**3GPP TSG-RAN WG4 Meeting # 96e R4-200XXXX**

**Electronic Meeting, Aug. 17 – Aug .28, 2020**

**Agenda item:** 7.9.3

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for [96e][320] NR\_eMIMO\_Demod

**Document for:** Information

# Introduction

As agreed in previous RAN4 meeting, the overall impact on RAN4 Performance requirements on Rel-16 eMIMO WI as summarized in below table:

|  |  |  |
| --- | --- | --- |
| Sub-items | BS Demod  | UE Performance |
| UE Demod | CSI |
| Item 1: CSI enhancement for Type II codebook | No | NO | Yes |
| Item 2: Multi-TRP/Panel transmission | Single DCI based transmission schemes | No | Yes | No |
| Multi-DCI based transmission scheme | No | Yes | No |
| Item3:Beam management enhancement | Item3a: L1-SINR measurement | No | No | No |
| Item3b: BFR for Scell | No | No | No |
| Item3c: DL/UL beam indication with reduced latency and overhead | No | No | No |
| Item4: Full TX power UL transmission | No | No | No |
| Item5: Low PAPR RS | NO | NO | No |

The scope of this email discussion mainly focuses to identify the test scope of performance requirements include demodulation and CSI, decide the test set-up including detailed test parameters and introduce corresponding test cases into specifications.

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

* 1st round: Discuss and identify the potential impact on UE performance requirement based on RAN1 feature, and discuss the details test parameters to facilitate the test case setup for requirements. In order to make the discussion more concentrative, some open issues suggested to be deferred into 2nd round.
	+ For detailed test set-up, suggest to focused on FR1 first in 1st round
* 2nd round: Further discuss the left open issue, pending on the progress on 1st round.

# Topic #1: PDSCH demodulation requirements (Multi-Panel/TRP transmission schemes)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2009613** | Apple | Proposal 1: Use RX FFT timing based on TCI state #0 from TRP#1 for multi-TRP transmission.Proposal 2: PDSCH demodulation requirements with multi-DCI transmission scheme are introduced with non-overlapping PDSCH allocationProposal #3: Introduce PDSCH demodulation requirements with multi-DCI with 2TX transmission from each TRP.Proposal #4: Do not introduce demodulation requirements in FR2 for multi-TRP |
| **R4-2009738** | Intel | Observation 1: Performance benefits of single wide Rx beam reception from multi-Panel Tx for cell-edge UEs as well for cell-center UEs are not clear and require further studyObservation 2: To define performance requirements for FR2 single-DCI based multi-TRP TDMShemeA and inter-slot TDM schemes changing of current OTA test methodology is requiredProposal 1: Do not define FR2 performance requirements for reception for multi-TRP/Panel in Rel-16Observation 3: Typical time offset distribution in multi-TRP configuration* Strategy 1
	+ Less than 12% and 8% UEs have TO less than -0.5us for ISD 500m and 200m, respectively.
	+ Less than 3% UEs have TO higher than 2us for ISD 500m and all UEs in scenario with ISD 200m have TO not higher than 1.3us
* Strategy 2
	+ No negative TO values
	+ Less than 4% UEs have TO higher than 2us for ISD 500m and all UEs in scenario with ISD 200m have TO not higher than 1.3us

Observation 4: Link-level analysis show that* With proper TO compensation 2us TO leads to negligible performance degradation for 15 kHz SCS and rather limited loss (<1dB) for 30 kHz SCS
* With proper TO compensation which assumes fixed timing shift with respect to FFT window demodulation performance loss due to negative TO can be fully avoided

Proposal 2: Use 2us and -0.5us TO values for requirement definition for both 15 kHz and 30 kHz SCS.Proposal 3: Deprioritize multi-DCI based multi-TRP/panel scheme with fully and partially overlapped resource allocations.Proposal 4: Consider only 2Tx antenna configuration per each TRP for requirements definition.Observation 5: Single-DCI repetition schemes are features to increase transmission reliabilityProposal 6: Define performance requirements for each single-DCI based multi-TRP repetition Tx scheme.Proposal 7: Use parameters from Table 2 and Annex B as simulation parameters for single-DCI based multi-TRP Tx repetition schemes.Proposal 8: Use 1% BLER as a test metric for single-DCI based multi-TRP repetition Tx schemes performance requirements.Proposal 9: Introduce the following test cases and define applicability rules between them in accordance to tables 3~6:* FO + positive TO:
	+ Single-DCI SDM
	+ Single-DCI FDMSchemeA
	+ Single-DCI FDMSchemeB
	+ Single-DCI TDMSchemeA
	+ Single-DCI inter-slot TDM
* FO + negative TO:
	+ Multi-DCI non-overlapped
 |
| **R4-2010068** | CMCC | Simulation Results |
| **R4-2010140** | Samsung | **Test scope:**Proposal 1: Introducing PDSCH demodulation requirements for transmission schemes related to URLLC operation* For detailed scheme, further down-selected with 1 or 2 scheme(s) from {FDM scheme A, FDM scheme B, TDM scheme A, inter-slot TDM scheme} ;
* We preferred to at least introduce test case covering TDM scheme

Proposal 2: Introduce PDSCH demodulation requirements with Multi-Panel/TRP transmission schemes with below two cases in FR2* Single Tx/Rx beam with same QCL Type –D for multi-TRP transmission (eMBB scheme)
* Multi-TRP transmission with multi-TX beams in TDM manner (URLLC TDM scheme)

**Evaluation results**General observation: It’ s feasible to use the agree test parameters to introduce performance requirementsObservation 1: Without power scaling, 3 dB power offset observed among full-overlapping and non-overlapping cases as show in figure A.1-1Observation 2: Performance with time offset is more sensitive with/without time offset compensation under “TDLA-30” compared to “TDLC-300” fading channel as received path more concentrated as show in figure A.1-2Observation 3: Performance with frequency offset is more sensitive with/without frequency offset compensation under low Doppler spread case “TDLA-30-10Hz” compared to “TDLC-300-100Hz” as show in figure A.1-3.Observation 4: For frequency offset, with 200Hz for FR1 FDD, 300Hz for FR1 TDD:* There is enough performance gap to discriminate different UE behavior with and w/o time/frequency compensation
* The performance loss compared to ideal case (without TO/FO) less than 0.5 dB with proper compensation

Observation 5: For positive time offset, 2us for FR1 FDD, 1us for FR1 TDD* Enough performance gap observed to discriminate UE behaviour
* <0.5dB performance loss compared to ideal case with proper compensation

Observation 6: For positive time offset, 2us for FR1 FDD, 1us for FR1 TDD* Performance gap among different UE behaviour around 1~2 dB
* <1 dB performance loss observed compared ideal case with proper compensation

Observation 7: For FR2* Performance gap around 1.6 dB with 600Hz frequency offset
* Performance gap around 2.4 dB with 0.25us time offset
* Performance gap around 0.2 dB with -0.0625us time offset

**Test Parameters**Proposal 3: Using TP1 is Reference to define timing and frequency offset* Timing offset = time offset among TP2 and TP1
* Frequency offset = frequency offset among TP2 and TP1

Proposal 4: Define performance requirements in receiver agonistic manner* No need to align the receiver assumption, FFT window adjustment strategy up to UE implementation as well as proper performance ensured by requirements

Proposal 5: Introduce both negative and positive time offset among two TPs to ensure proper UE performance considering UE mobility Proposal 6: Introduce time offset as ∆t=2^(-μ) ∆t\_1, ∆t\_1 = [-0.5, 2] μs* The time offset value scaled with SCS
* FR1 FDD 15kHz: {2,-0.5} us
* FR1 TDD 30kHz: {1,-0.25} us

Proposal 7: For FR2, further evaluate below candidate values:* Frequency offset: {1400Hz,2800Hz} which is 0.05~ 0.1 ppm of 28GHz
* Positive time offset: {0.25us, 0.375us, 0.5us} which is 1/8 ~ 1/4 of 2su
* Negative time offset: {-0.0625us, -0.09375us, -0.125 us} which is 1/8 ~ 1/4 of -0.25us

Proposal 8: Using only 2Tx per TRP as antenna configuration to introduce test cases.Proposal 9: Only introduce non-overlapping cases for multi-DCI based on PDSCH requirements.**Overall Test cases**Test case 1: Single-DCI based on PDSCH requirements with fully overlapping resource (eMBB)* Test 1a: Single-DCI with frequency offset and negative time offset
* Test 1b: Single-DCI with positive time offset

Test case 2: Multi-DCI based on PDSCH requirements with non- overlapping resource (eMBB)* Test 2a: Multi-DCI with frequency offset and negative time offset
* Test 2b: Multi-DCI with positive time offset

Test case 3: Single-DCI based on PDSCH requirements (URLLC)* Test 3a: Single-DCI based FDM scheme A with frequency offset and negative time offset
* Test 3b: Single-DCI based inter-slot TDM with positive time offset
 |
| **R4-2010481** | Ericsson | Observation 1: No performance degradation for both mDCI-based FDM (SDM with non-overlapped) and sDCI-based SDM due to the frequency offset. Observation 2: Significant performance impact for both mDCI-based FDM (SDM with non-overlapped) and sDCI-based SDM due to the larger negative time offset. Proposal 1: UE receiver for multi-TRP PDSCH demodulation requirements is up to UE implementation. For alignment purpose, RAN4 should assume that UE always sets the FFT timing based on TCI state #0 (TRP1). ​Proposal 2: Set timing offset to the value in the range Δt=2-μΔt1 with Δt1 = [-0.5, 2] μs. Proposal 3: TRS from different TRP should be non-collided. The signals/channels from all the TRPs should use the same Cell ID. Proposal 4: Configure 2T2R and 2T4R per TRP for multi-TRP PDSCH demodulation requirements.Proposal 5: For frequency offset and timing offset:* Set frequency offset (200Hz for FDD and 300kHz for TDD) and positive time offset (2us for FDD SCS=15kHz and 1us for TDD SCS=30kHz) for mDCI-based SDM.
* Set frequency offset (200Hz for FDD and 300kHz for TDD) and negative time offset (-0.5us for FDD SCS=15kHz and -0.25us for SCS=30kHz) for sDCI-based SDM.

Proposal 6: Not to introduce test case(s) for multi-panel/TRP transmission schemes in FR2.Proposal 7: RAN4 defines PDSCH demodulation requirements for sDCI-based FDM Scheme A.Proposal 8: If UE is capable of two CORESTPoolIndex reception and passes mDCI-based SDM tests, UE can skip sDCI-based FDM Scheme A. Proposal 9: RAN4 uses the 70% of maximum throughput as the test metric of PDSCH demodulation requirements for single-DCI based multi-TRP transmission. |
| **R4-2010719** | MTK | Observation 1: Without compensation, the performance is degraded with 200Hz frequency offset. Observation 2: The performance gap is small for timing offset $∆t $= -0.5 μs and $∆t $= 2 μs |
| **R4-2011012** | Huawei, HiSilicon | Proposal 1: Not to define any test case for single-DCI based multi-panel/TRP transmission schemes (URLLC)Proposal 2: Not to define any FR2 test cases for multi-panel/TRP transmissionObservation 1: Taking TCI state #0 as the reference TP (TRP1) is not strictly clear especially when switching happened.Proposal 3: FFT timing based on TRP with the highest RSRP on sync signals + fixed timing shiftProposal 4: Setting timing offset by scaled with SCSProposal 5: Using only 2us for timing offset valueProposal 6: Not to configure TRS/CSI-RS colliding in multi-panel/TRP transmission test casesProposal 7: Define multi-DCI based PDSCH test cases with only non-overlapping for resource allocationProposal 8: Only use 2T2R, 2T4R for antenna configurationProposal 9: Propose option 2 and option 3 for the number of test cases for multi-DCI scheduled PDSCH requirements:* Option 2:
	+ Test 1 Multi- DCI with frequency offset and Non-overlapping scheduling
	+ Test 2 Multi DCI with positive time offset and Non-overlapping scheduling
* Option 3:
	+ Test 1 Multi- DCI with frequency offset, positive time offset and Non-overlapping scheduling

Proposal 10: Propose option 2 and option 3 for the number of test cases for single-DCI scheduled PDSCH requirements:* Option 2:
	+ Test 1 Single-DCI with frequency offset and overlapping scheduling
	+ Test 2 Single-DCI with positive time offset and overlapping scheduling
* Option 3:
	+ Test 1 Single-DCI with frequency offset, positive time offset and overlapping scheduling
 |
| **R4-2011421** | Qualcomm | Proposal 1: Do not define requirements for URLLC multi-TRP schemesProposal 2: Do not define multi-TRP requirements for FR2Proposal 3: Assume the UE always fixes its FFT timing based on TCI state #0 (TP1) to define RAN4 performance requirements for multi-TRP schemesProposal 4: Define a single test case with both timing offset and frequency offset to limit number of test cases for multi-TRP schemes.Proposal 5: Define multi-DCI multi-TRP requirements only for non-overlapping PDSCH scheduling.Proposal 6: Define multi-DCI multi-TRP requirements only for 2Tx at each TRP. |

## Open issues summary

Last RAN4 meeting agreements in WF R4-2008813 and R4-2008814 as captured in Annex.

List of open issues:

* Sub-Topic 1-1: Test Scope
	+ Issue 1-1-1: Necessity of introducing test case(s) for single DCI-based multi-panel/TRP transmission schemes (URLLC)
	+ Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2
* Sub-Topic 1-2: Generic test set-up
	+ Issue 1-2-1: Reference for timing offset/frequency offset set-up
	+ Issue 1-2-2: Baseline receiver assumption for FFT window timing
	+ Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)
	+ Issue 1-2-4: TRS/CSI-RS configuration
	+ Issue 1-2-5: Timing offset among multi-panel/TRP for FR2 (Postpone to 2nd round)
	+ Issue 1-2-6: Frequency offset among multi-panel/TRP for FR2 (Postpone to 2nd round)
* Sub-Topic 1-3: Test parameters for Multi-DCI based multi-TRP/Panel transmission schemes (eMBB)
	+ Issue 1-3-1: Resource allocation
	+ Issue 1-3-2: Antenna configuration per each TRP
	+ Issue 1-3-3: Number of Test cases
* Sub-Topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)
	+ Issue 1-4-1: Number of Test cases
* Sub-Topic 1-5: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (URLLC)
	+ Issue 1-5-1: Transmission schemes
	+ Issue 1-5-2: Test metric
	+ Issue 1-5-3: Test applicability (Postpone to 2nd round)
	+ Issue 1-5-4: Number of Test cases (Postpone to 2nd round)
	+ Issue 1-5-5: PDSCH configuration for single-DCI based multi-TRP repetition schemes

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

**Issue 1-1-1: Necessity of introducing test case(s) for single DCI-based multi-panel/TRP transmission schemes (URLLC)**

Note: detailed selection of transmission schemes will be discussed under sub-topic 1-5.

* Proposals
	+ Option 1: Yes (Intel, Samsung, Ericsson)
	+ Option 2: No (Huawei, Qualcomm)
* Recommended WF
	+ Companies’ view quite diverse for whether to introduce PDSCH requirements for URLLC single DCI based transmission schemes and the detailed selection of transmission schemes; suggest to discuss and identify the difference from UE processing aspect compared to existing URLLC test cases (URLLC WI) and eMBB operation multi-panel/TRP transmission scheme test cases

**Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2**

* Proposals
	+ Option 1: No (Huawei, Intel, Ericsson, Apple, Qualcomm)
	+ Option 2 (Samsung): Introduce PDSCH demodulation requirements with Multi-Panel/TRP transmission schemes in FR2
* Case 1: Single Tx/Rx beam with same QCL Type-D for multi-TRP transmission (eMBB).
* Case 2: Multi-TRP transmission with multi-Tx beams in TDM manner (URLLC TDM scheme)
* Recommended WF
	+ For case 1: further discuss: Whether the scenario with simultaneous transmission from mTRPs with single Tx/Rx beam direction (only one QCI type-D), where two panels implemented in the same site or two TRPs located in different sites is valid scenario for FR2?
	+ For case 2: considering current OTA Test limitation for demodulation test cases, no test cases for case 2 in Rel-16; and further discuss in future release with consideration of test ability issue

### Sub-topic 1-2: Generic test set-up

**Issue 1-2-1: Reference for timing offset/frequency offset set-up**

* Proposals
	+ Option 1: Using TP1 is Reference to define timing and frequency offset (Samsung, Ericsson)
* Timing offset = time offset among TP2 and TP1
* Frequency offset = frequency offset among TP2 and TP1
* Recommended WF
	+ Agree option 1

**Issue 1-2-2: Baseline receiver assumption for FFT window timing**

In Previous meeting, the assumption for UE receiver implementation is agreed in RAN4#94bis-e meeting

|  |
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| The test case design should be ensure receiver implementation agnostic with assumption of single FFT operation |

* Proposals
	+ Option 1: Using TP1 is Reference to define timing and frequency offset (Samsung, Ericsson)
	+ Option 2: Define performance requirements in receiver agonistic manner (Samsung)
* No need to align the receiver assumption, FFT window adjustment strategy up to UE implementation as well as proper performance ensured by requirements
	+ Option 3: Assume the UE always fixes its FFT timing based on TCI state #0 (TP1) to define RAN4 performance requirements for multi-TRP schemes (Qualcomm, Apple)
	+ Option 4: UE receiver for multi-TRP PDSCH demodulation requirements is up to UE implementation. For alignment purpose, RAN4 should assume that UE always sets the FFT timing based on TCI state #0 (TRP1) (Ericsson)
* Recommended WF
	+ It’s up to UE implementation for FFT windowing timing adjustment strategy; Define performance requirements in receiver agonistic manner. Meanwhile define RAN4 performance requirements based on the assumption of UE fixed FFT timing based on TCI state #0 (TP1 i.e. SSB only transmitted from TP1).

**Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)**

* Proposals
	+ Option 1: Set timing offset of first path from two TRPs by scaled with SCS: $∆t=2^{-μ}∆t\_{1}$, $∆t\_{1} $= [-0.5, 2]μs (Samsung, Ericsson)
	+ Option 2: Not consider negative timing offset, and set timing offset by scaled with SCS $∆t=2^{-μ}∆t\_{1}$, only TO = 2us for 15 kHz SCS, and TO = 1us for 30 kHz SCS (Huawei)
	+ Option 3: Set timing offset TO =2us and TO=-0.5us for both 15KHz and 30KHz SCS, not scaled with SCS (Intel)
* Recommended WF
	+ Positive time offset
* For FR1 FDD with 15kHz : 2us
* For FR1 TDD with 30kHz: further down-select among 2us/1us
	+ Negative time offset:
* Issue 1: further discuss whether negative time offset is valid in real deployment scenario? And whether need to introduce test cases covering negative time offset?
* Issue 2: if introduced, what’s the proper values
* For FR1 FDD with 15kHz: -0.5 us if introduced
* For FR1 TDD with 30kHz: further down-select among -0.5/-0.25us if introduced

**Issue 1-2-4: TRS/CSI-RS configuration**

In Previous meeting, the assumption for generating different scrambling sequence for PDSCH scheduled by multi-DCI is agreed in RAN4#94bis-e meeting

|  |
| --- |
| * Configure different scrambling sequences for PDSCH scheduled by Multi-DCI
 |

* Proposals
	+ Option 1: Non-collided for TRS/CSI-RS from different TRP (Ericsson, Huawei, Qualcomm)
* Recommended WF
	+ Agree to introduce the test cases with non-colliding TRS/CSI-RS in multi-TRP/panel.

**Issue 1-2-5: timing offset among multi-panel/TRP for FR2 (deferred to 2nd round)**

* Proposals
	+ Option 1: Introduce time offset as ∆t=2^(-μ) ∆t\_1, candidate values for further evaluation
* Positive time offset : ∆t\_1 ={0.25us,0.375us,0.5us}, which is 1/8 ~1/4 of 2us
* Negative time offset: ∆t\_1 ={-0.0625us, -0.09375us, -0.125 us }, which is 1/8 ~1/4 of -0.25us
* Recommended WF
	+ Postpone to 2nd round pending on discussion status on issue 1-1-2:

**Issue 1-2-6: Frequency offset among multi-panel/TRP for FR2 (deferred to 2nd round)**

* Proposals
	+ Option 1: Candidate values for further evaluation
* Frequency offset: {1400Hz, 2800Hz}, which is 0.05~0.1 ppm of 28GHz
* Recommended WF
	+ Postpone to 2nd round pending on discussion status on issue 1-1-2:

### Sub-topic 1-3: Test parameters for Multi-DCI based multi-TRP/Panel transmission schemes (eMBB)

 **Issue 1-3-1: Resource allocation**

* Proposals
	+ Option 1: Candidate values for further evaluation Option 1: Only non-overlapping cases (Huawei, Qualcomm, MTK, Samsung, Apple)
	+ Option 2: Deprioritize multi-DCI based multi-TRP/panel scheme with fully and partially overlapped resource allocation (Intel)
* Recommended WF
	+ Agree option 1: Only non-overlapping cases

**Issue 1-3-2: Antenna configuration per each TRP**

* Proposals
	+ Option 1: Only 2T2R, 2T4R (Intel, Huawei, Apple, Ericsson, Samsung)
* Recommended WF
	+ Agree option 1: Only 2T2R, 2T4R

**Issue 1-3-3: Number of test cases**

* Proposals
	+ Option 1: 2 test cases per duplex mode (Samsung)
* Test 1a Multi- DCI with frequency offset and negative time offset and non-overlapping scheduling
* Test 1b Multi DCI with positive time offset and non-overlapping scheduling
	+ Option 2: 2 test cases per duplex mode (Huawei)
* Test 1a Multi- DCI with frequency offset and Non-overlapping scheduling
* Test 1b Multi- DCI with positive time offset and Non-overlapping scheduling
	+ Option 3: 1 test case per duplex mode (Huawei, Ericsson, Qualcomm?)
* Test1 Multi- DCI with frequency offset, positive time offset and Non-overlapping scheduling
	+ Option 4: 1 test case per duplex mode (Intel, Qualcomm?)
* Test1 Multi- DCI with frequency offset, negative time offset and Non-overlapping scheduling
* Recommended WF
	+ Introduce one test case per duplex mode cover both frequency offset and time offset, the values of time offset (positive or negative) pending on the decision on issue 1-2-2 (time offset); meanwhile further discussion the necessity to introduce one additional test case per duplex mode cover only the impact of time offset (negative or positive), separately
	+ Companies’ feedback needed for above proposal, also pending on decision on issue: 1-2-2 (time offset)

### Sub-topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)

**Issue 1-4-1: Number of test cases**

* Proposals
	+ Option 1: 2 test cases per duplex mode (Samsung)
* Test 1a Single DCI with frequency offset, negative time offset and overlapping scheduling (Ericsson, Qualcomm?)
* Test 1b Single DCI with positive time offset and overlapping scheduling
	+ Option 2: 2 test cases per duplex mode (Huawei)
* Test 1a Single DCI with frequency offset and overlapping scheduling
* Test 1b Single DCI with positive offset and overlapping scheduling
	+ Option 3: 1 test case per duplex mode (Huawei, Intel, Qualcomm?)
* Test 1 Single DCI with frequency offset, positive time offset and overlapping scheduling
* Recommended WF
	+ Introduce one test case per duplex mode cover both frequency offset and time offset, the values of time offset (positive or negative) pending on the decision on issue 1-2-2 (time offset); meanwhile further discussion the necessity to introduce one additional test case per duplex mode cover only the impact of time offset (negative or positive), separately
	+ Companies’ feedback needed for above proposal, also pending on decision on issue: 1-2-2 (time offset)

### Sub-topic 1-5: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (URLLC)

**Issue 1-5-1: Transmission schemes**

* Proposals
	+ Option 1: Define performance requirements for all the single-DCI based multi-TRP Tx repetition schemes (FDM Scheme A, FDMSchemeB, TDMSchemeA, Inter-slot TDM)(Intel)
	+ Option 2: Single-DCI based FDM Scheme A (Ericsson)
	+ Option 3: Down-selected with 1 or 2 scheme(s) from { FDM Scheme A, FDM SchemeB, TDMSchemeA, Inter-slot TDM } , at least covering TDM scheme (Samsung)
* Recommended WF
	+ Related to discussion on issue 1-1-2, suggest to discuss and identify any new behaviour from UE processing aspect for each transmission schemes which not verified by existing URLLC test cases (URLLC WI) and eMBB operation multi-panel/TRP transmission scheme test cases

**Issue 1-5-2: Test Metric**

* Proposals
	+ Option 1: 70% TP (Ericsson)
	+ Option 2: 1% BLER (Intel)
* Recommended WF
	+ Companies’ feedback needed for above proposal

**Issue 1-5-3: Test applicability rule**

* Proposals
	+ Option 1(Intel)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Only single-DCI SDM | Only single-DCI repetition scheme(s) | Only multi-DCI without over-ing | Both single-DCI SDM and multi-DCI | Both single-DCI SDM and repetition scheme(s) | Both single-DCI repetition scheme(s) and multi-DCI | Both single-DCI repetition scheme(s), SDM and multi-DCI |
| Single-DCI SDM:FO + positive TO | Yes |  |  | Yes |  |  | Yes |
| Multi-DCI Non-Overlapped:FO + negative TO |  |  | Yes | Yes |  |  | Yes |
| Single-DCI repetition scheme:FO + positive TO |  | Yes(Note 1) |  |  | Yes(Note 1) | Yes(Note 1) |  |
| Note 1: In case of supporting both single DCI based FDM scheme(s) and TDM scheme(s) UE can be tested only for TDM scheme. |

* Only TDM scheme can be tested if UE supporting both single DCI based FDM scheme(s) and TDM scheme(s)
* Only FDMSchemeB can be tested if UE supporting both single DCI based FDMSchemeA and FDMSchemeB
* Only TDMSchemeA can be tested if UE supporting both TDMScheme A and inter-slot TDMrepetition schemes
* Only TDM can be tested if UE supporting both FDM and TDM repetition schemes
	+ Option 2: If UE is capable of two CORE CORESTPoolIndex reception and passes mDCI-based SDM tests, UE can skip sDCI-based FDM Scheme A (Ericsson)
* Recommended WF
	+ Companies’ feedback needed for above proposal, also pending on decision on issue: 1-5-1 (transmission scheme)

**Issue 1-5-4: Number of test cases**

* Proposals
	+ Option 1(Samsung): 2 test cases per duplex mode
* Test 1a (Samsung, Ericsson): Single-DCI based FDM scheme A with frequency offset and negative time offset
* Test 1b: Single-DCI based inter-slot TDM with positive time offset
	+ Option 2 (Intel): 4 test cases per duplex mode
* Test 1a: Single-DCI based FDMScheme A with frequency offset and positive time offset
* Test 1b: Single-DCI based FDMScheme B with frequency offset and positive time offset
* Test 1c: Single-DCI based TDMScheme A with frequency offset with positive time offset
* Test 1b: Single-DCI based inter-slot TDM with frequency offset with positive time offset
* Recommended WF
	+ Companies’ feedback needed for above proposal, also pending on decision on issue: 1-2-2, 1-5-1 (resource allocation) and 1-2-2 (time offset)

**Issue 1-5-5: PDSCH configuration for single-DCI based multi-TRP repetition schemes**

* Proposals
	+ Option 1(Intel):
* Reused the parameters (TDD configuration, SSB and CSI-RS configuration, PDCCH setup, Propagation conditions and TO/FO) agreed for single-DCI based Tx scheme for each repetition scheme
* MCS 13
* Resource configuration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | FDMSchemeA | FDMSchemeB | TDMSchemeA | Inter-slot TDM |
| Mapping type | Type A | Type A | Type A | Type A |
| Resource allocation type | Type 1 | Type 1 | Type 1 | Type 1 |
| DMRS configuration | Type 1, 1+1 | Type 1, 1+1 | Type 1, No additional symbols | Type 1, 1+1 |
| Antenna port index | {1000} for TCI#1 and {1001} for TCI#2 | {1000} for TCI#1 and {1001} for TCI#2 | {1000} for TCI#1 and {1001} for TCI#2 | {1000} for TCI#1 and {1001} for TCI#2 |
| Start symbol and time duration | PDSCH#1: 2, 12PDSCH#1: 2, 12 | PDSCH#1: 2, 12PDSCH#1: 2, 12 | PDSCH#1: 2, 6PDSCH#1: 8, 12 | PDSCH#1: 2, 12PDSCH#1: 2, 12 |
| FDD PRB allocation | PDSCH#1: PRB#0 to PRB#25PDSCH#2: PRB#26 to PRB#51 | PDSCH#1: PRB#0 to PRB#25PDSCH#2: PRB#26 to PRB#51 | PDSCH#1: PRB#0 to PRB#51PDSCH#2: PRB#0 to PRB#51 | PDSCH#1: PRB#0 to PRB#51PDSCH#2: PRB#0 to PRB#51 |
| TDD PRB allocation | PDSCH#1: PRB#0 to PRB#52PDSCH#2: PRB#53 to PRB#105 | PDSCH#1: PRB#0 to PRB#52PDSCH#2: PRB#53 to PRB#105 | PDSCH#1: PRB#0 to PRB#105PDSCH#2: PRB#0 to PRB#105 | PDSCH#1: PRB#0 to PRB#105PDSCH#2: PRB#0 to PRB#105 |

* Recommended WF
	+ Companies’ feedback needed for above proposal, also pending on decision on issue: 1-2-1, 1-5-1 (resource allocation) and 1-2-2 (time offset)

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CompanyA | **Sub-Topic 1-1: Test Scope*** Issue 1-1-1: Necessity of introducing test case(s) for single DCI-based multi-panel/TRP transmission schemes (URLLC)
* Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2

**Sub-Topic 1-2: Generic test set-up*** Issue 1-2-1: Reference for timing offset/frequency offset set-up
* Issue 1-2-2: Baseline receiver assumption for FFT window timing
* Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)
* Issue 1-2-4: TRS/CSI-RS configuration
* Issue 1-2-5: Timing offset among multi-panel/TRP for FR2 (Postpone to 2nd round)
* Issue 1-2-6: Frequency offset among multi-panel/TRP for FR2 (Postpone to 2nd round)

**Sub-Topic 1-3: Test parameters for Multi-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-3-1: Resource allocation
* Issue 1-3-2: Antenna configuration per each TRP
* Issue 1-3-3: Number of Test cases

**Sub-Topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-4-1: Number of Test cases

**Sub-Topic 1-5: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (URLLC)*** Issue 1-5-1: Transmission schemes
* Issue 1-5-2: Test metric
* Issue 1-5-3: Test applicability (Postpone to 2nd round)
* Issue 1-5-4: Number of Test cases (Postpone to 2nd round)
* Issue 1-5-5: PDSCH configuration for single-DCI based multi-TRP repetition schemes
 |
| Intel | **Sub-Topic 1-1: Test Scope*** **Issue 1-1-1: Necessity of introducing test case(s) for single DCI-based multi-panel/TRP transmission schemes (URLLC)**

To define performance requirements the usual practice is based on two main reasons:1. Specific demodulation processing

As was discussed on the previous meeting all multi-TRP Tx schemes correspond to different UE features. In this case there is a possibility that particular UE may support, for instance, FDMSchemeA and do not support other Tx schemes like SDM which is more complex. In this case demodulation performance will not be guaranteed if RAN4 define requirements only for multi-DCI based and single-DCI based SDM Tx schemes. The common essential difference between all schemes is a resource allocation approach which is completely different for each scheme. Beside that there are specific receive processing difference for each scheme:“FDMSchemeA”: It is a simplest Tx scheme in terms of receive processing since it operates with only one codeword and comparing to SDM scheme it does not deal with inter-layer interference. In this case it is more likely that simplest URLLC capable device will support this scheme - not SDM, especially considering RAN1 system-level observations that SDM scheme provides less reliability than FDM/TDM schemes and more suitable for eMBB rather than for URLLC use cases [R1-1905064]. “FDMSchemeB”: In order to provide reliable performance UE needs to properly combine Tx occasions with different RVs. Potentially it can impact soft buffer implementation since in normal conditions UE does not apply HARQ combining in slots with first HARQ indices and do not combine different codewords. “TDMSchemeA”: Specific resource allocation approach may impact overall demodulation processing implementation. Some companies mentioned that this scheme is similar to mini-slot repetition in single-TRP Tx scenario. Same time they correspond to different UE capabilities and demodulation flow between scenarios with Single-TRP Tx and multi-TRP Tx is completely different.“Inter-slot TDM”: Specific resource allocation approach may impact overall demodulation processing implementation. Some companies mentioned that this scheme is similar to slot-aggregation in single-TRP Tx scenario. Same time they correspond to different UE capabilities and demodulation flow between scenarios with Single-TRP Tx and multi-TRP Tx is completely different. 1. Performance gains

Based on RAN1 link-level analysis “FDM” schemes outperforms SDM scheme in terms of demodulation performance. About 1~2 dB difference can be observed due to inter-layer interference and less accurate channel estimation in SDM scheme.[ R1-1905026, R1-1905030, R1-1904313]Considering defined UE features separation and provided receive processing different for each scheme as well as observed performance gains for repetition Tx schemes comparing to SDM scheme we support requirements definition for repetition schemes (Option 1)**Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2**Case 1: From system design perspective both options (two panels implemented in the same site or two TRPs located in different sites with single Rx beam reception) are valid. Same time performance benefits of such operation for FR2 are not clear. Scenario with single Tx TRP/panel with single narrow beam reception is more preferable due to higher antenna Rx gain comparing to wide Rx beam reception in FR2. At this stage we do not see any performance benefits that these scenarios may bring. Therefore, we think that these scenarios will not be used in real field. In this case there is no necessity to define corresponding requirements. Case 2: Agree with recommended WF for case 2. **Sub-Topic 1-2: Generic test set-up*** **Issue 1-2-1: Reference for timing offset/frequency offset set-up**

Agree with recommended WF. * **Issue 1-2-2: Baseline receiver assumption for FFT window timing**

This issue strictly related to SSB configuration during the test procedure. In real field there are several options on how SSB can be transmitted in multi-TRP Tx scenario: Option1: SSB is transmitted only from one TRP; Option 2: SSB is transmitted from both TRPs with same SSB index (SFN manner); Option3: SSB is transmitted from both TRPs with different SSB indices but all of them correspond to same physical cell-Id. Considering QCL relationship between SSB and transmitted TRSs options 1 and 2 potentially may lead to large performance degradation since propagation conditions on TRSs might be completely different comparing to SSB propagation conditions in terms of delay and Doppler characteristic. Same time option 3 allows to accurately estimate propagation conditions from each TRP.However, from test methodology perspective option 3 leads to increased test complexity since in this case it is not clear how to set TO between two TRPs since during the test UE may set its timing based on both TRPs. To simplify the test option1 might be considered especially considering the agreement on Issue 1-2-1 in which TO/FO are added to the second TRP. In result, we agree with recommended WF but would like to slightly change the wording:It’s up to UE implementation for FFT windowing timing adjustment strategy; Define performance requirements in receiver **agnostic** manner. Meanwhile define RAN4 performance requirements based on the assumption of UE **sets** FFT timing based on TCI state #0 (TP1 i.e. SSB only transmitted from TP1).Regarding SSB configuration we support option when SSB is transmitted only from one TRP.* **Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)**

Positive TO:Based on our link-level simulation results 2us TO leads to rather limited performance degradation (< 1dB) for 30 kHz SCS comparing to scenario without TO. Considering obtained reliable performance we suggest using same 2us TO for both 15 kHz and 30 kHz SCSs which will mean that from performance requirements perspective RAN4 does not restrict the multi-TRP deployments for 30 kHz SCS (ISD) and 15 kHz and 30 kHz might be deployed in same cells.Negative TO:Based on our system level simulation results depending on UE synchronization strategy both positive and negative TO might be present in multi-TRP deployments. Due to large scale channel model parameters, potential blockages negative TO might appear in real field. In this case we think that it is necessary to have requirements not only with positive but also with negative TO.Based on provided link-level simulation results there is no need to scale negative TO with SCS for FR1 since there is no performance difference between scenarios with -0.5us TO and without TO for 30 kHz SCS. In total we propose to define requirements for both positive and negative TO and do not apply scaling regarding SCS.* **Issue 1-2-4: TRS/CSI-RS configuration**

Agree with recommended WF with slightly modified wording which reflect previous discussions: “Agree to introduce the test cases with **only** non-colliding TRS/CSI-RS in multi-TRP/panel”**Sub-Topic 1-3: Test parameters for Multi-DCI based multi-TRP/Panel transmission schemes (eMBB)*** **Issue 1-3-1: Resource allocation**

Agree with recommended WF * **Issue 1-3-2: Antenna configuration per each TRP**

Agree with recommended WF* **Issue 1-3-3: Number of Test cases**

To reduce work efforts one test case per Duplex mode is a reasonable assumption. In this case we are fine with first part of the proposed WF. Same time we do not see necessity to continue discussion regarding separate test case introduction to test only TO compensation. Nothing new will be tested comparing to test with both TO and FO. **Sub-Topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)*** **Issue 1-4-1: Number of Test cases**

Same view as on Issue 1-3-3: One test case per Duplex mode is enough and there is no need to introduce additional test case to cover only TO impact. Beside that we would like to capture that if both positive and negative TO will be agreed to introduce, then different TO should be used in multi-DCI and single-DCI based test cases. |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going 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:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

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

|  |  |
| --- | --- |
| **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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: CSI requirements(Rel-16 TypeII codebook)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| **R4-2011366** | Ericsson | Observation 1: A SU-MIMO test cannot be used for Type II CSI reporting since the performance benefit of Type II feedback is not visible. This is due to that SU-MIMO doesn’t take advantage of the rich channel feedback of Type II reportingObservation 2: In MU-MIMO scenario with rich channel environment (CDL) employing ZF precoding with Type II CSI feedback provides the gNB with sufficient information to schedule multiples UEs close to each other with high MCS and rank. Observation 3: Type I CSI feedback does not provide sufficient information for the ZF algorithm to correctly calculate the most suitable precoders to achieve FRC maximum throughput.Observation 4: Zero-forcing algorithm is needed to properly cancel out interference in between the two scheduled UEs.Proposal: Configure paramCombination-r16 = 6, R = 1.Proposal: Use same parameters as Rel-15 Type II MU-MIMO PMI test case design where applicable. |
| **R4-2009614** | Apple | Observation 1: For link level assessment, no performance improvement would be observed with MU-MIMO compared to SU-MIMO test setupObservation 2: There is no impact on UE PMI reporting based on no knowledge of co-scheduled UE and baseline receiver as MMSE-IRC with MU-MIMO setup compared to SU-MIMOObservation 3: MU-MIMO setup is more complicated compared to SU-MIMO, involving aligning scheduling mode with co-scheduled UE.Proposal 1: Use SU-MIMO test setup for requirements for PMI reporting with enhanced Type II codebook.Proposal #2: For enhanced Type II codebook, introduce requirements with SU-MIMO test setup with the following assumptions:* ParamCombination-r16: 6, with L =4, pν =1/2, β=1/2.
* Codebook parameter configuration, paramCombination-r16: 6
* Number of PMI sub-bands per CQI sub-band, R:1
* Channel Model: TDLA 30-50Hz
* Antenna correlation: XP-Medium
* Subband Size: 4
 |
| **R4-2009858** | Nokia | Observation 1: eType II PMI is primarily intended to enhance MU-MIMO throughput by providing a much more accurate representation of the strongest channel eigenvectors than Type I SP PMI. This allows the gNB to steer the beams of co-schedule UEs in each other’s null space with less residual interference.Observation 2: SU-MIMO throughput is less sensitive than MU-MIMO to PMI inaccuracies because MU-MIMO throughput is limited by interference between co-scheduled UEs. Hence, a DUT could pass an SU-MIMO test for eType II without fulfilling the eType II PMI requirements, because the throughput difference between Type I SP and eType II is not large enough for SU-MIMO transmission.Observation 3: In the MU-MIMO test case, with both Option 1 and 2 for the co-scheduled UE channel generation, $X\_{b}$, the ZF precoder calculation can be simplified as$$W=\left[\begin{matrix}\overbar{W}\_{a}&X\_{b}^{H}\end{matrix}\right]$$where $\overbar{W}\_{a}$ is the orthogonalized and normalised $W\_{a}$ and $X\_{b}^{H} $is the normalized projection of the co-scheduled PMI on the null space of $\overbar{W}\_{a}$$$X\_{b}^{H}=\left(I-\overbar{W}\_{a}\overbar{W}\_{a}^{H}\right)W\_{b} diag\left(q\right)^{-1/2}$$Proposal 1: RAN4 to select Option 2 (MU-MIMO) as test case for eType II PMI reporting as it is the only test setup that can guarantee appropriate UE PMI reporting requirements for MU-MIMO, given a suitable test metric.Proposal 2: RAN4 to adopt ZF precoder as precoder calculation for the MU-MIMO test case. If complexity is an issue for TE vendors, the precoder calculation can be simplified by applying the ZF principle of orthogonality only to the co-scheduled UE (details in Observation 3).Proposal 3: RAN4 to adopt throughput ratio between following PMI and random PMI as test metric for the MU-MIMO test case of eType II. Relative throughput between following PMI for Type I SP and eType II can also be considered. |
| **R4-2010141** | Samsung | Proposal 1: Introducing R16 Type II codebook PMI requirements with MU-MIMO Set-up only if RAN4 can reach consensus on test feasibility and detailed test set-up for MU-MIMO set-up in RAN4#96e; otherwise, introducing Type II codebook PMI requirements in Rel-16 with SU-MIMO Set-up and further evaluate and introducing Type II codebook PMI requirements with MU-MIMO set-up in future release.Proposal 2-Number of ports: introduce Rel-16 Type II codebook PMI test cases with 16 Tx ports considering test complexity and test coverage. Proposal 3- Number of PMI sub-bands per CQI band: R =1 considering supporting R=2 is a separate optional feature.Proposal 4-codebook parameter: using below configuration* ParamCombination-r16: 6, with L =4, pν =1/2, β=1/2.
* Sub-band Size:
	+ 4 for FDD with 15kHz SCS, 10MHz CBW
	+ 8 for TDD with 30kHz SCS, 40MHz CBW

Proposal 5-Beam steering: Introduce a generic beam steering model into specification in a future proof manner which the number of beams configurable.Proposal 6-Propagation condition: Introduce test case with MIMO correlation -XP Medium and TDLA30-5Proposal 7-MCS&Rank: It’s feasible to use MCS20 (64QAM), Rank2 for introducing test cases. |
| **R4-2010805** | R&S | Observation 1: Further clarifications on the exact requirements for MU-MIMO based testing are needed to fully judge the test system impactProposal 1: RAN4 agrees to follow Option 1 and defines requirements with up to 16Tx PortsProposal 2: RAN4 agrees on Option1 and defines TCs for SU-MIMOProposal 3: RAN4 agrees on Option 2 and reuses the definition as specified in B.2.3B.4A of TS 36.101. |
| **R4-2011013** | Huawei, HiSilicon | Observation 1: For SU-MIMO test setup, the performance of Follow PMI for Type II has an obvious gain over Follow PMI for Type I single panelProposal 1: Using SU-MIMO test setup for Rel-15/Rel-16 Type II codebook PMI reporting testProposal 2: Consider having a MU-MIMO setup based demodulation test with test metric of either follow PMI based or random PMI based ThroughputProposal 3: Take either option 1 or 2 for Sub-band Size configuration for SU-MIMOProposal 4: Introduce beam steering model and specify using generic number of beamsProposal 5: Take either XP High or XP Medium but slightly prefer XP Medium for MIMO correlation configuration for SU-MIMO |
| **R4-2011421** | Qualcomm | Proposal 7: Define PMI reporting test cases for Enhanced Type II codebook under similar assumptions as that of the test cases for Rel-15 Type II Codebook.Observation 1: UE reports the same precoder for both SU-MIMO and MU-MIMO test setups.Proposal 8: Use SU-MIMO test setup for defining Enhanced Type II PMI reporting tests.Proposal 9: Do not extend the beam steering model beyond 2 clusters and reuse the dual cluster beam steering defined in 36.101.Proposal 10: Define enhanced Type II PMI reporting tests only for 16 Tx ports.Proposal 11: Use smaller sub-band size, i.e., 4 for FDD 10MHz and 8 for TDD 40MHz, for defining PMI reporting tests for enhanced Type II codebook.Proposal 12: Use XP High correlation to define PMI reporting requirements for enhanced Type II codebook.Proposal 13: Use R = 1 in PMI reporting requirements for enhanced Type II codebook. |

## Open issues summary

Last RAN4 meeting agreements captured in WF R4-2008816 which also summarized in Annex.

List of open issues:

* Sub-Topic 2-1: MU-MIMO scheduling model
	+ Issue 2-1-1: Transmitted signal modelling
	+ Issue 2-1-2: Precoder generation in TE for DUT and co-scheduled UEs
	+ Issue 2-1-3: Beam steering model
* Sub-Topic 2-2: Test set-up SU-MIMO VS. MU-MIMO
	+ Issue 2-2-1: SU-MIMO VS MU-MIMO Setup
* Sub-Topic 2-3: Test parameters for SU-MIMO option
	+ Issue 2-3-1: Number of ports
	+ Issue 2-3-2: Number of PMI Sub-bands per CQI Sub-band
	+ Issue 2-3-3: paramCombination-r16
	+ Issue 2-3-4: Sub-band Size
	+ Issue 2-3-5: Beam steering model: how to specify beam steering model in to specification
	+ Issue 2-3-6: Channel Model
	+ Issue 2-3-7: MIMO Correlation
	+ Issue 2-3-8: MCS and Rank
* Sub-Topic 2-4: Test parameters for MU-MIMO option
	+ Issue 2-4-1: Number of ports (MU-MIMO only)
	+ Issue 2-4-2: Number of PMI Sub-bands per CQI Sub-band
	+ Issue 2-4-3: paramCombination-r16
	+ Issue 2-4-4: Sub-band Size
	+ Issue 2-4-5: Channel Model
	+ Issue 2-4-6: MIMO Correlation
	+ Issue 2-4-7: MCS and Rank
	+ Issue 2-4-8: Test metric

### Sub-topic 2-1: MU-MIMO scheduling model

**Issue 2-1-1: Transmitted signal modeling**

* Proposals
	+ Option 1: $y\_{1}=h\_{1}w\_{1}x\_{1}+h\_{1}w\_{2}x\_{2}+n\_{1}$ (Qualcomm)
* Recommended WF
	+ FFS

**Issue 2-1-2: Precoder generation in TE for DUT and co-scheduled UEs**

* Proposals
	+ Option 1: Using ZF Precoder for DUT and co-scheduled UE (Ericsson)

|  |
| --- |
| * W = XH\*(X\*XH + λI)-1, where
	+ X = [Xa; Xb], is the DL channel estimate for the two co-scheduled UEs, where
		- Xa is the channel estimated for DUT i.e., Xa= WaHfrom reported type II PMI
		- Xb is the channel of co-scheduled UE
			* FFS whether Xb= WbH(from a PMI corresponding to the artificial UE), or if Xb is actual generated channel Hb.
	+ W = [Wa Wb] is the resulting precoder for the two co-scheduled UEs
		- Wa is the DUT precoder
		- Wb is the co-scheduled UE precoder
 |

* + Option 2: Using ZF to generate co-schedule UE precoder (Nokia)

|  |
| --- |
| $$W=\left[\begin{matrix}\overbar{W}\_{a}&X\_{b}^{H}\end{matrix}\right]$$**where** $\overbar{W}\_{a}$ **is the orthogonalized and normalised** $W\_{a}$ **and** $X\_{b}^{H}$ **is the normalized projection of the co-scheduled PMI on the null space of** $\overbar{W}\_{a}$$$X\_{b}^{H}=\left(I-\overbar{W}\_{a}\overbar{W}\_{a}^{H}\right)W\_{b} diag\left(q\right)^{-1/2}$$ |

* Recommended WF
	+ N.A

**Issue 2-1-3: Beam steering model**

* Proposals
	+ Option 1: No beam steering model applied in MU-MIMO test set-up (Ericsson)
* Recommended WF
	+ N.A

### Sub-topic 2-2: Test setup (SU-MIMO vs MU-MIMO)

**Issue 2-2-1: SU-MIMO VS MU-MIMO Setup**

* Proposals
	+ Option 1: SU-MIMO Set-up (Apple, R&S, Huawei, Qualcomm)
	+ Option 2: MU-MIMO Set-up (Ericsson, Nokia, Samsung)
	+ Option 3: Using SU-MIMO set-up to Introduce PMI test cases meanwhile a MU-MIMO setup based demodulation test with test metric of either follow PMI based or random PMI based throughput can be introduced (Huawei)
* Recommended WF
	+ Further discuss the details of MU-MIMO scheduling , including how to generate Precoder in TE side, and how to get the channel of co-scheduled UE; how to generate channel model for co-scheduled UE; what’s beam steering assumption;
	+ Also TE venders feedback are encouraged for the test feasibility especially for Tx signal generation with precoder for DUT and generated UE

### Sub-topic 2-3: Test parameters for SU-MIMO option

**Issue 2-3-1: Number of ports**

* Proposals
	+ Option 1: 16 ports with (N1,N2) = (4,2) and (O1,O2)=(4,4) (Samsung, Apple, R&S, Qualcomm)
* Recommended WF
	+ Option 1, introduce requirements with 16 ports

**Issue 2-3-2: Number of PMI Sub-bands per CQI Sub-band**

* Proposals
	+ Option 1: R=1 (Samsung, Apple, Qualcomm)
* Recommended WF
	+ Agree Option 1, introduce requirements with R=1

**Issue 2-3-3: paramCombination-r16**

* Proposals
	+ Option 1: paramCombination-r16: 6, with L =4, pν =1/2, β=1/2 (Samsung, Apple, Ericsson )
* Recommended WF
	+ Agree option 1

**Issue 2-3-4: Sub-band Size**

* Proposals
	+ Option 1: (Samsung, Apple?, Huawei, Qualcomm, Ericsson)
* 4 for FDD with 15kHz SCS, 10MHz CBW
* 8 for TDD with 30kHz SCS, 40MHz CBW
	+ Option 2: (Huawei)
* 8 for FDD with 15kHz SCS, 10MHz CBW
* 16 for TDD with 30kHz SCS, 40MHz CBW
* Recommended WF
	+ Agreed option 1.

**Issue 2-3-5: Beam steering model: how to specify beam steering model in to specification**

* Proposals
	+ Option 1: Same as specified in B.2.3B.4A of TS 36.101 (Qualcomm, R&S)
	+ Option 2: Specify using generic number of beams (Huawei, Samsung)
* Recommended WF
	+ Introduce beam steering model into specification with configurable number of beams in a future proof manner (i.e. L can configured as 1, 2 or >2)

**Issue 2-3-6: Channel Model**

* Proposals
	+ Option 1: TDLA30-5 (Apple)
* Recommended WF
	+ Agreed option 1. 4 companies provide the initial results based on TDLA30-5. One company shows better performance can be achieved with TDLA30-5 channel model compared with TDLC300-5 channel model.

**Issue 2-3-7: MIMO Correlation**

* Proposals
	+ Option 1: XP High (Huawei, Qualcomm)
	+ Option 2: XP Medium (Samsung, Apple, Huawei)
* Recommended WF
	+ Agreed option 2. 4 companies provide the initial results, 3 companies results show that with XP medium can achieve better performance compared with XP High under TDLA30-5 channel model. 1 company result shows XP High correlation provides better throughput ratio compared to XP Medium correlation with TDLA30-10 channel model.

**Issue 2-3-8: MCS and Rank**

* Proposals
	+ Option 1: MCS 20 (64QAM Table), Rank 2 (Samsung)
* Recommended WF
	+ Agreed option 1.

### Sub-topic 2-4: Test parameters for MU-MIMO option

**Issue 2-4-1: Number of ports**

* Proposals
	+ Option 1: 32 ports with (N1,N2) = (4,4) and (O1,O2)=(4,4) (Ericsson)
	+ Option 2: 16 ports with (N1,N2) = (4,2) and (O1,O2)=(4,4) (Samsung)
* Recommended WF
	+ FFS

**Issue 2-4-2: Number of PMI Sub-bands per CQI Sub-band**

* Proposals
	+ Option 1: R=1 (Samsung, Ericsson)
* Recommended WF
	+ Agree Option 1, introduce requirements with R=1

**Issue 2-4-3: paramCombination-r16**

* Proposals
	+ Option 1: paramCombination-r16: 6, with L =4, pν =1/2, β=1/2 (Samsung, Apple, Ericsson )
* Recommended WF
	+ Agree option 1

**Issue 2-4-4: Sub-band Size**

* Proposals
	+ Option 1: (Samsung, Apple?, Huawei, Qualcomm, Ericsson)
* 4 for FDD with 15kHz SCS, 10MHz CBW
* 8 for TDD with 30kHz SCS, 40MHz CBW
	+ Option 2: (Huawei)
* 8 for FDD with 15kHz SCS, 10MHz CBW
* 16 for TDD with 30kHz SCS, 40MHz CBW
* Recommended WF
	+ Agree option 1

**Issue 2-4-5: Channel Model**

* Proposals
	+ Option 1: TDLC300-5 (Ericsson)
* Recommended WF:
	+ Note: the details proposal of option 1 is provided in Tdoc R4-2011365, which belong Agenda 7.16.1.2
	+ Companies’ feedback needed for above proposal, also pending on the issue of 2-1-1

**Issue 2-4-6: MIMO Correlation**

* Proposals
	+ Option 1: XP High (Huawei, Qualcomm)
	+ Option 2: XP Medium (Samsung, Apple, Huawei)
* Recommended WF:
	+ Agreed option 2?

**Issue 2-4-7: MCS and Rank**

* Proposals
	+ Option 1: MCS 7 (64QAM Table), Rank 1 (Ericsson)
* Recommended WF:
	+ Companies’ feedback needed for above proposal

**Issue 2-4-8: Test metric**

* Proposals
	+ Option 1: The ratio of following PMI and random PMI (Nokia)
	+ Option 2 : The ratio of following PMI with following PMI with enhanced type II codebook and type I single panel codebook (Ericsson)
* Recommended WF:
	+ Companies’ feedback needed for above proposals

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | **Sub-Topic 2-1: MU-MIMO scheduling model*** Issue 2-1-1: Transmitted signal modeling
* Issue 2-1-2: Precoder generation in TE for DUT and co-scheduled UEs
* Issue 2-1-3: Beam steering model

**Sub-Topic 2-2: Test set-up SU-MIMO VS. MU-MIMO*** Issue 2-2-1: SU-MIMO VS MU-MIMO Setup

**Sub-Topic 2-3: Test parameters for SU-MIMO option*** Issue 2-3-1: Number of ports
* Issue 2-3-2: Number of PMI Sub-bands per CQI Sub-band
* Issue 2-3-3: paramCombination-r16
* Issue 2-3-4: Sub-band Size
* Issue 2-3-5: Beam steering model: how to specify beam steering model in to specification
* Issue 2-3-6: Channel Model
* Issue 2-3-7: MIMO Correlation
* Issue 2-3-8: MCS and Rank

**Sub-Topic 2-4: Test parameters for MU-MIMO option*** Issue 2-4-1: Number of ports
* Issue 2-4-2: Number of PMI Sub-bands per CQI Sub-band
* Issue 2-4-3: paramCombination-r16
* Issue 2-4-4: Sub-band Size
* Issue 2-4-5: Channel Model
* Issue 2-4-6: MIMO Correlation
* Issue 2-4-7: MCS and Rank
* Issue 2-4-8: Test metric
 |
| Rohde & Schwarz | **Issue 2-1-2: Precoder generation in TE for DUT and co-scheduled UEs**From our current understanding, the proposed options to generate precoding based on channel conditions are not something that we can see as feasible TE implementations.This is also one of the the reasons, why we propose in our paper to utilize SU-MIMO testing for now.**Issue 2-3-5: Beam steering model:**We still think we should reuse the existing LTE model, due to the increased complexity an open ended model brings to TE implementation. But we can further discuss. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going 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:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Way forward on PMI reporting requirement for NR eMIMO | Qualcomm |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: Sub topic 1-2…. |

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Annex

*Agreements for PDSCH requirements in last RAN4 meeting:*

|  |
| --- |
| Performance requirements for multi-panel/TRP in FR1* Reference for timing offset/frequency offset
	+ Option 1
		- Using TP which carry on SSB transmission with default TCI state #0 as the reference TP (TP1)
		- Timing offset = time offset among TP2 and TP1
		- Frequency offset = frequency offset among TP2 and TP1
	+ Other options not precluded
* Baseline receiver assumption for FFT window timing
	+ Option 1: Assuming UE always fix FFT timing based on TCI state #0 (TP1) as baseline assumption to define RAN4 performance requirements
	+ Option 2: FFT timing based on TRP with the highest RSRP on sync signals + fixed timing shift
	+ Option 3: FFT timing based on nearest TRP
	+ Other options not precluded
* Timing Offset among multi-panel/TRP
	+ Timing offset values
		- Option 1: $∆t=2^{-μ}∆t\_{1}$, $∆t\_{1} $= [-0.5, 2]μs
		- Option 2: $∆t=2^{-μ}∆t\_{1}$, $∆t\_{1}$ = 2μs
		- Option 3: FFS on Introducing timing offset which scaled with SCS ∆t=2^(−μ) ∆t1, Candidate values for simulation purpose: {-1, -0.5, 1, 3}
	+ Values for requirements definition should be derived based on performance analysis and analysis on typical TO distributions. Final values should ensure that reasonable UE implementations can meet the requirements
* Frequency Offset among multi-panel/TRP
	+ 200Hz for FR1 FDD 15kHz, 300Hz for FR1 TDD 30kHz
* TRS/CSI-RS configuration
	+ Taking non-colliding TRS/CSI-RS in multi-TRP/panel as baseline assumption meanwhile interested companies are encouraged to bring more analysis and evaluation results for non-colliding and colliding cases
* Multi-DCI based PDSCH requirements
	+ Resource allocation
		- Option 1: Only non-overlapping cases
		- Option 2: Both non-overlapping and full-overlapping cases
	+ CRS rate-matching
		- Do not define performance requirements for multi-DCI based multi-TRP with UE rate-matching around configured CRS pattern
	+ PDCCH configuration
		- K0 = 0, AL=8
	+ PDSCH configuration for each TRP
		- PDSCH resource mapping type: Type A
		- Resource allocation type: Type 1
		- DM-RS configuration: Type 1 with single-symbol DM-RS: 1+1
		- Antenna ports indexes: {1000,1001} and {1002,1003}, i.e. different CDM groups for two TRPs
		- Starting symbol (S): 2
		- Time duration (L): 12
		- Frequency domain: half of the maximum bandwidth by indicating the start resource block , the allocated resource blocks
		- Antenna configuration:
* Option1: Only 2T2R, 2T4R
* Option2: Both 2T2R, 2T4R and 4T2R, 4T4R
	+ Number of test cases
		- Option 1: 3 test cases per duplex mode
* Test 2a Multi- DCI with frequency offset and Non-overlapping scheduling
* Test 2b Multi DCI with positive time offset and Non-overlapping scheduling
* Test 2c Multi DCI with negative time offset and overlapping scheduling
	+ - Other options are not preclude
* Single-DCI based multi-TRP/Panel
	+ Introduce PDSCH demodulation requirements for Single-DCI based SDM scheme with full-overlapping resource allocation
		- Layer combination: 1+1 for both 2Rx and 4Rx
		- Number of TCI state: Two TCI states configuration
		- Number of test cases
		- Option 1: 3 test cases per duplex mode
* Test 1a Single DCI with frequency offset and overlapping scheduling
* Test 1b Single DCI with positive time offset and overlapping scheduling
* Test 1c Single DCI with negative time offset and overlapping scheduling
	+ - Other options are not preclude

Performance requirements for multi-panel/TRP in FR2* Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2
	+ Option 1: No
	+ Option 2: Do not define FR2 requirements for simultaneous reception from multi-TRP/Panel (eMBB) and Study testability for FR2 single-DCI based multi-TRP schemes 3 and 4
	+ Option 3: Further discuss technical details and relevance of single wide Rx beam reception in FR2
* TCI state configuration for FR2
	+ Option 1: Single Type D

 * + Other options are not preclude

PDSCH requirements with Single-DCI based multi-TRP/Panel transmission schemes (URLLC)* Candidate Schemes
	+ URLLC single-DCI based multi-TRP/panel transmission schemes
		- SDM scheme (1a)
		- Repetition schemes
* FDM scheme A (2a)
* FDM scheme B (2b)
* TDM scheme A (3)
* Inter-slot TDM scheme (4)
* Necessity of PDSCH requirements
	+ Whether already agreed requirements for multi-DCI based and single-DCI based multi-TRP transmission scheme and URLLC single-TRP requirements can cover single DCI based URLLC multi-TRP transmission schemes
		- Option 1: Yes. FDM schemes can be verified by multi-DCI based and single-DCI based SDM multi-TRP transmission schemes. TDM schemes can be verified by single-DCI based SDM multi-TRP transmission scheme and URLLC single-TRP slot aggregation
		- Option 2: No. Each scheme is a separate UE feature. Different resource allocation approach comparing to single-DCI based SDM multi-TRP transmission scheme. Different CDM group and TBS calculation assumptions comparing to multi-DCI based and single-DCI based SDM multi-TRP transmission schemes. Non-synchronized (with TO/FO) transmission comparing to single TRP URLLC slot aggregation scenario. Specific sub-features for some schemes as: CW combining, number of repetitions.
		- Option 3: Cannot cover at least FDM scheme A.
* PDSCH requirements introduction
	+ Whether already agreed requirements for multi-DCI based and single-DCI based multi-TRP transmission scheme and URLLC single-TRP requirements can cover single DCI based URLLC multi-TRP transmission schemes
		- Option 1: Not need to define
		- Option 2a: Yes, for schemes 2a, 2b, 3 and 4
		- Option 2b: Yes, only for one scheme from FDM schemes and one from TDM schemes
* Make decision on whether to introduce test cases in Q3 2020
* Interested companies are encouraged to provide simulation assumptions on the next meeting in order to have sufficient time for requirements definition if they will be agreed to introduce on the next meeting
* Further discuss test applicability rule (If requirements will be agreed to define)
	+ Option 1: FDM scheme is skipped if UE passes the multi-DCI based multi-TRP transmission and/or TDM scheme is skipped if UE passes URLLC slot aggregation requirements
	+ Other options are not precluded
* Test Metric for requirement definition
	+ Option 1: 1 % BLER which is more suitable for URLLC service
	+ Option 2: 70%@max throught
 |

*Agreements for PMI test cases in last RAN4 meeting:*

|  |
| --- |
| * Test setup:
	+ Option 1: Only use SU-MIMO test setup, i.e., one tested UE
	+ Option 2: MU-MIMO based test setup, i.e., one tested UE + one co-scheduled UE (generated by TE)
* The baseline receiver assumption is UE without interference cancellation capability with/without co-scheduled UE.
* Under the baseline UE receiver assumption, the PMI calculation processing will not change with and without co-scheduled UE.
* TE vendors are encouraged to provide feedback for the test feasibility of MU-MIMO test setup.
* Proponents for each option need to provide technical analysis for how the test set-up can guarantee UE PMI reporting requirements with enhanced type II codebook for its intended purpose.

Detailed test set-up for SU-MIMO and MU-MIMO* Number of CSI-RS ports
	+ Option 1: 16 ports with (N1,N2) = (4,2) and (O1,O2)=(4,4)
	+ Option 2 : 32 ports with (N1,N2) = (4,4) and (O1,O2)=(4,4)
* Number of PMI Sub-bands per CQI Sub-band
	+ Option 1: R = 1 as baseline
	+ Option 2: R = 2
* Codebook parameter configuration
	+ Option 1: paramCombination-r16: 6, with L =4, *pν* =1/2, β=1/2 as baseline
	+ Other options not precluded
* Sub-band Size
	+ Option 1:
		- 4 for FDD with 15kHz SCS, 10MHz CBW
		- 8 for TDD with 30kHz SCS, 40MHz CBW
	+ Option 2:
		- 8 for FDD with 15kHz SCS, 10MHz CBW
		- 16 for TDD with 30kHz SCS, 40MHz CBW
* Beam-Steering Model
	+ Configure only two beams in beam steering model for Rel-16 type II test cases
	+ FFS how to specify beam steering model into specification
		- Option 1: Same as specified in B.2.3B.4A of TS 36.101
		- Option 2: Specify using generic number of beams
	+ FFS if beam steering model needs to be modified to account for co-scheduled UE
* Channel Model
	+ TDLA30-5 as baseline
	+ Other options not precluded
* MIMO Correlation
	+ Option 1: XP High
	+ Option 2: XP Medium
	+ Down-select to one option based on simulation results in the next meeting
* MCS and Rank
	+ MCS 20 (64QAM Table), Rank 2 as baseline
	+ Other options not precluded
* For initial simulations:
	+ Use the parameters listed in previous slides.
	+ The remaining parameters will be same as for Rel-15 Type II codebook simulation assumptions in R4-2008847

Test metric* Test Metric for MU-MIMO
	+ Option 1: Relative throughput ratio between following PMI for Rel-16 enhanced Type II and Rel-15 Type II codebook
	+ Option 2: Relative throughput ratio between following PMI and random PMI
	+ Other options not precluded

Scheduling Parameters for MU-MIMO* Channel model for co-scheduled UE
	+ Option 1: Possibility for spatially separated from DUT
	+ Other options not precluded
* Scheduling mode
	+ Option 1: Zero-forcing
	+ Other options not precluded
* DCI value for antenna mapping (Table 7.3.1.2.2-2 from 38.212):
	+ Option 1: DUT = 3 with DMRS seed=0, co-scheduled UE=5 with random DMRS seed (Rank 1, DMRS antenna port mapping 1000 for DUT, 1002 for co-scheduled UE)
	+ Option 2: DUT = 7 with DMRS seed=0, co-scheduled UE=8 with random DMRS seed, (Rank 2, DMRS antenna port mapping [1000, 1001] for DUT, [1002, 1003] for co-scheduled UE)
	+ Other options not precluded
 |