**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. |
| Qualcomm | **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)

Prefer Option 2 as mentioned in our paper that URLLC schemes can be covered by m-DCI, SDM and URLLC slot aggregation requirements.* Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2

Having m-TRP with single Tx/Rx beam seems like an artificial setup for the sake of testing it. So, we prefer not to have these requirements for Case 1. Ok 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

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

Recommended WF seems ok. Need more time to confirm this.* Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)

Ok with recommended WF,* Issue 1-2-4: TRS/CSI-RS configuration

Ok with recommended WF,**Sub-Topic 1-3: Test parameters for Multi-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-3-1: Resource allocation

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

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

Prefer Option 3 or Option 4.**Sub-Topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-4-1: Number of Test cases

Prefer Option 3.**Sub-Topic 1-5: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (URLLC)**Prefer to discuss this after we have decided on Issue 1-1-1.  |
| Apple | **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)

Option 2. Based on UE processing for different single DCI URLLC transmission schemes, we don’t see a huge impact from different schemes compared to already agreed testcases. Given the limited time and already a significant number of testcases and issues to resolve for multi TRP requirements, we propose to down prioritize this for now. * Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2

Option 1: No necessity to introduce requirements in FR2 for multiTRP transmission. We don’t agree with the recommended WF. **Sub-Topic 1-2: Generic test set-up*** Issue 1-2-1: Reference for timing offset/frequency offset set-up

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

Option 3. Option 4 seems to be same as option 3. * Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)
* Issue 1-2-4: TRS/CSI-RS configuration

We support the recommended WF.* 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

Option 1. We propose to only introduce requirements with non overlapping resource allocation . We support the recommended WF.* Issue 1-3-2: Antenna configuration per each TRP

We support the recommended WF.* Issue 1-3-3: Number of Test cases

We support introducing 1 testcases with both time and frequency offset per duplex mode. Additional test is not needed with other time offset alone. **Sub-Topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-4-1: Number of Test cases

Option 3. 1 test per duplex mode with frequency offset, timeoffset and overlapping scheduling. **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
 |
| MediaTek | **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)

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

We support option 1.**Sub-Topic 1-2: Generic test set-up*** Issue 1-2-1: Reference for timing offset/frequency offset set-up

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

OK with the recommended WF.* Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)

OK with the recommended WF,* Issue 1-2-4: TRS/CSI-RS configuration

OK with the recommended WF.**Sub-Topic 1-3: Test parameters for Multi-DCI based multi-TRP/Panel transmission schemes (eMBB)*** **Issue 1-3-1: Resource allocation**

We support the recommended WF to only introduce requirements with non-overlapping resource allocation.* **Issue 1-3-2: Antenna configuration per each TRP**

We support the recommended WF. * **Issue 1-3-3: Number of Test cases**

OK with option 3.**Sub-Topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-4-1: Number of Test cases

OK with option 3. |
| Huawei, HiSilicon | Issue 1-1-1: Prefer option 2. RAN4 does not define test case for every single UE feature. For this issue, If we want, we can always find differences between each URLLC transmission scheme, otherwise there is no meaning for RAN1 to define it. However, what we focus is whether the major demodulation process or feature that has been covered and verified by already defined test cases. If so, we can skip this feature to reduce the overall number of test cases. As we mentioned before, the major demodulation feature of those transmission schemes for URLLC are well covered by exist or agreed-to-introduce test cases. Therefore, we don’t see the need for define new requirements for those schemes. Issue 1-1-2: For case 1, single wide Rx beam reception might have problem with the reception angle. UE at the cell edge has few chances to be on one side of two TRPs. And if one UE is in the middle of two TRPs, then one Rx beam is struggling to be wide enough to cover two transmission beams. Thus, we think case 1 is not realistic. Thus, we prefer not have requirements for case 1. For case 2, we are fine for further discuss this issue in future release, but for now we cannot agree on anything on this issue. Issue 1-2-1, 1-2-2: OK with recommended WF. It is straightforward to use TRP with TCI state #0 as the reference. What we concern is the criteria for deciding TCI state #0, like highest RSRP or nearest distance etc. But since these criteria might related to the UE specific implementation, RAN4 should not define such restrictions. Issue 1-2-3: Based on our comments for issue 1-2-1 and 1-2-2, positive and negative timing offset are both theoretically possible. But we are not sure in practice, how many chances that a negative timing offset could be met. Since the feature of Multi-TRP mainly serves those edge UEs, how many chances that they are in a scenario with two TRPs on one side. But if all companies think negative timing offset is necessary, we are fine to consider it. For positive timing offset value, we prefer to select 2us for 15kHz SCS and scaling for 30kHz SCS. Without scaling, 2us is a little bit risky for 30kHz SCS. Issue 1-2-4: Agree recommended WF. Issue 1-3-1: Agree recommended WF.Issue 1-3-2: Agree recommended WF.Issue 1-3-3: For limiting the number of test cases, we are fine to define one test covers both frequency offset and one selected time offset. If both positive timing offset and negative timing offset are introduced, then two different value can be applied on multi-DCI based test case and single-DCI based test case respectively. Thus, we are ok with option 3 or 4.Issue 1.4-1: Same comments as issue 1-3-3.Issue 1-5-1~1-5-5: Prefer not to discuss this since the decision of issue 1-1-1 has not been made. |
| Ericsson | **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)

We think there is no difference from UE demodulation point. Therefore our motivation to define FDM Scheme 1 is the case if UE does not support multi-DCI. Also the metric is same as eMBB, i.e., 70% of max Tput with HARQ retransmission enabled. * Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2

We prefer Option 1. We have concern Option 2 because the UE performance in this setup is affected the OTA test environment. We are wondering FR2 UE can keep the same reception performance regardless of OTA test environment. **Sub-Topic 1-2: Generic test set-up*** Issue 1-2-1: Reference for timing offset/frequency offset set-up

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

Agree with the recommended WF. * Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)

We are ok to set negative time offset larger than -0.5us for SCS=15kHz and -0.25us for SCS=30kHz However it does not mean the number of test cases are increased just to test the negative time offset. If RAN4 specify 2 test cases, for example, one for multi-DCI SDM and another for single-DCI SDM, then we can set +2us for one case and -0.5 for another case. From our simulation it is observed the significant performance degradation with -0.5us for SCS=30kHz. We therefore propose to set -0.25us for SCS=30kHz. * Issue 1-2-4: TRS/CSI-RS configuration

Agree with the recommended WF. * 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

Agree with option 1.* Issue 1-3-2: Antenna configuration per each TRP

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

We don’t want to increase the test cases just to test for frequency offset/time offset configuration. Since we set one test case for multi-DCI SDM (applicable for FDD/TDD and 2Rx/4Rx) and one test case for single-DCI SDM, one case sets frequency offset + positive time offset and another case sets frequency offset and negative time offset. We are open which case uses positive/negative 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

Same comments as 1-3-3.Since we set one test case for multi-DCI SDM (applicable for FDD/TDD and 2Rx/4Rx) and one test case for single-DCI SDM, one case sets frequency offset + positive time offset and another case sets frequency offset and negative time offset. We are open which case uses positive/negative time offset.**Sub-Topic 1-5: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (URLLC)*** Issue 1-5-1: Transmission schemes

We think there is no difference from UE demodulation point. Therefore our motivation to define FDM Scheme 1 is the case if UE does not support multi-DCI. Also the metric is same as eMBB, i.e., 70% of max Tput with HARQ retransmission enabled. * Issue 1-5-2: Test metric

Option 1. * 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  |
| Samsung | **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)

The major debate point for the necessity of introducing test cases of URLLC transmission schemes is whether UE behaviour already covered by the agreed Multi-TRP transmission test cases and/or test cases introduced under URLLC WI.URLLC based on transmission schemes and eMBB based on transmission schemes target to differentdeployment and usage scenariosIn our view, at least the following aspects cannot be covered in current test case for eMBB or Rel-16 URLLC--Compared to URLLC test cases, these transmission schemes also required to support multi-TCI states with different QCL information associated with same TBS which transmitted from different TRPs-Meanwhile, the time/frequency non-synchronization transmission cannot be verified in current Rel-16 single TRP URLLC test -Compared to current eMBB test cases, the special scheduling and processing, such as mini-slot scheduling, CW combing within slots and across slots for URLLC operation cannot be verified in current eMBB test From UE feature perspective, single DCI-based multi-panel/TRP with different transmission schemes belongs different UE feature, UE maybe or maybe not to support FDM or TDM schemes,Based on above analysis, the UE function/behaviour can be partially verified in the already agreed URLLC test cases or multi-TRP transmission test cases for eMBB transmission from UE processing aspect; meanwhile there are still delta compared what already agreed test cases. As a whole independent feature itself, the UE behaviour hasn’t been covered by existing test cases.* Issue 1-1-2: Necessity of introducing test case(s) for multi-panel/TRP transmission schemes in FR2

The debate point in RAN4 whether there are realistic deployment scenarios to schedule UE which only capable of single Rx beam for multi-Panel/TRP transmission schemes in FR2. We see at least two potential scenarios for multi-panel/TRP transmission with same TX/Rx beam direction:- FR2 scheduling scenario A: two panels implemented in the same site with same transmitted beam to UE - FR2 scheduling scenario B: two TRPs located in different sites with the same transmitted beam direction to UEFor case 2, Considering the current OTA test ability issue, we are fine with recommend WF**Sub-Topic 1-2: Generic test set-up*** Issue 1-2-1: Reference for timing offset/frequency offset set-up

We are fine with recommend WF.* Issue 1-2-2: Baseline receiver assumption for FFT window timing

We are fine with recommend WF.* Issue 1-2-3: Timing offset among multi-panel/TRP (FR1 only)

We still prefer option 1* + Positive time offset

• For FR1 FDD with 15kHz : 2us• For FR1 TDD with 30kHz : 1us* + Negative time offset

• For FR1 FDD with 15kHz : -0.5• For FR1 TDD with 30kHz : -0.25For time offset, taking LTE CoMP transmission scheme experience; positive and negative time offset according to FFT window has unsymetric performance impact in receiver side. Reasonable UE implementation will employ some strategy to reduce the probability of negative time offset refer to FFT window i.e. adjusting FFT window based on the earliest received signal path, nearest TRP with strongest received power plus fixed timing offset. On the other hand, there is always a probability that received signals arrive before or lag behind FFT window in reality considering UE mobility and FFT window adjustment cycle i.e. UE move to the canter area among two TPs.Based on our initial results, we show the different performance gap with Therefore, we think it is necessary to introduce both postive and negative offset among two TPs to ensure proper UE implemantion and performance.As for value of timing offset with 30KHz. in our view, it should be depended on the ISD of deployment. 30KHz is mainly applied in TDD operation, where carrier frequency is high, the cell size is not expected with too large, In our view, around 200ISD should be enough.Based on Intel’ contribution,In case of ISD=200m, around 85% UE have TO within the range of [-0.25, 1] us. Given current deployment, option 3 is out of CP range.Therefore, it make sense to introduce the test cases with timing offset within the range for 30KHz. Meanwhile, the motivation of introduce timing/frequency is to verify the proper UE behaviour with TO/FO compensation. Based on our initial results, less than 0.5 dB performance loss observed compared to ideal case with proper compensation for positive timing offset , and less than 1dB performance loss observed compared ideal case with proper compensation for negative timing offset. In our view, the existed performance gap is enough to discriminate different UE behaviour with and without time compensation. * Issue 1-2-4: TRS/CSI-RS configuration

We are fine with the recommend WF following the previous agreement**Sub-Topic 1-3: Test parameters for Multi-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-3-1: Resource allocation

We are fine with the recommend WF* Issue 1-3-2: Antenna configuration per each TRP

We are fine with the recommend WF* Issue 1-3-3: Number of Test cases

We still prefer option 1.To compact the test case, we are fine to introduce one test case per duplex mode to cover both frequency offset and time offset.As mention, both positive and negative time offset can appear among 2 TRP transmission scenario. Considering the performance different between positive and negative time offset, we think it is needed to define the test cases to cover both positive and negative timing offset to verify UE behaviour. If companies have the concerns the number of test cases, we can define the test related applicability rule.Single-DCI and multi-DCI are different UE feature. Most likely, UE supported multi-DCI based transmission can also support single-DCI based transmission, then if UE pass the multi-DCI based transmission tested, it can skip the single-DCI test.**Sub-Topic 1-4: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (eMBB)*** Issue 1-4-1: Number of Test cases

To compact the test case, we are fine to introduce one test case per duplex mode to cover both frequency offset and time offset.As mention, both positive and negative time offset can appear among 2 TRP transmission scenario. Considering the performance different between positive and negative time offset, we think it is needed to define the test cases to cover both positive and negative timing offset to verify UE behaviour. If companies have the concerns the number of test cases, we can define the test related applicability rule.Single-DCI and multi-DCI are different UE feature. Most likely, UE supported multi-DCI based transmission can also support single-DCI based transmission, then if UE pass the multi-DCI based transmission tested, it can skip the single-DCI test.**Sub-Topic 1-5: Test parameters for Single-DCI based multi-TRP/Panel transmission schemes (URLLC)*** Issue 1-5-1: Transmission schemes

We prefer option 1. As mentioned, single-DCI based transmission with different schemes belong different UE feature. FDMschemeB requirement additional signalling for UE to support CW combination with different RV. TDMschemeA is similar with Rel-16 URLLC feature with intra-slot repetition. Whether to define the requirement of Rel-16 URLLC feature is not decided yetSo, we suggest to down selected with 1 or 2 schemes from {FDM scheme A, FDM scheme B, TDM scheme A, Inter-slot TDM}. FDM scheme A and inter-slot TDM is preferred.  |

### 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

Nokia: the modelling assumes we will only rank1 transmission during the test.

Samsung: This modelling only for data part, what’s the details Rx assumption ? What’s NZP CSI-RS. DMRS configurations?

If no colliding DMRS, NZP CSI-RS, then we can not aware of interference from receiver side.

Nokia: Yes, this is only data part.

QC: we should not restrict to rank1 transmission

Agreement: Taking Option 1 (this mode only assumes Rank1 transmission) as the assumption for MU-MIMO set-up

* it’s not exclude to further extend the model which can be applied for rank2 transmission if needed

Further discuss for the details, NZP-CSI configuration/DMRS configuration assumption

**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

Nokia: Both option 1 and option 2 align the basic ZF forcing assumption. We can go with option 1 with random PMI for co-scheduled UE Xb. For option 2, we should ensure precoder located in null space of DUT for co-scheduled.

E///: One missing part is normnization factor in the equation. In our simulation, we already consider that part.

QC: we have Wb, and Xb pending on Wb. That part not clear.

E///: We generate Wb from co-scheduled UE with PMI reporting .

Question: How to generate Xb/Wb for co-scheduled UE?

Option 1: PMI reporting from co-scheduled UE

Option 2: Random PMI

Option 3: Fixed PMI

R&S: With Op1 based on PMI reporting from co-scheduled UE, how to get that? Also getting fading channel from UE need to be further clarified.

QC: We have similar concern as R&S. From system point of views, not clear for me how to verify DUT reporting PMI.

Nokia: We just to generate an interfence signal for DUT assuming we have MU-MIMO in gNB side. There are several options, we think using random PMI for co-scheduled UE. Key point is to generate inference to model MU-MIMO scenario.

Apple: Similar concern as QC raised. There are several options for the generation precoder of co-scheduled UE.

China Telecomm: We have concern on random PMI test set-up, if scheduled UE reporting PMI and another UE reporting random PMI; then the whole performance over two users questionable? In our understanding, RAN1 scenarios also applicable at least ran2 per UE, then we should to align with rank2. Shall we need to medium/high correlation among two UEs, these factors also impact the performance.

QC: Share similar question as China Telecomm, with the set-up, whole system maybe not work welling with such set-up.

QC: In UE side, no special processing for interference, just increase the interference level. And no difference for SU-MIMO vs MU-MIMO, only difference from UE side would be SINR level in test, is that only purpose to verify PMI reporting in low SINR level.

E///: The purpose is not verify TP was to verify PMI reporting. TDL channel is not proper for this cases with limited channel realizations. In our simulation, we use CDL channel, then we can achieve high MCS and high throughput.

The purpose is to ensure UE using type II codebook to make calculation and PMI reporting other than using Type I codebook estimation to make cheating to pass the test cases.

Nokia: If we schedule UE proper and UE reporting Type II codebook other than Type I codebook, the NW apply similar ZF BF to find null space for each UE to ensure individual UE will achieve good performance.

Type II can support up to rank4 per UE, we are proposing to focus on rank1. For co-scheduled UE, gNB will employ ZF BF to ensure the transmission orthognatilty among them.

QC: Our concern not about Type II vs Type I, we agree Type II achieve gain over Type I under some scenarios i.e. MU-MIMO with rich channel realization. Our concern was the test set-up, for receiver side , UE not do anything for interference signaling.

E//: The point is to ensure PMI reporting correctly, we would like differeiate performance with type II and Type I reporting under setup to avoid UE cheating. Verify UE reporting with low SINR not the purpose.

Nokia: From DUT aspect, no processing difference . The difference is under gNB side operation, this is not random interference, this is controlled by gNB based on the type of PMI reporting from UEs.

Apple: this is something related to gNB operation, that’s beyond the test purpose of UE PMI requirements. Given SINR is low, the performance is low.

R&S: Similar concern as Apple, we are not going to verify TE/gNB, we are going to verify UE.

Samsung: Type II codebook is gNB configuration, with type II codebook configured, then how UE can use type I codebook construction for PMI reporting as this is controlled by NW configuration.

Huawei: we have similar concern as Apple, the purpose not for gNB implementation. We still observe performance gap among Type II and Type I with proper parameters under SU-MIMO set-up.

If some UE implemented advanced receivers, we can bring potential punishment for such kind of advanced UE. That’s another we propose to use demod test cases.

Irrespective of SU-MI MO test set-up or MU-MIMO set-up:

The test purpose of such requirements was to verify UE PMI reporting accuracy following NW configuration with RAN1 feature: enhanced type II codebook

* There is no restriction for gNB scheduling with such requirements.
* RAN4 need to ensure UE reporting PMI follow Type II codebook other than Type I codebook under proper test set-up either with MU-MIMO set-up or SU-MIMO set-up.
* We need to ensure the performance requirements with proper test set-up as receiver implementation agonistic manner i.e. no pushniment for advanced receiver with inference cancellation capability.

Agreement: FFS check the feasibility and details among below candidate options for precoder generation in TE

* Option 1( further provide the details from proponent company E///)
* Option2

How to generate Xb (channel for co-scheduled UE)

* Xb is the channel of co-scheduled UE
	+ Option 1: PMI reporting from co-scheduled UE
	+ Option 2: Random PMI
	+ Option 3: Fixed PMI
	+ Option 4: True Channel

We will comeback during 2nd round for above open issues and SU-MIMO vs MU-MIMO set-up.

Proponents for SU-MIMO set-up and MU-MIMO set-up need to clarify how to meet the agreed test purpose.

Agreement: Further discuss and consider how to ensure UE following Type II codebook for reporting

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

Based on analysis provided in our paper, the reported PMI by UE will not change based on the test setup. There are also concerns from TE vendors. Therefore, we prefer to use SU-MIMO test setup.**Sub-Topic 2-3: Test parameters for SU-MIMO option*** Issue 2-3-1: Number of ports

Ok with recommended WF.* Issue 2-3-2: Number of PMI Sub-bands per CQI Sub-band

Ok with recommended WF.* Issue 2-3-3: paramCombination-r16

Ok with recommended WF.* Issue 2-3-4: Sub-band Size

Ok with recommended WF. * Issue 2-3-5: Beam steering model: how to specify beam steering model in to specification

Prefer Option 1. As we have already agreed to configure only 2 beams, there is no incentive to extend the beam steering model to generic number of beams. We can reuse the LTE model which has two independent beams. Otherwise, it may give an impression to an outsider that it is feasible to test with any number of beams while that is not the case. Also, it is not practical to assume that UE can receive signal from more than 2 independent beams with same power.* Issue 2-3-6: Channel Model

Ok with recommended WF.* Issue 2-3-7: MIMO Correlation

Prefer XP High. But ok to compromise to XP Medium.* Issue 2-3-8: MCS and Rank

Ok with recommended WF.**Sub-Topic 2-4: Test parameters for MU-MIMO option**Prefer to discuss after the decision on Issue 2-2-1. |
| Apple | **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

No comment on these issues as our preference is to use SU-MIMO test setup. **Sub-Topic 2-2: Test set-up SU-MIMO VS. MU-MIMO*** Issue 2-2-1: SU-MIMO VS MU-MIMO Setup

Option 1. We recommend to define requirements with SU-MIMO test setup. Results shown in Ericsson’s paper with MU-MIMO in CDL channel and the comparison is performance with MU-MIMO set up when Type II and Type I are used. This doesn’t justify that MU-MIMO setup is better to test Type II. Also, the evaluation results from Ericsson with MU-MIMO setup are for lower MCS and Rank 1 which results in much lower TP than the SU-MIMO set up we have been using, so that doesn’t show that MU-MIMO setup can achieve better performance with Type II codebook.**Sub-Topic 2-3: Test parameters for SU-MIMO option*** Issue 2-3-1: Number of ports

We support the recommended WF. * Issue 2-3-2: Number of PMI Sub-bands per CQI Sub-band

We support the recommended WF. * Issue 2-3-3: paramCombination-r16

We support the recommended WF. * Issue 2-3-4: Sub-band Size

Option 1. We support the recommended WF.* Issue 2-3-5: Beam steering model: how to specify beam steering model in to specification

We support option 1. * Issue 2-3-6: Channel Model

We support the recommended WF. * Issue 2-3-7: MIMO Correlation

We support the recommended WF. * Issue 2-3-8: MCS and Rank

We support the recommended WF.  |
| Huawei, HiSilicon | Issue 2-1-1: Need more investigations. Issue 2-1-2: For simplicity perspective, another option of (Xa, Xb) = (PMIa, fixed PMIb) can be considered. The fixed PMIb could be generated once and be kept fixed throughout the simulation.Issue 2-2-1: Throughout the discussion for the past several meetings on this issue, these two setup of SU-MIMO and MU-MIMO both have their advantages. For SU-MIMO, testing is simple and more straightforward. For MU-MIMO, testing can take advantage of the rich channel feedback of Type II reporting, and more obvious gain can be observed. We are fine for further discuss on both options. Since there is limited timeslot left for completing this WI, and for moving forward, an alternative option of adding a demodulation test with test metric of either follow PMI based or random PMI based throughput. Companies can consider whether this option can be seen as a way of testing MU-MIMO. Issue 2-3-1~2-3-6: Agree with recommended WF. Issue 2-3-7: OK with recommended WF. Issue 2-3-8: Agree with recommended WF.Issue 2-4-1: Prefer Option 2. Issue 2-4-2~2-4-4: Agree with recommended WF. Issue 2-4-5~2-4-7: Need more investigations. Issue 2-4-8: Prefer option 2, to avoid the potential performance ratio (follow vs random) degradation brought by advanced receiver. |
| Ericsson | **Issue 2-1-1: Transmitted signal modeling**The signal seen from the DUT would be according to Option 1.**Issue 2-1-2: Precoder generation in TE for DUT and co-scheduled UEs**We are ok with Option 2 since it is aligned with our proposed setup. We did not include the normalization factor diag(q)^-1/2 in our equation from the previous WF. We did however simulate with this model in mind to normalize the precoders according to option 2. Furthermore, we believe Nokia proposed another simplified model for generating the precoder for the co-scheduled UE using the Gram-Schmidt orthogonalization method which is not captured here in this summary. We think those are the two options that should be listed here. I.e., We support Option 2, but also would like to discuss the other method proposed by Nokia as well.**Issue 2-2-1: SU-MIMO VS MU-MIMO Setup** We’re proposing an MU-MIMO based test setup based on the intended deployment scenario for Type II codebooks. SU-MIMO has seen marginal to no gains when comparing Type I codebook with Type II codebook. Furthermore, we agree that from a UE perspective there is no difference in how the PMI will be reported irrespective of an SU-MIMO, or MU-MIMO test setup. With these two points in mind this leaves room for a poor UE implementation where a Type I CSI report could be reported with Type II format and still pass RAN4 testing, whereas in a MU-MIMO test case we’ve shown in our simulations that proper Type II CSI reporting is needed to achieve maximum theoretical throughput. The SU-MIMO test furthermore does not fulfil the purpose of ensuring that the channel state information reported to the BS enables selection of orthogonal MU-MIMO beam parings. Without a proper test, the network will not know whether UE implementations vary and will not be able to ensure that MU-MIMO orthogonality is achievable, and the MU-MIMO feature, which is an important building block of NR would risk to become a paper feature with little ability to provide gain.Justifiably we think RAN4 should implement test setups which would share similarities for the intended use case. In this case Type II PMI codebook are inherently designed for an MU-MIMO operation in a live network. Thus, it does not make sense to simply reuse the test method from SP Type I requirements since the two codebooks are designed for different operation.**Issue 2-4-1: Number of ports** We think that supporting Option 1 makes more sense since this would implicitly verify that a correct implementation of Type II codebook is supported for 16Tx ports as well. However, we are open to discuss the feasibility of testing with different number of Tx ports based on input from TE vendors.**Issue 2-4-2, 2-4-3, 2-4-4:** Agree with recommended WF.**Issue 2-4-5: Channel Model** We prefer a channel model with a large delay spread to get frequency selectivity across the subband size. In RAN4 we have defined TDLC with 300ns delay spread which is the largest delay spread currently defined.**Issue 2-4-6: MIMO Correlation**We support option 2 given that medium correlation has shown more benefit in simulations.**Issue 2-4-8: Test metric** For the purpose of defining performance requirements we support Option 2 comparing Type II with Type I. Type II codebook was developed to extend the MU-MIMO support of NR. Employing a Random PMI does not make sense since this will never be a precoding scheme employed at the gNB side. Thus, for benchmarking purposes the logical reference performance would be Type I codebook with a similar configuration. |
| Vodafone | **Issue 2-2-1: SU-MIMO VS MU-MIMO Setup**Option 2. Still agree with Ericsson’s views here. Our concern is that SU-MIMO throughput is not a validation of successful type II reporting. It confirms a CSI feedback mechanism is working, but not that type II CSI of a sufficient quality has been received. This leaves the door open for poor UE implementation that could cripple MU-MIMO in deployed networks.  |
| Orange | **Sub-Topic 2-2: Test set-up SU-MIMO VS. MU-MIMO*** Issue 2-2-1: SU-MIMO VS MU-MIMO Setup

We support Option 2 in order to ensure the right performance for MU-MIMO with codebook type II, i.e., to ensure that the UE feedback is the closest to the eigenvectors of the MIMO channel. |
| Samsung | **Sub-Topic 2-1: MU-MIMO scheduling model*** Issue 2-1-1: Transmitted signal modelling

Generally, we are fine with this modelling. It is the common understanding for MU-MIMO signal modelling for data part.While the details of RS configuration should be further clarified, such as whether CRS-RS/TRS colliding for two co-located UE will be considered, whether NZP CSI-RS, IMR should be configured?* Issue 2-1-2: Precoder generation in TE for DUT and co-scheduled UEs

In our understanding, either option 1 or option are feasible for MU-MIMO setup, we think the impact on the UE receiver processing is minor. While the details for precoder generation should be clarified?For option 1: how to decide the regularization facto? The motivation of adding regularization factor is to guarantee matrix invertible, the setting should be based on the condition number of matrix, whether applied the same value of regularization factor for the different strategies for channel generation for co-located UE, such as PMI corresponding to the artificial UE or actual generated channelIn option 2: we agree the interference of coming from co-located can be null with Gram-Schmid method, which is benefit the TP achieved by DUT UE, From the test UE, it is fine.while for co-located UE, the interference coming from DUT is still existed, How can guarantee the whole MU-MIMO performance achieved by these two UEs, if these two UEs are beam pairing in the real network?In terms of test applicability , we need the confirmation from TE vendor about the feasibility of Tx signal generation with precoder for DUT and channel model for co-located UE * Issue 2-1-3: Beam steering model

We think more clarification is needed. With MU-MIMO setup, if there is no beam steering model for DUT and co-located UE, how can guarantee the different beam directions for each UE?**Sub-Topic 2-2: Test set-up SU-MIMO VS. MU-MIMO*** Issue 2-2-1: SU-MIMO VS MU-MIMO Setup

We are fine with MU-MIMO setup. Rel-16 type II codebook can provide more accurate representation of actual channel, gNB can achieve better separation, so it can provide more benefit in MU-MIMO operations compared with type I codebook. With SU-MIMO setup, it is not close to the real network scenario of scheduling type II codebook, maybe not reflect the advantage of type II codebook over than Type I codebook under multi-user co-scheduling scenario. Therefore, it make sense to consider the MU-MIMO setup for type II codebook To achieve comparable performance of MU-MIMO in real network, the test parameters should be properly design, such as scheduling, MU-MIMO beam pairing, UE receiver type. Based on the test procedure of MU-MIMO setup, we do see some details set-up is unclear, it needs to be further clarified to make it feasible.Regarding the UE receiver type, as agreed in last RAN4 meeting, the baseline receiver assumption is UE without interference cancellation capability with/without co-scheduled UE. What is the baseline receiver assumption , MMSE or MMSE-IRC？In case of MMSE receiver, what is the practical noise/interference estimation assumption? In case of MMSE IRC, how can DUT aware the interference of co-located UE? If not, what is the interference/noise estimation assumption?Meanwhile, the feasibility of MU-MIMO, related with PMI calculation and generation for DUT and co-located UE, the channel model generation for co-located UE should be confirmed from TE vendor.On the other hand, no matter SU-MIMO test sup or MU-MIMO setup, the purpose is to verify the gain of type II codebook compared with type I codebookBased on our initial results, we do see some gain of Rel-16 type II codebook, around 4dB SNR gain can be achieved with FDD 16X2 XP medium condition under SU-MIMO setup. In that sense, type II is also feasible for SU-MIMO test up. Meanwhile, from the test feasibility aspect, it has been widely used in existing LTE and NR PMI test cases, the feasibility already been verified. So, the poor UE implementation can be avoided by meeting the requirement of type II codebook**Sub-Topic 2-3: Test parameters for SU-MIMO option*** Issue 2-3-1: Number of ports

We are fine with recommend WF.* Issue 2-3-2: Number of PMI Sub-bands per CQI Sub-band

We are fine with recommended WF. * Issue 2-3-3: paramCombination-r16

We are fine with recommended WF. * Issue 2-3-4: Sub-band Size

We are fine with recommended WF. * Issue 2-3-5: Beam steering model: how to specify beam steering model in to specification

We are fine with recommended WF and option 2. Although only two beams is configured in beam steering model for Rel-16 type II test cases, from future proof manner, we think it is more proper to use a generic beam steering approach, which can be applied for PMI test cases with different codebook types i.e. single beam direction (Type I codebook), dual beam directions (Rel-15 Type II codebook) and multi-beam directions (Rel-16 Type II codebook). We think there is no impact on current test for type II codebook.* Issue 2-3-6: Channel Model

We are fine with recommended WF. * Issue 2-3-7: MIMO Correlation

We are fine with recommended WF and option 2. Based on results, with XP medium can achieve better performance compared with XP high condition. * Issue 2-3-8: MCS and Rank

We are fine with recommended WF. **Sub-Topic 2-4: Test parameters for MU-MIMO option*** Issue 2-4-1: Number of ports

We prefer option 2. NR Rel-15 Type II codebook and Rel-16 advanced Type II codebook are the extension of LTE Rel-14 advanced codebook which they share similar codebook structure. It’s better we can align the number of Tx ports with PMI test case of LTE eFD-MIMO advanced codebook to provide comparable performance. The test complexity especially the number of required individual MIMO channel faders also needs to be consideredWith MU-MIMO test setup, additional independent MIMO faders should be also generated for co-located UE, The test complexity will be further increased.The purpose is to verify the UE PMI feedback behavior, we think 16 Tx port should be enough to show the gain of type II. Also 32 Tx port requirement has already introduced in type I codebook, the test coverage for different number of Tx port can be fulfilled. Meanwhile, in order to verify the type II codebook One candidate test metric is considered with ratio of following PM with enhanced type II codebook and type I single panel codebook. Both 16 Tx and 32 Tx ports requirement are introduced for type I single panel codebook, where 16 Tx port is defined for sub-band PMI, and 32Tx port is defined for wideband PMI. Since only sub-band PMI is supported for Rel-16 enhanced type II, if we apply with test metric of following PMI with enhanced type II codebook and type I single panel codebook, in that sense, only 16 Tx port can be available.* Issue 2-4-2: Number of PMI Sub-bands per CQI Sub-band

We are fine with recommend WF. Since R=2 is a UE optional feature.* Issue 2-4-3: paramCombination-r16

We are fine with recommend WF. * Issue 2-4-4: Sub-band Size

We are fine with recommend WF and option 1. * Issue 2-4-5: Channel Model

We propose with TDLA30-5Hz, following the assumption of Type I codebook requirement Issue 2-4-6: MIMO CorrelationWe prefer option 2* Issue 2-4-7: MCS and Rank

We are fine with option1 with Rank1, while the MCS, we suggest with high MCS, which is similar assumption with type I codebook requirement. The current MCS is too low, it cannot guarantee the benefit of MU-MIMO compared with SU-MIMO test up.  |
| Nokia/NSB | **Sub-Topic 2-1: MU-MIMO scheduling model*** Issue 2-1-1: Transmitted signal modeling

Option 1 is a correct model for the signal seen by the DUT with 1 rx antenna and rank-1 precoder for both the DUT and co-scheduled UE* Issue 2-1-2: Precoder generation in TE for DUT and co-scheduled UEs

Option 1 is the ideal option, we also support Option 2 as a way of simplifying the test.As pointed out by Ericsson, both Option 1 and 2 are aligned in the intention of generating a ZF precoder for the co-scheduled UE, so we support both options. Option 2 is intended to simplify the ZF precoder implementation by observing that we may not need to steer the precoder for the DUT in the null space of the co-scheduled UE because we do not measure the throughput of the co-scheduled UE. This simplification would avoid the matrix inversion.We are also open to consider a further simplification proposed by Huawei in their comments on this issue, i.e., in fixing the PMI of the co-scheduled UE throughout the simulation, provided that the precoder of the co-scheduled UE is maintained orthogonal to the PMI reported by the DUT.* Issue 2-1-3: Beam steering model

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

We support Option 2.Rel-16 Type II codebooks were designed by RAN1 specifically to enhance support for MU-MIMO operations. Evaluation methodology and performance metrics for the design of Rel-16 Type II assumed MU-MIMO in RAN1 so we think it is not possible to test performance requirements in RAN4 with an SU-MIMO test.In Option 1, there is no cross-layer interference from co-scheduled UEs, good beamforming gain can be achieved with Type I, and there is not big margin of improvement with eType II. However, in Option 2, which is an interference-limited MU-MIMO test, accurate representation of the channel eigenvectors is crucial and eType II significantly outperforms Type I. Therefore, the performance gain of eType II relative to Type I can only be verified with Option 2.Although the PMI calculation and demodulation at the DUT is the same in SU- or MU-MIMO setup, there is a significant difference in throughput at the DUT between the two setups because of the presence of co-scheduled UEs. In our view, this test should be designed to guarantee performance in the latter case, i.e. with a co-scheduled UE.We also suggested ways to simplify the MU-MIMO test to ease the TE implementation (see comments on subtopic 2-1-2). **Sub-Topic 2-4: Test parameters for MU-MIMO option*** Issue 2-4-1: Number of ports

Fine prefer Option 2 (16 ports) but are ok with Option 1 (32 ports)* Issue 2-4-2, 2-4-3, 2-4-4

Agree with recommended WF* Issue 2-4-5: Channel Model

Option 1 is ok* Issue 2-4-6: MIMO Correlation

Preference for Option 2* Issue 2-4-7: MCS and Rank

Option 1 is ok* Issue 2-4-8: Test metric

Initially we supported both Options but we agree with Ericsson’s argument that Option 2 is a more accurate metric for this test case. |

### 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
 |