Network deployments where cell planning is used for CSI-RS can only partially mitigate the problem in the general case, due to strongly interfering stray signals transmitted from cells further away which are commonly observed in e.g., metropolitan deployments.
    - Observation 4: Network deployment with colliding CSI-RS between all cells have significant benefits to the operator in terms of no need for such network planning, ease of network densification and evolution when adding new sites, lower reference signal overhead and low interference at low load in network. Deploying with non-colliding RS should be avoided due to these reasons.
    - Observation 5: Colliding CSI-RS with 3GPP sequence (original) has the worst performance across the whole SNR range. The throughput loss is more than 10%.
    - Observation 6: Non-colliding or new sequence for CSI-RS improves performance but has other drawbacks as discussed in this contribution
    - Observation 7: There is an obviously performance degradation when false PMI reporting configured using the ‘wrong W1 model’.
  + Observation 3(MTK):
    - There is throughput degradation when UE report wrong PMI under the scenario of inter-cell interference.
* Proposals
  + Option 1(Huawei, Samsung): No
    - Option 1a (Huawei): Firstly focus on the RAN1 feature for FeMIMO demodulation requirements definition considering the limitation TU for RAN4 FeMIMO performance part.
    - Option 1b (Samsung): NO discussion/handling of the topic for PMI reporting under inter-cell interference in Rel-17 FeMIMO WI
* This issue can be handled under either TEI-17 or Rel-18 specific WI pending on the consensus in RAN4
  + Option 2(Ericsson): RAN4 to first evaluate the impact brought by false PMI reporting solution, then discuss a proper model to reveal this issue, and consider introducing the corresponding PMI reporting requirement to resolve this issue
  + Option 3 (MTK, Ericsson): RAN4 defines PMI reporting requirement for inter-cell interference scenario
  + Option 4(Apple):
    - RAN4 further evaluates PMI reporting in ICI before deciding to introduce requirements.
    - The scope of PMI reporting in ICI is approved in FeMIMO WID or part TEI-17 for further discussion in RAN4.
* Recommended WF
  + Encourage comments if any
  + Based on WID of Rel-17 FeMIMO WI, PMI reporting with inter-cell interference is out of FeMIMO WI scope. Following WID, moderator suggest to not define PMI reporting requirement with inter-cell interference in Rel-17 FeMIMO WI. Encourage companies to check whether it is acceptable?
  + FFS on discussion and handling of PMI reporting requirement with inter-cell interference under either TEI-17 or Rel-18 specific WI pending on the consensus of RAN4 group

**Issue 5-1-2: PMI reporting with inter-cell interference evaluation assumption**

* Proposals
  + Option 1(Apple): For further evaluation of PMI reporting in ICI use the following simulation assumptions:
    - Antenna config: 8x2 XP High
    - Prop. channel model: TDLA30-5; ensure that channel from target and interference cell are statistically independent and have different beam direction (to ensure PMI are different)
    - NZP CSI-RS for interference:
* Overlapping with serving cell
* Non-overlapping with serving cell
  + - CSI-IM for interference: non overlapping with CSI-IM for serving cell
    - Loading for interference cell: PDSCH transmission is enabled in all slots for interference cell
    - Evaluate performance based on TP ratio with and with ICI for (1) overlapping NZP CSI-RS (2) non-overlapping NZP CSI-RS
* Recommended WF
  + Pending on issue 5-1-1

**Issue 5-1-3: Test metric of PMI reporting with inter-cell interference**

* Proposals
  + Option 1(MTK)
    - TP ratio with following PMI with inter-cell interference and follow PMI without interference
* Recommended WF
  + Pending on issue 5-1-1

## Companies views’ collection for 1st round

### Open issues

*One of the two formats, i.e. either example 1 or 2 can be used by moderators.*

Sub topic 5-1

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 5-1-1  Issue 5-1-2  Issue 5-1-3 |
| Apple | **Issue 5-1-1: whether to define PMI reporting requirement for inter-cell interference scenario in Rel-17 FeMIMO**  We agree with the moderator’s observation. We raised the same issue in last meeting discussion and this meeting that this is not part of FeMIMO enh. We are fine to evaluate if there is agreement to include this as part of FeMIMO WID or as part of TEI if suitable.  Other issues can be decided pending where this issue can be discussed. |
| Qualcomm | **Issue 5-1-1: whether to define PMI reporting requirement for inter-cell interference scenario in Rel-17 FeMIMO**  Given that it may require further evaluation and limited WI time budget, we are in agreement with moderator’s suggestion not to define requirement in inter-cell scenario. Since this will require further evaluation, we are also not sure whether this could be included in TEI, however, we are open to discuss this during Rel-18 timeframe. If possible, we could also request RAN1 to consider re-designing CSI-RS sequences across ports, e.g., randomized with different scrambling sequences. |
| Ericsson | **Issue 5-1-1: whether to define PMI reporting requirement for inter-cell interference scenario in Rel-17 FeMIMO**  We support option 2 and 3. Like many companies suggested in RAN1 discussion, we also found there is a need to address this issue in RAN4, especially when the proposal of revising the CSI-RS sequence was not approved. We found it might be necessary to consider defining such performance requirement to guarantee the performance.  Detailed description and the root cause of this issue can be found in our contribution R4-2205425.  To be simple, when interfering cell is strong at the cell edge, the corresponding spatial covariance matrix of the interference term of the channel estimate, Ree, does not only deviate from being spatially white, but it also equals to the spatial covariance of the interfering cell. So, actually the UE is reporting the wrong PMI to its serving cell.  In our model for initial evaluation, we assume a wrong W1 selection to reflect the wrong PMI reporting from UE. Usually, we calculate the W1 by finding the max wideband power for each antenna. Here, we can use another W1 which does not max the wideband power, this is the wrong W1.  From our initial evaluation, we observed average 2dB performance loss with the model above and colliding CSI-RS configured.  Non-colliding CSI-RS by network planning can solve some of the issue, especially in a perfectly hexagonal site layout. But in reality, there could be street canyon effects, hilly terrain etc where a cell far away strongly interferes in some spots of a serving cell. Besides, non-colliding CSI-RS also has many drawbacks including:   * It requires frequency planning and re-planning of RS resources * It generatesinterference from adjacent cells to PDSCH, even if the adjacent cell has no ongoing traffic * It may generate significant RS overhead due to the use of ZP CSI-RS for protection of PDSCH   Therefore, to consider another way out instead of non-colliding CSI-RS scheduling, we encourage companies to further check and consider the need of such requirement.  **Issue 5-1-2: PMI reporting with inter-cell interference evaluation assumption**  We are fine with option 1 for initial evaluation.  **Issue 5-1-3: Test metric of PMI reporting with inter-cell interference**  We are fine with option 1 for initial evaluation. |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| Moderator (Samsung) | Yunchuan Yang | [yc0301.yang@samsung.com](mailto:yc0301.yang@samsung.com) |
| Nokia, Nokia Shanghai Bell | Karsten Petersen | Karsten.petersen@nokia-bell-labs.com |
| Intel | Artyom Putilin | artyom.putilin@intel.com |
| Apple | Manasa Raghavan | Manasa.raghavan@apple.com |
| Qualcomm | Jahidur Rahman | rahman@qti.qualcomm.com |

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)