**3GPP TSG-RAN WG4 Meeting #94-e R4-2002383**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.11.3

**Source:** Moderator (Samsung)

**Title:** Email discussion summary for RAN4#94e\_#92\_NR\_eMIMO\_Demod

**Document for:** Information

# Introduction

*Rel-16 NR eMIMO WI is a RAN1 leading WI with below major enhancement in RAN1 area*

* *Enhancement on MU-MIMO support*
* *Enhancement on multi-TRP/panel*
* *Enhancement on multi-beam operation*
* *Enhancement on low PAPR RS*
* *Enhancement on full Tx power uplink transmission*

*As agreed in RAN#85, one objective of RAN4 performance part is to specify necessary UE performance requirements for the specified enhancement, and 4 meeting cycles are allocated for NR eMIMO performance. This meeting is the 1st meeting to discuss the performance requirement of NR eMIMO.*

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

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

* *Demodulation and CSI requirements(8.11.3)*
* *General (8.11.3.1)*
* *Demodulation requirements(8.11.3.2)*
* *CSI requirements(8.11.3.3)*

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

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

# Topic #1: Demodulation requirements (8.11.3&8.11.3.2)

*This section contains T-docs with corresponding proposals and observations submitted to the agenda item with general and demodulation requirements (8.11.3.1 and 8.11.3.2). The guideline of this section is to identify the work scope of demodulation parts based on RAN1 features. Based on the test scope, the related test case design should be specified to verify the functionality of RAN1 feature*

## Companies’ contributions summary

|  |  |  |
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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000319 | Samsung | Observation 2: New PDSCH performance requirements required for both Multi-PDCCH based multi-TRP/multi-panel transmission and Single-PDCCH based multi-TRP/multi-panel transmission  Observation 3: Deprioritize URLLC enhancement with multi-TRP/multi-panel transmission which pending on progress on performance requirements of Rel-16 URLLC WI  Observation 4: No performance requirements (demodulation and CSI) impact foreseen for Rel-16 eMIMO Beam management enhancement sub-features including: L1-SINR measurement, Beam failure recovery for SCell and DL/UL beam indication with reduced latency and overhead  Observation 5: No performance requirements (demodulation and CSI) impact foreseen for Rel-16 eMIMO sub-feature: UL Full Tx power transmission  Observation 6: FFS whether PDSCH/PUSCH/PUCCH performance requirements required to verify DMRS sequence enhancement functionality.  Observation 7: If needed, existing BS/UE performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification  Proposal 1: Work Scope of Performance requirements (demodulation and CSI) for Rel-16 eMIMO WI   * New PDSCH performance requirements required to verify DL Multi-TRP/Panel transmission for both single PDCCH based and multiple PCCH based on transmission * Deprioritize Multi-TRP/Panel transmission for URLLC pending on progress on performance requirements of Rel-16 URLLC WI. * FFS whether BS and UE demodulation requirements required for DMRS sequence enhancement * If needed, existing BS/UE performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters mediation |
| R4-2000322 | Samsung | Observation 1: For Single-PDCCH based multi-TRP/Panel transmission, different combinations of layers from 2 TRPs supported with restriction per CW per TRP.  Observation 2: Two separate TCI state can be actived in a single DCI.  Proposal 1: New PDSCH demodulation test cases required for Single-PDCCH based multi-TRP/Panel transmission to cover below features:   * DMRS ports combinations among two TRPs * Two TCI states activation in single DIC code point * PDSCH scheduling with overlap/non-overlapping   Observation 3: From scheduling perspective, fully/partially/non-overlapped PDSCHs at time and frequency domain are allowed for Multiple-PDCCH based multi-TRP/Panel transmission.  Observation 4: New PDCCH scheduling schemes, ACK/NACK feedback schemes has been introduced for Multiple-PDCCH based multi-TRP/Panel transmission.  Observation 5: New Rate-mating behaviour has been defined for multi-TRP/panel transmission.  Proposal 2 :New PDSCH demodulation test cases required for Multiple-PDCCH based multi-TRP/Panel transmission to cover below features   * PDSCH scheduling schemes: overlapping, non-overlapping and partial overlapping transmission * PDCCH scheduling schemes: with/without CORESET pool index configured * ACK/NACK feedback schemes: Joint or separate * UE rate-matching behaviour   Proposal 3: Test case 1: Single PDCCH based on Mutil-TRP/Panel transmission   * Full overlapping scheduling PDSCH * Layer combination: 1 +1 * Two TCI states * Time offset among TPs: 0us * Frequency offset among 2TPs: [300Hz]   Proposal 4: Test case 2: Mutil- PDCCH based on Mutil-TRP/Panel transmission   * Non- overlapping scheduling PDSCH * CW combination: 2 +2 * Time offset among TPs: 2us * Frequency offset among 2TPs: 0Hz * ACK/NACK: Joint feedback   Proposal 5: Test case 3: Mutil- PDCCH based on Mutil-TRP/Panel transmission   * Partial overlapping scheduling PDSCH * CW combination: 1+1 * Time offset among TPs: -0.5us * Frequency offset among 2TPs: 0Hz * ACK/NACK: Separate feedback |
| R4-2000352 | Qualcomm | Proposal 1: Prioritize defining requirements for SDM Scheme, FDM Scheme A, FDM Scheme B and Multi-DCI based m-PDSCH among different multi-TRP schemes. |
| R4-2001363 | Ericsson | Observation 1: ‘Multi-TRP/panel transmission with both ideal and non-ideal backhaul’ is the only objective which needs to define new UE demodulation requirements  Proposal 1: RAN4 defines new PDCCH/PDSCH demodulation requirements for the multi-PDCCH based multi-TRP PDSCH transmission in the Rel-16 eMIMO WI performance part  Proposal 2: If RAN4 is going to define new PDCCH/PDSCH demodulation requirements for the multi-DCI based multi TRP transmission, verify at least the cases that PDSCHs are fully overlapped and PDSCHs are not overlapped  Proposal 3: If RAN4 is going to define new PDCCH/PDSCH demodulation requirements for the multi-DCI based multi TRP transmission, RAN4 should consider the scenario that the TRSs/CSI-RSs collide between 2 TRPs.  Proposal 4: RAN4 should discuss whether to define new PDSCH demodulation requirements for reliable PDSCH transmission with multi-TRP |
| R4-2001466 | Huawei, HiSilicon | Proposal 1: Define new performance requirements for Multi-PDSCH with full overlapped time-frequency resource allocation  Proposal 2: Not to define any new performance requirements for PDCCH for Multi-TRP  Proposal 3: Consider the time and frequency offsets of two TRPs in test cases design in Multi-TRP  Observation 1: Whether to define requirements for Multi-TRP in URLLC need to be further discussed since it is similar with the one in eMBB to some extent except the test metric  Observation 2: If performance requirements for Multi-TRP in URLLC are needed, then we prefer to down select to scheme 1a or 4 considering to reduce the workload |
| R4-2001467 | Huawei, HiSilicon | Proposal 1: Propose not to define new performance requirement for PDSCH enhancement in DMRS sequence generation  Proposal 2: Propose not to define any new PDSCH/PDCCH performance requirements for DL latency and overhead reduction in Multi-Beam for eMIMO  Observation 1: Consider the agreements of SCell recovery are more related to the RRM work scope, there is rather no impact on demodulation part and can be ignored  Observation 2: Introducing L1-SINR measurement has few impact on demodulation part and can be ignored |
| R4-2001469 | Huawei, HiSilicon | Proposal 1: Not to define PUCCH performance requirements for multi-PDSCH feedback |
| R4-2001470 | Huawei, HiSilicon | Proposal 1: Propose not to define any new PUSCH and PUCCH performance requirements for DFT-S-OFDM based DMRS enhancement  Proposal 2: Propose not to define any new PUCCH performance requirements for UL latency and overhead reduction. |
| R4-2001740 | Intel | Proposal 1: Define PDSCH demodulation requirements for multi-DCI and single DCI based schemes using same PDSCH test configuration.  Proposal 2: Define PDSCH demodulation requirements for repetition schemes 2a, 3 and 4.  Proposal 3: Define one DL test to verify receive processing of Rel-16 DMRS.  Proposal 4: Define one UL CP-OFDM test to verify receive processing of Rel-16 DMRS reusing setup (with modification in DMRS configuration) and SNR point from one of existing Rel-15 PUSCH requirements.  Proposal 5: Do not define UL requirements to verify receive processing of Rel-16 DMRS for scenarios with DFT-S-OFDM waveform. |

## Open issues summary

### Sub-topic 1-1: Test scope of Enhancement on Multi-TRP/Panel transmission (1st round)

*In Rel-16, based on integrated framework of NR system, the details objectives for enhancements on multi-TRP/panel transmission are as follows:*

* *Enhancements on Multi-TRP/Panel transmission including improved reliability and robustness with both ideal and non-ideal backhaul:*
  + *Specify downlink control signalling enhancements for efficient support of non-coherent joint transmission*
  + *Perform study and, if needed,*
  + *Multi-TRP techniques for URLLC requirements are included in this WI*

*Based on RAN1 feature, this sub-topic mainly focuses to identify whether new PDSCH demodulation with scheduled by multi-DCI/single-DCI should be specified, as well as for URLLC requirements. Meanwhile, if RAN4 agree to define the requirement, RAN4 should discuss the test case design to verify the functionality of multi-TRP/Panel transmission*

*Open issues and candidate options before e-meeting:*

**Issue 1-1-1: Multi-PDSCH requirement scheduled by multi-DCI**

* Proposals
  + Option 1: Define the PDSCH requirements required by multi-PDCCH scheduling based multi-TRP/multi-panel transmission (Samsung, Huawei, Ericsson, QC, Intel, CMCC, DCM)
* Recommended WF
  + Agree above proposal

**Issue 1-1-2: Multi-PDSCH requirement scheduled by single-DCI**

* Proposals
  + Option 1: Define the PDSCH requirements required by single-PDCCH scheduling based on multi-TRP/multi-panel transmission (Samsung, Intel, QC, CMCC, DCM)
  + Option 2: Not to define multi-PDSCH requirement scheduled by single-DCI (Huawei)
* Recommended WF
  + 7 companies discuss issue 1-1-2, 5 companies agree to define requirement. 1 company prefers to not define requirement, 1 company agrees to define requirement if there is different form PDSCH demodulation requirement, compared with multi-DCI based scheduling. Based on the majority view, at this stage for 1st round, Moderatorwould like to suggest
* Option 1

**Issue 1-1-3: Multi-TRP requirements for URLLC**

* Proposals
  + Option 1: FFS to define requirements for Multi-TRP in URLLC (Huawei, Ericsson)
  + Option 2: Deprioritize URLLC requirements with Multi-TRP pending on the progress on performance requirements of Rel-16 URLLC WI (Samsung, Huawei, Ericsson)
  + Option 3: Define requirements for Multi-TRP in URLLC with conventional eMBB performance metrics (Intel)
  + Option 4: Not to define multi-TRP requirements for URLLC (QC)
* Recommended WF
  + 5 companies discuss issue 1-1-3. 3 companies prefer to deprioritize URLLC requirements for multi-TRP. 1 company prefer not to define requirement. Moderator would like to suggest companies the following two options for further discussion, and encourage companies to provide comments:
* Deprioritize URLLC requirements with multi-TRP in NR eMIMO WI pending on the progress on performance requirements of Rel-16 URLLC WI
* Define multi-TRP requirement for reliability transmission

**Issue 1-1-4: PUCCH requirement for multi-PDSCH feedback**

* Proposals
  + Option 1: Not to define PUCCH performance requirements for multi-PDSCH feedback(Huawei, Samsung, QC, Intel, Nokia)
* Recommended WF
  + Agree above proposal

**Issue 1-1-5: Multi-PDCCH requirement**

* Proposals
  + Option 1: Not to define any new performance requirements for multi-PDCCH for multi-TRP(Huawei, Samsung, QC, Intel)
* Recommended WF
  + Agree above proposal

**Issue 1-1-6: Single PDCCH requirement**

* Proposals
  + Option 1: Not to define any new requirements for single PDCCH for multi-TRP(Huawei, Samsung, QC, Intel)
* Recommended WF
  + Agree above proposal

### Sub-topic 1-2: Test setup of Enhancement on Multi-TRP/Panel transmission (2nd round)

*In Rel-16, based on integrated framework of NR system, the details objectives for enhancements on multi-TRP/panel transmission are as follows:*

* *Enhancements on Multi-TRP/Panel transmission including improved reliability and robustness with both ideal and non-ideal backhaul:*
  + *Specify downlink control signalling enhancements for efficient support of non-coherent joint transmission*
  + *Perform study and, if needed,*
  + *Multi-TRP techniques for URLLC requirements are included in this WI*

*In this sub-topic, based on the test scope discussion in 1st round, RAN4 should discuss the test case design to verify the functionality of multi-TRP/Panel transmission*

*Open issues and candidate options before e-meeting:*

**Issue 1-2-1: Test case design principle for Multi-PDSCH requirement scheduled by multi-DCI (if agreed to introduce requirement)**

* Proposals
  + Option 1: cover features (Samsung):

- PDSCH scheduling schemes: overlapping, non-overlapping and partial overlapping transmission

- PDCCH scheduling schemes: with/without CORESET pool index configured

- ACK/NACK feedback schemes: Joint or separate

- UE rate-matching behaviour

* + Option 2: Consider the time and frequency offsets of two TRPs in test cases design in Multi-TRP (Huawei)
  + Option 3: Consider the scenario that the TRSs/CSI-RSs collide between 2 TRP (Ericsson)
  + Option 4: Use same PDSCH configuration for multi-DCI and single-DCI scenario (Intel)
* Recommended WF
  + Discuss above proposals

**Issue 1-2-1-1: PDSCH scheduling in time-frequency resource allocation**

* Proposals
  + Option 1: both non-overlapping scheduling PDSCH and partial overlapped scheduling PDSCH(Samsung)
  + Option 2: Only define the performance requirements for multi-PDSCH with full-overlapped(Huawei)
  + Option 3: at least for full-overlapped and non-overlapped (Ericsson)
  + Option 4: Prioritize defining requirements for SDM Scheme, FDM Scheme A, FDM Scheme B and Multi-DCI based m-PDSCH among different multi-TRP schemes (QC)
* Recommended WF
  + Discuss above proposals

**Issue 1-2-1-2: CW combination from two TRPs**

* Proposals
  + Option 1: 2+2 for non-overlapping scheduling PDSCH, 1+1 for partial overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-1-3: Timing offset among 2TPs**

* Proposals
  + Option 1: 2us for non-overlapping scheduling PDSCH, -0.5us for partial overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-1-4: Frequency offset among 2TPs**

* Proposals
  + Option 1: 0Hz (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-1-5: ACK/NACK among 2TPs**

* Proposals
  + Option 1: joint feedback for non-overlapping scheduling PDSCH, separate feedback for partial overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-2: Test case design for Multi-PDSCH requirement scheduled by single-DCI (if agreed to introduce requirement)**

**Issue 1-2-2-1: Test Case Design Principle**

* Proposals
  + Option 1: Cover DMRS ports combination among two TRPs, Two TCI states activation in single DCI code point and PDSCH scheduling with overlap/non-overlapping (Samsung)
  + Option 2: Consider the time and frequency offsets of two TRPs in test cases design in Multi-TRP (Huawei)
* Recommended WF
  + Discuss above proposal

**Issue 1-2-2-2: Test Case design for PDSCH scheduling**

* Proposals
  + Option 1: Full overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Agree above proposal

**Issue 1-2-2-3: Test case design for lay combination**

* Proposals
  + Option 1: 1+1 layer combination for full overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-2-4: Test case design for two TCI states**

* Proposals
  + Option 1: Two TCI state activation in single TCI code point(Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-2-5: Test case design for timing offset among 2TPs**

* Proposals
  + Option 1: 0us (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-2-6: Frequency offset among 2TPs**

* Proposals
  + Option 1: [300Hz] (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-3: Test case design for Multi-PDSCH requirement for URLLC (if agreed to introduce requirement)**

**Issue 1-2-3-1: Transmission schemes**

* Proposals
  + Option 1: Down selection to scheme 1a and 4 (Huawei)
  + Option 2: Define PDSCH demodulation requirements for repetition schemes 2a, 3 and 4.(Intel)
* Recommended WF
  + Discuss above proposals

### Sub-topic 1-3: Test scope of Enhancement on Multi beam operation (1st round)

*Based on the revised WID of NR eMIMO for Rel-16, one objective related to the Multi-Beam enhancement is included as*

* *Enhancements on multi-beam operation, primarily targeting FR2 operation:*
  + *Perform study and, if needed, specify enhancement(s) on UL and/or DL transmit beam selection specified in Rel-15 to reduce latency and overhead*
  + *Specify beam failure recovery for SCell with DL/UL as well as DL-only, where PCell can be operating in FR1 as well as FR2*
  + *Specify measurement and reporting of either L1-RSRQ or L1-SINR*

*Based on RAN1 feature, this sub-topic mainly focuses to identify the potential impact on the performance requirements of UE with supported multi-Beam.*

*Open issues and candidate options before e-meeting:*

**Issue 1-3-1: L1-SINR measurement**

* Proposals
  + Option 1: No performance requirement including demodulation and CSI reporting (HW, Samsung, Ericsson, Intel, QC)
* Recommended WF
  + Agree above proposal

**Issue 1-3-2:** **BFR for Scell**

* Proposals
  + Option 1: No performance requirement including demodulation and CSI reporting(HW, Samsung, Ericsson, Intel, QC)
* Recommended WF
  + Agree above proposal

**Issue 1-3-3:** **DL/UL beam indication with reduced latency and overhead**

* Proposals
  + Option 1: No performance requirement including demodulation and CSI reporting (HW, Samsung, Ericsson, Intel, QC)
* Recommended WF
  + Agree above proposal

### Sub-topic 1-4: Test scope of Enhancement on low PAPR RS(1st round)

*Pi/2 BPSK modulation was introduced in Rel-15 for data symbols (both DL and UL). In Rel-16, in order to reach same level PAPR as Pi/2 BPSK modulation data symbols, new DMRS sequence generation has been introduced intending to reduce the PRPR for PDSCH/PUSCH using CP-OFDM waveform and PUSCH/PUCCH using DFT-s-OFDM. For receiver performance requirements respective, RAN4 should identity whether PDSCH/PUSCH/PUCCH performance is required to verify DMRS sequence enhancement functionality*

*Based on RAN1 feature, this sub-topic mainly focuses to identify the potential impact on the performance requirements of UE/BS demodulation requirement with lower PAPR RS.*

*Open issues and candidate options before e-meeting:*

**Issue 1-4-1: PDSCH demodulation requirement**

* Proposals
  + Option 1: FFS whether PDSCH performance required to verify DMRS sequence enhancement functionality. if needed, existing UE performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification (Samsung)
  + Option 2: Define one DL test to verify receive processing of Rel-16 DMRS(Intel, DCM)
  + Option 3: Not to define new performance requirement for PDSCH enhancement in DMRS sequence generation(Huawei, Ericsson, QC)
* Recommended WF
  + 6 companies discuss Issue 1-4-1. 3 companies prefer to not define new performance requirement for PDSCH enhancement in DMRS sequence generation. 2 companies prefer to define one DL test case. Moderator would like to suggest companies the following two options for further discussion, and encourage companies to provide comments
    - Option 1: Define one DL test to verify receiver processing of Rel-16 DMRS enhancement
* Option 1a: Existing UE performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification
* Option 1b: One new test case with test parameters modification
  + - Option 2: Not to define any new PDSCH performance requirement of Rel-16 DMRS enhancement

**Issue 1-4-2: PUSCH demodulation requirement**

* Proposals
  + Option 1: Not to define any new PUSCH performance requirements for DFT-s-OFDM based on DMRS enhancement (Huawei, Ericsson, Samsung, Intel)
  + Option 2 (Intel):
  + Define one UL CP-OFDM test to verify the receive processing from one of existing Rel-15 PUSCH requirement (Intel, DCM)
  + ~~Do not define UL requirements to verify receive processing of Rel-16 DMRS for scenarios with DFT-S-OFDM waveform (Intel)~~
  + Option 3: FFS whether PUSCH performance requirement required to verify DMRS sequence enhancement functionality if needed, existing BS performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification (Samsung, Nokia)
  + Option 4: Define new PUSCH performance requirements for DFT-s-OFDM based on DMRS enhancement (DCM)
* Recommended WF
  + 6 companies discuss issue 1-4-2
    - Regarding PUSCH requirement with DFT-s-OFDM, 4 companies prefer not to define requirement. Based on majority view, at this stage for 1st round, Moderator would like to suggest
* No new PUSCH requirement for DFT-s-OFDM based on DMRS enhancement
  + - Regarding PUSCH requirement with CP-OFDM, 2 companies prefer to define requirements. Moderator would like to suggest companies the following two options for further discussion, and encourage companies to provide comments
* Option 1: Define one UL PUSCH with CP-OFDM test to verify the receiver processing from one of existing Rel-15 PUSCH requirement. Existing PUSCH performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification
* Option 2: No new PUSCH requirement with Rel-16 DMRS enhancement for CP-OFDM

**Issue 1-4-3: PUCCH demodulation requirement**

* Proposals
  + Option 1: Not to define any new PUCCH performance requirements for DFT-s-OFDM based on DMRS enhancement (Huawei, Ericsson, Samsung)
  + Option 2: FFS whether PUCCH performance requirement required to verify DMRS sequence enhancement functionality if needed, existing BS performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification (Samsung, Nokia)
  + Option 3: Do not define UL requirements to verify receive processing of Rel-16 DMRS for scenarios with DFT-S-OFDM waveform (Intel)
  + Option 4: Define new PUCCH performance requirements for DFT-s-OFDM based on DMRS enhancement (DCM)
* Recommended WF
  + 6 companies discuss Issue 1-4-3. 4 companies prefer to not define new performance requirement for PUCCH enhancement for DFT-s-OFDM. Based on the majority view, at this stage, Moderator would like to suggest
    - No new PUCCH performance requirement for DFT-s-OFDM based on Rel-16 DMRS enhancement

### Sub-topic 1-5: Test scope of Enhancement on full Tx power uplink transmission (1st round)

*The objective of full transmission power of UL in the WID of Rel-16 MIMO is to specify enhancement to allow full power transmission in case of uplink transmission with multiple powers amplifies with assuming no change on UE power class.*

*Based on RAN1 feature, this sub-topic mainly focuses to identify the potential impact on the performance requirements of UE/BS demodulation requirement with full Tx power uplink transmission.*

*Open issues and candidate options before e-meeting:*

**Issue 1-5-1: Whether to define demodulation with related with full Tx power uplink transmission**

* Proposals
  + Option 1: No performance requirement including demodulation and CSI (Samsung, Intel, QC, Nokia)
* Recommended WF
  + Agree above proposal

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |
| Nokia, Nokia Shanghai Bell | 1-1-4: Nokia agrees with option 1/WF.  Only the payload transmitted over PUCCH changes, not the demodulation of the PUCCH.  1-4-2: Nokia agrees with option 3.  We would like to further study, how the reference signal change affects PUSCH demodulation performance, and especially, to further evaluate possible differences between conducted and OTA testing. Previous R15 configurations can be re-used. If the SNR operating point changes significantly, the introduction of a limited number of requirements can be discussed.  1-4-3: Nokia agrees with option 2; reasoning as in 1-4-2.  1-5-1: Nokia agrees with option 1/WF.  A transmitter side power increase does not change receiver side demodulation performance, which is defined by SNR operating points. |
| Huawei, HiSilicon | Sub topic 1-1:  For issue 1-1-1, 1-1-2, Based on our observation, we think there are no difference on demodulation part between single DCI scheduled multi-PDSCH and multi-DCI scheduled multi-PDSCH, given that TCI structure of PDCCH will not lead to performance difference. Therefore we think defining both single and multi-PDCCH scheduled PDSCH is kind of repetitive work especially using the same test configuration. Thus, we prefer to define ether single or multi-PDCCH scheduled multi-PDSCH requirements. Considering the scenario of multi-DCI scheduled multi-PDSCH is more typical than another, we support only defining requirements for multi-DCI scheduled multi-PDSCH.  For issue 1-1-3, like our observation1 in R4-2001466, since the multi-TRP in URLLC is to some extent much similar with multi-TRP in eMBB, and since URLLC is still on discussion so that many issues are remain undetermined, we prefer at lease deprioritize the requirements for it for now. Therefore, we support both option1 and 2.  Sub topic 1-2:  Sub topic 1-4  Issue 1-4-1:  For DMRS mapping method for PDSCH, the existed mapping method in Rel-15 will be reused and that will bring no changes in Rel-16. From the perspective of demodulation, this improvement only related to the changes on DMRS sequence generation formula, in which new parameters are added rather than replacing the original generation procedure and no new algorithms or typical scenarios are introduced, which will lead to no performance difference. In that case, we prefer not to define any new performance requirements for sub topic 1-4.  Issue 1-4-2, 1-4-3: Same comments as issue 1-4-1.  Others: |
| Samsung | Sub topic 1-1:  Issue 1-1-1: Multi-PDSCH requirement scheduled by multi-DCI  Prefer option 1: Define the PDSCH requirements required by multi-PDCCH scheduling based multi-TRP/multi-panel transmission  Based on RAN1 agreements, multi-TRP/panel transmission supported scheduled by multi-DCI is supported in Rel-16  Corresponding new PDCCH schemes including TCI state scheduling, HARQ schemes and DMRS port mapping were introduced for multi-TRP/panel transmission. Considering the new PDSCH scheduling, PDCCH scheduling as well as new rate matching, RAN4 need to verify the UE processing from receiver performance requirements perspective.  Issue 1-1-2: Multi-PDSCH requirement scheduled by single-DCI  Prefer option 1: Define the PDSCH requirements required by single-DCI  Based on RAN1 agreements, multi-TRP/panel transmission supported scheduled by single-DCI is supported in Rel-16.  For Single-PDCCH based multi-TRP/Panel transmission, different combinations of layers from 2 TRPs supported with restriction per CW per TRP. Two separate TCI state can be activated in a single DCI, RAN4 need to verify the UE processing from receiver performance requirements perspective.  Issue 1-1-3: Multi-TRP requirements for URLLC  Prefer option 1 and option 2: Deprioritize URLLC requirements with Multi-TRP pending on the progress on performance requirements of Rel-16 URLLC WI  For URLLC enhancement, considering a parallel discussion on introducing Rel-15/Rel-16 URLLC performance requirement is still on-going under Rel-16 URLLC enhancement WI. The test methodology and proper metric is still FFS, we can consider to deprioritize URLLC enhancement requirements under eMIMO WI in initial stage.  Issue 1-1-4: PUCCH requirement for multi-PDSCH feedback  Prefer option 1: Not to define PUCCH performance requirements for multi-PDSCH feedback  Issue 1-1-5: Multi-PDCCH requirement  Prefer option 1: no requirement for Multi-PDCCH detection, The new PDCCH scheduling should be considered for requirement of Multi-TRP/Panel transmission based on multi-DCI scheduled  Regarding multi-PDCCH scheduling, as indicated with RAN1 agreement, UE does not assume any dependency amongst the multiple PDCCH for the purposes of PDCCH. Therefore, there is no performance different with single PDCCH in Rel-15. As for the ACK/NACK feedback for received PDSCHs, both separate and joint are supported. It will have the impact on the UE receiver processing and related HARQ combination processing. Therefore, the new PDCCH scheduling should be considered for requirement of Multi-TRP/Panel transmission  Issue 1-1-6: Single PDCCH requirement  Prefer option 1: no requirement for single PDCCH  Sub topic 1-2:  Sub topic 1-3:  Issue 1-3-1: L1-SINR measurement  Prefer option1: no performance requirement including demodulation and CSI reporting  Beam management enhancement consists of L1-SINR measurement, Beam failure recovery for SCell and DL/UL beam indication with reduced latency and overhead. All these features were introduced for L1/L2 Beam management optimization and belongs RRM scope. Even L1-SINR was configured under CSI report structure, similar as L1-RSRP measurement and reporting introduced in Rel-15 NR WI, corresponding measurement period and accuracy requirements for L1-SINR belongs to RRM scope.  Issue 1-3-2: BFR for Scell  Prefer option 1: no performance requirement including demodulation and CSI reporting  Same comments with L1-SINR measurement  Issue 1-3-3: DL/UL beam indication with reduced latency and overhead  Prefer option 1: no performance requirement including demodulation and CSI reporting    Sub topic 1-4:  Issue 1-4-1: PDSCH demodulation requirement  Prefer option FFS for PUSCH with CP-OFDM, if needed, existing UE performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification  Regarding CP-OFDM for PUSCH, DMRS enhancement is related with the cinit for pseudo-random sequence generation related with CDM group and nSCID. In terms of performance requirement and BS receiver processing perspective, there is no different, only with configuration changed. In Rel-15 PDSCH, RAN4 has already defined the PUSCH requirements with CDM group 0, in case of CDM group 0, the DMRS cinit for pseudo-random sequence generation is same with Rel-15. Thus, we prefer to FFS. If needed, existing PDSCH performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification  Issue 1-4-2: PUSCH demodulation requirement  Prefer option 1 and option 3: Not to define any new PUSCH performance requirements for DFT-s-OFDM based on DMRS enhancement; FFS for PUSCH with CP-OFDM, if needed, existing BS performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification.  In Rel-16, DMRS enhancements were introduced for CP-OFDM, and DFT-s-OFDM related with pi/2 BPSK for PUSCH and PUCCH.  Regarding CP-OFDM for PUSCH, DMRS enhancement is related with the cinit for pseudo-random sequence generation related with CDM group and nSCID. In terms of performance requirement and BS receiver processing perspective, there is no different, only with configuration changed. In Rel-15 PUSCH, RAN4 has already defined the PUSCH requirements with CDM group 1, i.e, the CDM group without data is 2. Thus, it is not necessary to define the requirement with DMRS enhancement. If needed, existing PUSCH performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification  Regarding DFT-s-OFDM, DMRS enhancement is related with lower PAPR DMRS sequence under pi/2 PBSK modulation for PUSCH and PUCCH format3/4. In terms of performance requirement and BS receiver processing perspective, there is no different. Meanwhile, there is no requirement of pi/2 BPSK in Rel-15, considering it is optional feature for UE. Therefore, we suggest to not define requirement for DMRS enhancement for DFT-s-OFDM related PUSCH and PUCCH  Issue 1-4-3: PUCCH demodulation requirement  Prefer option 1: Not to define any new PUCCH performance requirements for DFT-s-OFDM  Regarding DFT-s-OFDM, DMRS enhancement is related with lower PAPR DMRS sequence under pi/2 PBSK modulation for PUSCH and PUCCH format3/4. In terms of performance requirement and BS receiver processing perspective, there is no different. Meanwhile, there is no requirement of pi/2 BPSK in Rel-15, considering it is optional feature for UE. Therefore, we prefer to not define requirement for DMRS enhancement for DFT-s-OFDM related PUSCH and PUCCH  Sub topic 1-5:  Issue 1-5-1: Whether to define demodulation with related with full Tx power uplink transmission  Prefer option 1: no performance requirement including demodulation and CSI reporting  The objection of full transmission power of UL in the WID of R16 MIMO is to specify enhancement to allow full power transmission in case of uplink transmission with multiple power amplifiers (assume no change on UE power class). This is related to transmitter side, no impact on receiver side foreseen |
| CMCC | Sub topic 1-1:  Issue 1-1-1: we support option 1 (Define the PDSCH requirements required by multi-PDCCH scheduling based multi-TRP/multi-panel transmission)  Issue 1-1-2: we support option 1 (Define the PDSCH requirements required by single-PDCCH scheduling based on multi-TRP/multi-panel transmission) |
| Qualcomm | Sub topic 1-1:  Issue 1-1-1: Ok with Option 1.  Issue 1-1-2: Ok with Option 1.  Issue 1-1-3: We prefer not to define these requirements at this point since we have plenty of other higher priority requirements to define under this WI.  Issue 1-1-4/5/6: Ok with Option 1.  Sub topic 1-3: Ok to not defining any performance requirements.  Sub topic 1-4: Ok to not defining any new performance requirements.  Sub topic 1-5: Ok to not defining any performance requirements. |
| Ericsson | Sub topic 1-1-2: If we understand correctly this feature schedules multi-PDSCH with multi-TRP/multi-panel with single PDCCH. From the PDSCH demodulation point of view we don’t see any difference from multi-DCH based multi-PDSCH scheduling. If there are difference from PDSCH demodulation, we are fine to define it.  Sub topic 1-1-3: It is not clear the purpose of test with multi-TRP requirements for URLLC. We tend to agree to option 2, it should check the progress of URLLC WI performance part and see what requirements are defined for URLLC before developing multi-TRP requirements, not work in parallel..  Sub topic 1-4-1: We do not see a reason why a difference in the DM-RS sequence should impact the PUSCH demodulation. Considering the expected workload of eMIMO WIs, i.e., multi-PDSCH transmission and Rel-16 type-II PMI reporting test and the lack of an obvious impact to PUSCH demod, we prefer Option 3.  Sub topic 1-4-2: Same comments as 1-4-1.  Sub topic 1-4-3: Same comments as 1-4-1. |
| Intel | **Sub-topic 1-1:**  **Issue 1-1-1: Multi-PDSCH requirement scheduled by multi-DCI**  Agree with WF  **Issue 1-1-2: Multi-PDSCH requirement scheduled by single-DCI**  Agree with WF  **Issue 1-1-3: Multi-TRP requirements for URLLC**  Considering below observations we think it is necessary to define requirements for URLLC multi-TRP operation schemes and consider them in eMIMO WI (Option 2).   * The follow performance objective is captured in NR Rel-16 eMIMO WI description: *Specify necessary UE performance requirements for the specified enhancements*. In the list of required enhancements *Multi-TRP techniques for URLLC requirements* are captured * Specifying URLLC demodulation requirements for multi-TRP operation are not captured in URLLC WI description. * From UE receive processing perspective URLLC schemes 2a, 2b, 3 and 4 require another assumption on demodulation flow compare to other Rel-16 multi-TRP operations since it is repetitions schemes.   In eMIMO WI we do not want to define requirements for low BLER to meet target reliability requirements of URLLC use cases. Demodulation performance requirements for URLLC multi-TRP transmission schemes should be defined using conventional eMBB performance metrics  **Issue 1-1-4: PUCCH requirement for multi-PDSCH feedback**  Agree with WF  **Issue 1-1-5: Multi-PDCCH requirement**  Agree with WF  **Issue 1-1-6: Single PDCCH requirement**  Agree with WF  **Sub-topic 1-3:**  **Issue 1-3-1: L1-SINR measurement**  Agree with WF  **Issue 1-3-2: BFR for Scell**  Agree with WF  **Issue 1-3-3: DL/UL beam indication with reduced latency and overhead**  Agree with WF  **Sub-topic 1-4**  **Issue 1-4-1: PDSCH demodulation requirement**  It is necessary to define performance test cases to verify that UE makes correct receive processing in case Rel-16 DMRS are transmitted. Otherwise we cannot guarantee reliable UE performance since it may assume another DMRS sequence compare to what was transmitted  Prefer Option 2.  **Issue 1-4-2: PUSCH demodulation requirement**  It is necessary to define performance test cases to verify that BS makes correct receive processing in case Rel-16 DMRS are transmitted. Otherwise we cannot guarantee reliable BS performance since it may assume another DMRS sequence compare to what was transmitted.  For PUSCH it should be done only for CP-OFDM scenario since for DFT-s-OFDM Rel-16 DMRS design is applicable only to pi/2 BPSK for which we have not any performance test cases.  Prefer Option 2 and also Option 1 since it is subset of Option 2.  **Issue 1-4-3: PUCCH demodulation requirement**  Prefer Option 3 and also Option 1 since it is subset of Option 3.  **Sub-topic 1-5**  **Issue 1-5-1: Whether to define demodulation with related with full Tx power uplink transmission**  Agree with WF |
| DOCOMO | Sub topic 1-1:  Issue 1-1-1: Agree with recommended WF  Issue 1-1-2: Agree with recommended WF  Sub topic 1-4:  Issue 1-4-1: We prefer Option 2  Issue 1-4-2: We prefer to define both CP-OFDM and DFT-s-OFDM tests with Rel.16 DMRS configuration since Rel.15 demodulation requirements do not verify the performance of this Rel.16 feature. We need further discussion on how to verify the performance for both CP-OFDM and DFT-s-OFDM with Rel.16 DMRS configuration.  Issue 1-4-3: Similar to PUSCH, Rel.15 demodulation requirements do not verify the performance with Rel.16 DMRS configuration, so we prefer to define tests to verify PUCCH performance with Rel.16 DMRS configuration. |

### 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#1-1** | *Tentative agreements:*  Issue 1-1-1  Define the PDSCH requirements required by multi-PDCCH scheduling based on multi-TRP/multi-panel transmission  Issue 1-1-4  No PUCCH requirement for multi-PDSCH feedback  Issue 1-1-5  No multi-PDCCH requirement for multi-TRP  Issue 1-1-6  No single-PDCCH requirement for multi-TRP  Issue 1-1-2: Whether to define the requirement of Multi-PDSCH requirement scheduled by single-DCI  7 companies discuss issue 1-1-2, 5 companies agree to define requirement. 1 company prefers to not define requirement, 1 company agrees to define requirement if there is different form PDSCH demodulation requirement, compared with multi-DCI based scheduling.  *Candidate options:*   * Option 1: Define the PDSCH requirements required by single-DCI scheduling based on multi-TRP/multi-panel transmission (Samsung, Intel, QC, CMCC, DCM) * Option 2: Not to define PDSCH requirements required by single-DCI scheduling based on multi-TRP/multi-panel transmission (Huawei)   *Recommendations for 2nd round:*  Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments  Issue 1-1-3: Whether to define the multi-TRP with URLLC requirement  5 companies discuss issue 1-1-3. 3 companies prefer to deprioritize URLLC requirements for multi-TRP. 1 company prefer not to define requirement  *Candidate options:*   * Option 1: Deprioritize URLLC requirements with multi-TRP in NR eMIMO WI pending on the progress on performance requirements of Rel-16 URLLC WI (Samsung, Huawei, Ericsson) * Option 2: Define multi-TRP for reliability transmission (Intel)   *Recommendations for 2nd round:*  Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments |
| **Sub-topic#1-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:*  Discuss the test setup for PDSCH requirements required by multi-PDCCH scheduling based on multi-TRP/multi-panel transmission  Discuss the test setup for PDSCH requirements required by single-PDCCH scheduling based on multi-TRP/multi-panel transmission |
| **Sub-topic#1-3** | *Tentative agreements:*  Issue 1-3-1  No performance requirement including demodulation and CSI reporting for L1-SINR measurement  Issue 1-3-2  No performance requirement including demodulation and CSI reporting for BFR for Scell  Issue 1-3-3  No performance requirement including demodulation and CSI reporting for DL/UL beam indication with reduced latency and overhead  *Candidate options:*  *Recommendations for 2nd round:* |
| **Sub-topic#1-4** | *Tentative agreements:*  Issue 1-4-1: PDSCH demodulation requirement  6 companies discuss Issue 1-4-1. 3 companies prefer to not define new performance requirement for PDSCH enhancement in DMRS sequence generation. 2 companies prefer to define one DL test case  *Candidate options:*   * Option 1: Define one DL test to verify receiver processing of Rel-16 DMRS enhancement * Option 1a: if defined, Existing UE performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification (Samsung) * Option 1b: One new test case with test parameters modification(intel, DCM) * Option 2: Not to define any new PDSCH performance requirement of Rel-16 DMRS enhancement (Huawei, Ericsson, QC)   *Recommendations for 2nd round:*  Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments  Issue 1-4-2: PUSCH demodulation requirement for CP-OFDM  6 companies discuss PUSCH requirement with CP-OFDM, 2 companies prefer to define requirements  *Candidate options:*   * Option 1: Define one UL PUSCH with CP-OFDM test to verify the receiver processing from one of existing Rel-15 PUSCH requirement. Existing PUSCH performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification (Intel, DCM) * Option 2: No new PUSCH requirement with Rel-16 DMRS enhancement for CP-OFDM (Huawei, Ericsson, Samsung)   *Recommendations for 2nd round:*  Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments  Issue 1-4-3: PUSCH demodulation requirement for DFTs-OFDM  6 companies discuss PUSCH requirement with DFT-s-OFDM, 4 companies prefer not to define requirement.  *Candidate options:*   * Option 1: Not to define any new PUSCH performance requirements for DFT-s-OFDM based on DMRS enhancement (Huawei, Ericsson, Samsung, Intel) * Option 2: Define the PUSCH performance requirements for DFT-s-OFDM based on DMRS enhancement (DCM)   *Recommendations for 2nd round:*  Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments  Issue 1-4-4: PUCCH demodulation requirement for DFT-s-OFDM  6 companies discuss Issue 1-4-3. 4 companies prefer to not define new performance requirement for PUCCH enhancement for DFT-s-OFDM.  *Candidate options:*   * Option 1: Not to define any new PUCCH performance requirements for DFT-s-OFDM based on DMRS enhancement (Huawei, Ericsson, Samsung, Intel) * Option 2: Define the PUCCH performance requirements for DFT-s-OFDM based on DMRS enhancement (DCM)   *Recommendations for 2nd round:*  Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments |
| **Sub-topic#1-5** | *Tentative agreements:*  Issue 1-5-1  No performance requirement including demodulation and CSI related with full Tx power uplink transmission  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on demodulation and CSI requirement of NR eMIMO | [Samsung] |
| #2 | WF on PDSCH demodulation requirement based on multi-TRP/panel transmission for NR eMIMO | [Huawei] |

### CRs/TPs

*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)

**Issue 1-1-2: Whether to define the requirement of Multi-PDSCH requirement scheduled by single-DCI**

7 companies discuss issue 1-1-2, 5 companies agree to define requirement. 1 company prefers to not define requirement, 1 company agrees to define requirement if there is different form PDSCH demodulation requirement, compared with multi-DCI based scheduling.

*Candidate options:*

* Option 1: Define the PDSCH requirements required by single-DCI scheduling based on multi-TRP/multi-panel transmission (Samsung, Intel, QC, CMCC, DCM)
* Option 2: Not to define PDSCH requirements required by single-DCI scheduling based on multi-TRP/multi-panel transmission (Huawei)

*Recommendations for 2nd round:*

Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments

**Issue 1-1-3: Whether to define the multi-TRP with URLLC requirement**

5 companies discuss issue 1-1-3. 3 companies prefer to deprioritize URLLC requirements for multi-TRP. 1 company prefer not to define requirement

*Candidate options:*

* Option 1: Deprioritize URLLC requirements with multi-TRP in NR eMIMO WI pending on the progress on performance requirements of Rel-16 URLLC WI (Samsung, Huawei, Ericsson)
* Option 2: Define multi-TRP requirement for reliability transmission (Intel)
* Option 3: Not define URLLC requirements with Multi-TRP/Panel transmission in Rel-16 eMIMO WI (QC)

*Recommendations for 2nd round:*

Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments

Based on comment from Ericsson and Huawei, Moderator would like to check Intel whether my understanding is correct?

* Option 1: Define multi-TRP requirement for reliability transmission (e.g. 0.1% BLER) with URLLC scenario
* Option 2: Define multi-TRP requirement for eMBB transmission scenario (e.g,70%TP)

Based on Intel comment in 1st round, Moderator would like to check whether Intel intention is option 2?

**Issue 1-4-1: PDSCH demodulation requirement**

6 companies discuss Issue 1-4-1. 3 companies prefer to not define new performance requirement for PDSCH enhancement in DMRS sequence generation. 2 companies prefer to define one DL test case

*Candidate options:*

* Option 1: Define one DL test to verify receiver processing of Rel-16 DMRS enhancement
* Option 1a: if defined, Existing UE performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification (Samsung)
* Option 1b: One new test case with test parameters modification(intel, DCM)
* Option 2: Not to define any new PDSCH performance requirement of Rel-16 DMRS enhancement (Huawei, Ericsson, QC)

*Recommendations for 2nd round:*

Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments

**Issue 1-4-2: PUSCH demodulation requirement for CP-OFDM**

6 companies discuss PUSCH requirement with CP-OFDM, 2 companies prefer to define requirements

*Candidate options:*

* Option 1: Define one UL PUSCH with CP-OFDM test to verify the receiver processing from one of existing Rel-15 PUSCH requirement. Existing PUSCH performance test cases can be reused or replaced with Rel-16 DMRS configuration without requirements and other test parameters modification (Intel, DCM)
* Option 2: No new PUSCH requirement with Rel-16 DMRS enhancement for CP-OFDM (Huawei, Ericsson, Samsung,)

*Recommendations for 2nd round:*

Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments

**Issue 1-4-3: PUSCH demodulation requirement for DFTs-OFDM**

6 companies discuss PUSCH requirement with DFT-s-OFDM, 5 companies prefer not to define requirement.

*Candidate options:*

* Option 1: Not to define any new PUSCH performance requirements for DFT-s-OFDM based on DMRS enhancement (Huawei, Ericsson, Samsung, Intel, Nokia)
* Option 2: Define the PUSCH performance requirements for DFT-s-OFDM based on DMRS enhancement (DCM)

*Recommendations for 2nd round:*

Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments

Based on majority view, Moderator would like to suggest company check whether option 1 is feasible?

**Issue 1-4-4: PUCCH demodulation requirement for DFT-s-OFDM**

6 companies discuss Issue 1-4-3. 4 companies prefer to not define new performance requirement for PUCCH enhancement for DFT-s-OFDM.

*Candidate options:*

* Option 1: Not to define any new PUCCH performance requirements for DFT-s-OFDM based on DMRS enhancement (Huawei, Ericsson, Samsung, Intel, Nokia)
* Option 2: Define the PUCCH performance requirements for DFT-s-OFDM based on DMRS enhancement (DCM)

*Recommendations for 2nd round:*

Moderator would like to suggest companies these two options for further discussion, and encourage companies to provide comments

Based on majority view, Moderator would like to suggest company whether check whether option 1 is feasible?

**Issue 1-2-1: Test case design principle for Multi-PDSCH requirement scheduled by multi-DCI (if agreed to introduce requirement)**

* Proposals
  + Option 1: cover features (Samsung):

- PDSCH scheduling schemes: overlapping, non-overlapping and partial overlapping transmission

- PDCCH scheduling schemes: with/without CORESET pool index configured

- ACK/NACK feedback schemes: Joint or separate

- UE rate-matching behaviour

* + Option 2: Consider the time and frequency offsets of two TRPs in test cases design in Multi-TRP (Huawei)
  + Option 3: Consider the scenario that the TRSs/CSI-RSs collide between 2 TRP (Ericsson)
  + Option 4: Use same PDSCH configuration for multi-DCI and single-DCI scenario (Intel)
* Recommended WF
  + 4 companies discuss the issue 1-2-1 for test case design principle for PDSCH requirements with related with multi-DCI scheduling. Moderator would like to suggest companies check whether the principle is feasible?
* Cover the feature
* PDSCH scheduling schemes: overlapping, non-overlapping and partial overlapping transmission
* PDCCH scheduling schemes: with/without CORESET pool index configured
* ACK/NACK feedback schemes: Joint or separate
* UE rate-matching behaviour
* Cover test parameters and scenario
* Time and frequency offset
* TRSs/CSI-RSs collide between 2 TRP
  + Regarding the PDSCH configuration, moderator would like to suggest companies the following two options further discussion, and encourage companies to provide comments
* Option 1: Use same PDSCH configuration for multi-DCI and single-DCI scenario
* Option 2: Differentiate the PDSCH configuration for multi-DCI and single-DCI scenario (Samsung, Huawei)

**Issue 1-2-1-1: PDSCH scheduling in time-frequency resource allocation scheduled by multi-DCI**

* Proposals
  + Option 1: both non-overlapping scheduling PDSCH and partial overlapped scheduling PDSCH(Samsung)
  + Option 2: ~~Only define the performance requirements for multi-PDSCH with full-overlapped~~ at least cover non-overlapping (Huawei)
  + Option 3: at least for full-overlapped and non-overlapped (Ericsson)
  + Option 4: ~~Prioritize defining requirements for SDM Scheme, FDM Scheme A, FDM Scheme B and Multi-DCI based m-PDSCH among different multi-TRP schemes~~ non-overlapping only (QC)
* Recommended WF
  + 4 companies discussed PDSCH scheduling schemes. Based on proposal for each company, at least non-overlapping transmission scheme is agreeable, Moderator would like to suggest company check whether non-overlapping transmission is agreeable?
* Non-overlapping (Samsung, Huawei, Ericsson, QC )
  + Additionally, Moderator would like to suggest companies these three options for further discussion, and encourage companies to provide comments
* Option 1: full overlapping(QC, Ericsson )
* Option 2: partial overlapping(Samsung)
* Option 3: Both full overlapping and partial overlapping

**Issue 1-2-1-2: CW combination from two TRPs scheduled by multi-DCI**

* Proposals
  + Option 1: 2+2 for non-overlapping scheduling PDSCH, 1+1 for partial overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection
  + Based on Issue 1-2-1-1, 4 companies agree non-overlapping should be considered, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments.
* Option 1: 2+2 for non-overlapping(Samsung)
* Option 2: 1+1
* Option 3: 1+2 or 2+1
* Option 4: both option 1,2 and option 3
  + Additionally, depend on the Issue 1-2-1-1, Moderator would like to suggest companies these options for further discussion , and encourage companies to provide comments
* Option 1: Full-overlapping
* Option 1a: 1+1 (Samsung)
* Option 1b: 1+2 or (2+1)
* Option 1c: (2+2)
* Option 1d: all
* Partial overlapping
* Option 1a: 1+1 (Samsung)
* Option 1b: 1+2 or (2+1)
* Option 1c: (2+2)
* Option 1d: all

**Issue 1-2-1-3: Timing offset among 2TPs scheduled by multi-DCI**

* Proposals
  + Option 1: 2us for non-overlapping scheduling PDSCH, -0.5us for partial overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection
  + Based on Issue 1-2-1-1, 4 companies agree non-overlapping should be considered, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments.
* Option 1: [2us] Samsung
* Option 2: other options are not precluded
  + Additionally, depend on the Issue 1-2-1-1, Moderator would like to suggest companies these options for further discussion , and encourage companies to provide comments
* Option 1: Full-overlapping
* Option 1a: [0] (Samsung)
* Option 1b: other options are not precluded
* Option 1: Partial overlapping
* Option 1a: [-0.5us] (Samsung)
* Option 1b: other options are not precluded

**Issue 1-2-1-4: Frequency offset among 2TPs scheduled by multi-DCI**

* Proposals
  + Option 1: 0Hz (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection
  + Based on Issue 1-2-1-1, 4 companies agree non-overlapping should be considered, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments.
* Option 1: [0us] Samsung
* Option 2: other options are not precluded
  + Additionally, depend on the Issue 1-2-1-1, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments
* Option 1: Full-overlapping
* Option 1a: [300] (Samsung)
* Option 1b: other options are not precluded
* Option 1: Partial overlapping
* Option 1a: [0us] (Samsung)
* Option 1b: other options are not precluded

**Issue 1-2-1-5: ACK/NACK among 2TPs scheduled by multi-DCI**

* Proposals
  + Option 1: joint feedback for non-overlapping scheduling PDSCH, separate feedback for partial overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection
  + Based on Issue 1-2-1-1, 4 companies agree non-overlapping should be considered, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments.
* Option 1: joint feedback (Samsung)
* Option 2: separate feedback
* Option 3: Only using separated ACK/NACK (QC)
  + Additionally, depend on the Issue 1-2-1-1, Moderator would like to suggest companies these options for further discussion , and encourage companies to provide comments
* Option 1: Partial overlapping
* Option 1a: separate feedback (Samsung)
* Option 1b: joint feedback
* Option 1: full overlapping
* Option 1a: separate feedback
* Option 1b: joint feedback

**Issue 1-2-2: Test case design for Multi-PDSCH requirement scheduled by single-DCI (if agreed to introduce requirement)**

**Issue 1-2-2-1: Test Case Design Principle scheduled by single-DCI**

* Proposals
  + Option 1: Cover DMRS ports combination among two TRPs, Two TCI states activation in single DCI code point and PDSCH scheduling with overlap/non-overlapping (Samsung)
  + Option 2: Consider the time and frequency offsets of two TRPs in test cases design in Multi-TRP (Huawei)
* Recommended WF
  + 2 companies discuss the issue 1-2-2-1 about test case design principle for PDSCH requirements with related with single-DCI scheduling. Moderator would like to suggest companies check whether the principle is feasible?
* Cover feature
* DMRS ports combination among two TRPs
* Two TCI states activation in single TCI code point
* PDSCH scheduling with overlap/non-overlapping
* Cover test parameters and scenario
* Time and frequency offset

**Issue 1-2-2-2: Test Case design for PDSCH scheduling scheduled by single-DCI**

* Proposals
  + Option 1: Full overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Based on Issue 1-2-1-1, if agreed to introduce single-DCI requirement, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments.
* Option 1: Full overlapping scheduling (Samsung)
* Option 2: other options are not precluded
* Option 3: fully non-overlapping ?(QC)

**Issue 1-2-2-3: Test case design for lay combination scheduled by single-DCI**

* Proposals
  + Option 1: 1+1 layer combination for full overlapping scheduling PDSCH (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection
  + Based on Issue 1-2-1-1, if agreed to introduce single-DCI requirement, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments
* Option 1: 1+1 (Samsung)
* Option 2: Other options are not precluded

**Issue 1-2-2-4: Test case design for two TCI states scheduled by single-DCI**

* Proposals
  + Option 1: Two TCI state activation in single TCI code point (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 1-2-2-5: Test case design for timing offset among 2TPs scheduled by single-DCI**

* Proposals
  + Option 1: 0us (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection
  + Based on Issue 1-2-1-1, if agreed to introduce single-DCI requirement, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments
* Option 1: [0us] (Samsung)
* Option 2: Other options are not precluded

**Issue 1-2-2-6: Frequency offset among 2TPs scheduled by single-DCI**

* Proposals
  + Option 1: [300Hz] (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection
  + Based on Issue 1-2-1-1, if agreed to introduce single-DCI requirement, Moderator would like to suggest companies these options for further discussion, and encourage companies to provide comments
* Option 1: [300Hz] (Samsung)
* Option 2: Other options are not precluded

**Issue 1-2-3: Test case design for Multi-PDSCH requirement for URLLC (if agreed to introduce requirement)**

**Issue 1-2-3-1: Transmission schemes**

* Proposals
  + Option 1: Down selection to scheme 1a and 4 (Huawei)
  + Option 2: Define PDSCH demodulation requirements for repetition schemes 2a, 3 and 4.(Intel)
  + Option 3: other options are not precluded
* Recommended WF
  + Discuss above proposals

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2  …. |
| Samsung | **Issue 1-1-2: Whether to define the requirement of Multi-PDSCH requirement scheduled by single-DCI**  Samsung still prefer option 1, the requirement of PDSCH scheduled by single-DCI based on multi-TRP/panel transmission is needed.  Regarding the comments from Ericsson “From the PDSCH demodulation point of view we don’t see any difference from multi-DCH based multi-PDSCH scheduling”  For single –DCI based scheduling, RAN1 can support that different layer combination. The DMRS port can be indicated with 2 TCI state in a DCI code point, e.g, in case of 1+1 lay combination, the DMRS port should be {0},{2} in two CDM groups  Meanwhile, the TCI configuration is enhanced for single-DCI, as agreed in RAN1  For single-DCI based Multi-TRP/panel transmission with at least one configured TCI states for the serving cell of scheduled PDSCH containing 'QCL-TypeD',   * If the offset between the reception of the PDCCH and the corresponding PDSCH is less than timeDurationForQCL and after the reception of activation command of TCI states for UE specific PDSCH, the UE may assume that DMRS ports of PDSCH follows QCL parameters indicated by default TCI state(s) as following:   + Use the TCI-states corresponding to the lowest codepoint among the TCI codepoints containing two different TCI states which are activated for PDSCH.   In that sense, based on the QCI parameter, UE will choose the different algorithm with considering the impact of timing offset/frequency offset. Therefore, it is necessary to verify receiver progressing based on single-DCI scheduling under QCL.  Regarding the comment form Huawei “single and multi-PDCCH scheduled PDSCH is kind of repetitive work especially using the same test configuration”  As mentioned, there is TCI configuration enhancement in single-DCI, it is necessary to verify the receiver processing ability with/without QCL assumption functionality based on single-DCI scheduling.  As for test case, we also think it is not necessary to repeat all the features and specified the requirement for both multi-DCI and single-DCI requirement. For detail test cases design, we can discuss how to differentiate them and cover the RAN1 important feature.  **Issue 1-1-3: Whether to define the multi-TRP with URLLC requirement**  Based on the intel comment, multi-TRP requirement with URLLC is proposed based on eMBB metrics  Normally, RAN1 can support 5 transmission schemes for multi-TRP with URLLC. Most of transmission scheme can be covered by multi-TRP scheduled by single-DCI, such as SDM, FDMA, and FDMB. As related with TDMA and TDMB, the transmission schemes are based on repetition within slot and with different slot. The slot repetition and mini-slot repetition are belonging to Rel-15 and Rel-16 URLLC features. Since the purpose of defining multi-TRP with URLLC requirement is based on eMBB metrics, so I think SDM, FDMA,FDMB should be enough and already be covered in single-DCI scheduled multi-TRP. Considering only 4 meeting cyclic for NR eMIMO, at this stage, we prefer to focus on requirement with single-DCI and multi-DCI firstly  **Issue 1-4-1: PDSCH demodulation requirement for CP-OFDM**  In Rel-15, different with BS side, number CDM without data = 1 is configured in UE side. With changing the DMRS port index for 2Rx, there is some impact, such as payload. However, I do not think there is too much different with existing requirement. Therefore, if needed, we think the existing requirement can be reused without change requirement.  **Issue 1-4-2: PUSCH demodulation requirement for CP-OFDM**  Samsung still prefer option 2, not to define requirement for UL-CP-OFDM based on Rel-16 DMRS enhancement.  Regarding on option 1: Define one UL CP-OFDM test to verify the receive processing from one of existing Rel-15 PUSCH requirement  In Rel-15, RAN4 defined the PUSCH requirement with number CDM without data = 2, up to 2 ports with mapping {0} and {0, 1}, the related CDM group =0. And NID0=0, nSCID =0 is the related parameters for DMRS generation  If DMRSuplink-r16 is configured, then  There is no changed for value of cinit compared with Rel-15, based on the test configuration of Rel-15  If we change the DMRS port with {2} and {2,3}, the Cinit can be different. As for payload and SNR for requirement, there is no change, considering the CDM without data=2, therefore, there is no data multiplexing with DMRS RE in the DMRS symbol  Regarding the cinit changed and DMRS port index change, Rel-15 can also support it with changing value of test parameters. From the functionality test perspective, we don't think we need to cover all the possible value in the test parameters  Therefore, we still prefer to no PUSCH requirement with Rel-16 DMRS enhancement for CP-OFDM  Regarding the comment from intel  “Otherwise we cannot guarantee reliable BS performance since it may assume another DMRS sequence compare to what was transmitted.”  Rel-15 can support with number of CDM without data=2, so either {0} {0,1} and {2} {2,3} can be configured with DCI 0-1. So, I do not think BS will assume another DMRS sequence.  **Issue 1-4-3: PUSCH demodulation requirement for DFT-s-OFDM**  **Issue 1-4-4: PUCCH demodulation requirement for DFT-s-OFDM**  Regarding as PUSCH and PUCCH with DFT-s-OFDM, the main enhancement is only available with pi/2 BPSK with changed the sequence. From receiver processing perspective, there is no impact with changed the sequence. In terms of performance, I also think there is no impact on the channel estimation.  Meanwhile, considering there is no requirement of pi/2 BPSK, and also it is optional feature Considering only 4 meeting cyclic, we have many important feature need to define requirement, we prefer to preclude the requirement with PUSCH/PUCCH with DFT-s-OFDM waveform at this stage.  Update 20200304  To Nokia:  Regarding the comment on port {0, 2} to check low PRPR DM-RS implementation.  As in Rel-15, RAN4 agreed to use the number of CDM ground without data =2, based on RAN1 specification. Under this condition, either {0,1},{2,3} and {0,2} can be supported. Finally, we only chose with {0,1} for test case. My understanding we have achieve the consensus to not cover RAN1 feature with all the possible combination. We should be focus on the essential configuration.  Meanwhile, we have similar view with Ericsson, Rel-16 DMRS enhancement for CP-OFDM is related with the Cinit generation for different CDM group, it not related with Low PAPR sequence.  For these three DMRS port index, Rel-15 can be supported, only changed with test parameters, there is no impact on the demodulation processing and related performance.  To Ericsson:  Our intention is to consider the HARQ combination related with two CW from Two TR. For joint feedback, my understanding it considers the situation where the CRC of one CW is error, so both two CWs will be retransmitted. While for separate feedback, only the CW with CRC error is re- retransmitted. Different re-transmission schemes will impact on the UE buffer processing and HARQ combination.  This is my understanding. If there is misunderstanding, we can clarify it.  To Huawei:  We do see some different processing with single-DCI and multi-DCI. As mentioned by Huawei  “for single-DCI scheduling, the codepoint of TCI in DCI will indicate 2 TCI states, one is corresponding to the CDM group for first antenna port in antenna mapping table, and the other one is corresponding to another CDM group. “  With two TCI state in single DCI point, the DMRS port for different lay should belong different CDM group, e.g, 1+1 layer combination, the DMRS port shall be {0},{2}, while for multi-DCI scheduling, with CORESETPoolIndex, the DMRS port can belong the same CDM group, e.g {0,1}. Two different DMRS port index will impact on the payload and channel estimation process as well the rate matching behaviour  Meanwhile, for single-DCI, The TCI configuration is enhanced  For single-DCI based Multi-TRP/panel transmission with at least one configured TCI states for the serving cell of scheduled PDSCH containing 'QCL-TypeD',  In that sense, based on the QCI assumption, it is needed to verify the receiver algorithm with considering the impact of timing offset/frequency offset.  As mention your contribution, Huawei also propose to consider the impact on timing and frequency offset.  Regarding the comment for issue 1-2-1, my intention is to clarify the principle when we considering the test case design based on RAN1 feature to identify which feature will impact on the UE implementation. E.g, rate matching behavior  As agreed in RAN1  For PDSCHs scheduled by M-DCI, the UE does not expect a PDSCH scheduling intended for that UE in a given slot if that PDSCH REs collide with DMRS REs associated with another PDSCH for the same UE  The relative rate matching should be considered.  Could you clarify which features will not impact on the UE receiver implementation?  As for detail cases, we can discuss separately. Our intention is not to combine all the feature in single test case. Our intention is to compact and limited test case with verify the essential RAN1 feature with different test cases. Base on your comment “Combos of parameters in limited test cases are necessary”, I think we are in the same page. |
|  | **Issue 1-4-2: PUSCH demodulation requirement for CP-OFDM**  **Issue 1-4-3: PUSCH demodulation requirement for DFTs-OFDM**  **Issue 1-4-4: PUCCH demodulation requirement for DFTs-OFDM** |
| Intel | **Issue 1-1-3: Whether to define the multi-TRP with URLLC requirement**  Single DCI based multi-TRP transmission schemes do not cover FDMA and FDMB URLLC transmission schemes since it is a repetitions schemes, not spatial multiplexing. Different scheduling procedures are applicable for them. To distinguish such transmission schemes RAN1 have designed corresponding RRC parameters.  Also, Rel-15 and Rel-16 URLLC features like slot repetition and mini-slot repetition assume one TCI state for repetitions. Same time in multi-TRP URLLC transmission schemes each repetition is associated with own TCI state which leads to completely different UE implementation and demodulation performance assuming time/frequency offsets between TRPs.  To summarize, demodulation performance of URLLC multi-TRP transmission schemes are not covered by existing test cases or will not be covered by test cases for eMBB multi-TRP transmission schemes.  **Issue 1-4-1: PDSCH demodulation requirement**  Changes is sequence generation is rather important aspect which can affect demodulation performance. We prefer to define new test case. One additional test case definition will not take big efforts.  Also, Option 1a is not feasible for 2Rx scenario since all 2 Rx demodulation requirements are defined with “Number of DMRS CDM groups without data” equal to 1 and changes of used DMRS antenna ports indexes from {1000,1001} to {1002,1003} requires changes of “Number of DMRS CDM groups without data” configuration (from 1 to 2). Such changes lead to modification of PDSCH payload and shift of SNR operating point. Therefore, we suggest to remove Option 1a. |
| Huawei, HiSilicon | **Sub topic 1-1:**  Issue 1-1-2: Whether to define the requirement of Multi-PDSCH requirement scheduled by single-DCI  Based on our understanding, the differences between single-DCI based multi-PDSCH and multi-DCI based multi-PDSCH only exist in PDCCH configurations. To be specific, in multi-DCI scheduling for example, the *CORESET* in *PDCCH-Config* contains two new RRC parameters: *CORESETPoolIndex* with different values in order to distinguish from different TRPs. On the other hand, for single-DCI scheduling, the codepoint of TCI in DCI will indicate 2 TCI states, one is corresponding to the CDM group for first antenna port in antenna mapping table, and the other one is corresponding to another CDM group.  From PDSCH demodulation perspective, we hardly find differences in algorithms of the receiver, in that case, we think defining requirements for multi-PDSCH for both types of scheduling is kind of repetitive work. In general, we think defining either of two types of scheduling is fine, maybe we can discuss it with the specific test scenarios discussion. However, since multi-DCI scheduling is more typical than the other, we prefer only defining requirements for multi-DCI scheduled multi-PDSCH and no new requirements for single-DCI scheduled mutli-PDSCH(option 2).  Issue 1-1-3: Whether to define the multi-TRP with URLLC requirement  For multi-TRP in URLLC, considering the discussion of URLLC demodulation requirements is still on going, we prefer to FFS on discussion for URLLC scenario of multi-TRP at least for this meeting. If the test metric, methodology and other related issues for URLLC topic are determined in this meeting, then interest companies can bring more information and discuss whether to define requirements for URLLC scenario for multi-TRP in the next meeting.  **Sub topic 1-4:**  We would still prefer not to define any new performance requirements.  **Sub topic 1-2:**  For issue 1-2-1, we think that those factors can be considered during the introduction of requirements, but it is hard to conclude that RAN4 must cover all those features during the test cases design, important scenarios should be considered first and maybe different features combinations like recommended in Option 2 can be considered. Specific test scenarios should be figured out firstly.  **Issue 1-2-1-1 ~ 1-2-1-5:**  Issue 1-2-1-1:  One correction that could the moderator help and replace the original option 2 as” at least cover non-overlapping” please. Thanks in advance.  As for test cases design, priority should be given for different scenarios, we would prefer not to cover all scenarios but some of them to avoid duplicate test cases. Combos of parameters in limited test cases are necessary. For the detailed test parameters (issue 1-2-1-2~1-2-1-5), considering this is the first time to discuss these parameters, other options should not be precluded for each issue.  **Issue 1-2-2:**  We prefer to further discuss it since requirements for multi-PDSCH scheduled by single-DCI has not been agreed to be introduced yet. |
| Ericsson | **Issue 1-1-3:** Option 1.  First we suggest clarifying the meaning of ‘multi-TRP with URLLC requirements.’ If this indends to define requirements to verify the higher reliability (e.g. 0.1% BLER), then we prefer option 1, or we don’t think RAN4 need to define requirements. If the purpose is to verify the SDM/TDM/FDM-based PDSCH transmission from two TRPs with metric like 70% of max Tput, we are ok to define it, but we may need more discussion whether to define all the transmission methods or choose a few methods and in such a case the scenario is not really URLCC, rather eMBB.  We would like to ask the moderator to clarify it and change the title to avoid misunderstanding.  **Issue 1-4-1:** Option 2.  The purpose of new PDSCH/PUSCH DMRS sequence for CP-OFDM is to reduce the PAPR to the same level as for data symbols for all port combinations. It is interesting from the transmitter RF performance; however, we don’t see any demodulation performance impact due to this new sequence.  Moreover, if we compare the DMRS sequences between Rel-16 and Rel-15, the DMRS sequences are identical if CDM group (λ) is 0. If we check TS38.101-4, the test cases up to rank 2 use ports=1000/1001, which correspond to CDM group 0. This means no DMRS sequence changes for test cases for rank 1 or rank 2. There are a few test cases using CDM group 1, which is for rank 4. However, the difference is only the sequence generation; we don’t think RAN4 need to define new requirements only for this new sequence.  **Issue 1-4-2/1-4-3/1-4-4:** Option 2.  The purpose of new PUSCH DMRS sequence is to reduce the PAPR to the same level as for data symbols for all port combinations. It is interesting from the transmitter RF performance; however, we don’t see any demodulation performance impact due to this new sequence.  Question to Nokia for the comments on issue 1-4-2 FFS for the case low PAPR DM-RS. Do you want to study the CP-OFDM PUSCH with low-PAPR DM-RS sequence? In our understanding, Rel-16 low-PAPR DM-RS sequence is only applicable for DFT-s-OFDM.  **Issue 1-4-3:** Option 1.  **Issue 1-2-1:** We are ok to start to discuss the test case design for multi-PDSCH requirement scheduled by multi-DCI.  - ACK/NACK feedback schemes: Joint or separate  We are not sure we need consider HARQ feedback is joint or separate because it is DL demodulation requirements. |
| Qualcomm | Issue 1-1-3: We would like to add another option for not defining URLLC requirements in Rel-16 eMIMO WI as we have plenty to do within this WI.  Issue 1-2: In general, as this is the first meeting, we would like to keep the parameters open in this meeting.  Issue 1-2-1-1: We would like to replace Option 4 with non-overlapping only as existing option 4 is not about PDSCH allocation.  Issue 1-2-1-5: We would like to add another option of only using separated ACK/NACK.  Issue 1-2-2-2: We would like to add another option of fully non-overlapping.  Issue 1-2-3-1: Question to Huawei: In our opinion, scheme 1a is not for URLLC. So, we think that it should be removed from Option 1. |

### 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 |
|  |
| R4-2002419 | Qualcomm:  Page 4: Please add Option 4 for not defining URLLC requirements with m-TRP |
| R4-2002420 | Qualcomm:  Page 2 is already covered in Samsung’s WF R4-2002419. So it should be removed instead of duplicating the same information.  Page 4: Option 4 should be removed since it is not about PDSCH allocation. Instead, it should be replaced with our preference “Only Non-overlapping”.  Page 5: We prefer to use only separated ACK/NACK as we should only focus on DL performance.  Page 7: Please also add “full non-overlapping” as another option for PDSCH resource allocation.  Page 8: It is same issue as discussed in R4-2002419 Page 4. So, it should be discussed only in one of the WFs and options should be aligned. As mentioned for previous WF, please add another option for not defining URLLC requirements with m-TRP.  Page 9: As per out understanding, Scheme 1a is not for URLLC. So, we are not sure why scheme 1a is mentioned in Option 1.  Page 3, 4, 6, 9: Please also add “Other options not precluded”. |

## 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 (8.11.3&8.11.3.2)

*This section contains T-docs with corresponding proposals and observations submitted to the agenda item with general and CSI requirements (8.11.3 and 8.11.3.2). The guideline of this section is to identify the work scope of CSI requirement based on RAN1 features. Based on the test scope, the related test case design should be specified to verify the functionality of RAN1 feature*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000319 | Samsung | Proposal 1: Work scope of Performance requirements (demodulation and CSI) for Rel-16 eMIMO WI   * New PMI requirements required for Rel-16 Type II codebook |
| R4-2000320 | Samsung | Proposal 1: (Codebook construction): Introduce PMI test cases with enhanced Type II codebook with below parameters:   * Number of CSI-RS ports: 16 ports with (N1,N2) = (4,2) and (O1, O2) = (4,4) * numberOfPMISubbandsPerCQISubband: R =2 * paramCombination-r16: 6, with L =4, pv =1/2,   Proposal 2: (Test metric): two alternatives can be considered   * Alt 1: Relative Throughput ration between follow PMI and random PMI * Alt 2: Relative throughput ratio with following PMI between enhanced Type II codebook and Rel-15 Type II codebook   Proposal 3: (Beam steering model): Taking beam steering approach as specified in B.2.3B.4A of TS36.101 as staring point with further extension applicable for number of L beams     * beam index * ， relative power of the l beam compared to first beam * , total power scaling factor   Proposal 4: (MCS and Rank): 16QAM ½ with rank2 can be selected as starting point  Proposal 5: (Other test parameters): Reuse test parameters from Rel-15 NR PMI test cases as starting points |
| R4-2000321 | Samsung | Observation 1: Enhanced Type II with paraCombination\_r16=6 achieve better performance than other case meanwhile UE processing complexity and reporting overhead increased |
| R4-2000352 | Qualcomm | Proposal 1: 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. |
| R4-2001735 | Ericsson | Proposal 1: Devise PMI Codebook Type II reporting test(s) covering CSI-RS interference from neighbouring cells and/or sectors |
| R4-2001468 | Huawei, HiSilicon | Proposal 1: We propose to define performance requirements for CSI reporting based on space-frequency compression  Proposal 2: We propose not to define performance requirements for UCI omission in CSI enhancement  Proposal 3: We propose not to define performance requirements for newly introduced L= 6 and rank 3/4 in CSI enhancement |
| R4-2001740 | Intel | Proposal 1: Define PMI reporting requirements to verify Rel-16 Type II feedback. |

## Open issues summary

### Sub-topic 2-1: Test Scope of Enhancement on MU-MIMO support (1st round)

*Based on the revised WID of NR eMIMO for Rel-16 in RAN#85, one objective related to the CSI enhancement for MU-MIMO is included as*

* *Enhancements on MU-MIMO support*
  + *Option 1: Specify overhead reduction, based on Type II CSI feedback, taking into account the trade-off between performance and overhead.*
  + *Perform study and, if needed, specify extension of Type II CSI feedback to rank>2*

*For PMI reporting in Rel-15, Type II codebook design has been introduced to improve the reporting accuracy and downlink capacity. An enhanced type II based on Rel-15 type II code book was introduced for Rel-16 eMIMO WI which taking into account the trade-off between performance and overhead, consisting of frequency domain compression, spatial domain compression, and linear combination. Meanwhile, RAN1 also specify an extension of Type II CSI feedback to rank >2.*

*Based on RAN1 feature, this sub-topic mainly focuses to identify the potential impact on the CSI requirements of enhanced type II codebook and extension of Type II CSI feedback to rank >2.*

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: Enhanced Type II Codebook requirement**

* Proposals
  + Option 1: Define the PMI reporting requirement for Enhanced of Type II Codebook (QC, Samsung, Huawei, Ericsson, Intel, DCM)
* Recommended WF
  + Agreed above proposal

**Issue 2-1-2:** **Enhanced Rel-15 Type II codebook with Rank3/4**

* Proposals
  + Option 1: Not to define performance requirements for L=6 and rank3/4 in CSI enhancement (Huawei, Samsung, QC, Intel)
* Recommended WF
  + Agreed above proposal

**Issue 2-1-3: UCI omission in CSI enhancement**

* Proposals
  + Option 1: Not to define performance requirements for UCI omission in CSI enhancement (Huawei, Samsung, QC, Intel)
* Recommended WF
  + Agreed above proposal

### Sub-topic 2-2: Test setup of Enhancement on MU-MIMO support (2nd round)

*Based on the revised WID of NR eMIMO for Rel-16 in RAN#85, one objective related to the CSI enhancement for MU-MIMO is included as*

* *Enhancements on MU-MIMO support*
  + *Option 1: Specify overhead reduction, based on Type II CSI feedback, taking into account the trade-off between performance and overhead.*
  + *Perform study and, if needed, specify extension of Type II CSI feedback to rank>2*

*For PMI reporting in Rel-15, Type II codebook design has been introduced to improve the reporting accuracy and downlink capacity. An enhanced type II based on Rel-15 type II code book was introduced for Rel-16 eMIMO WI which taking into account the trade-off between performance and overhead, consisting of frequency domain compression, spatial domain compression, and linear combination. Meanwhile, RAN1 also specify an extension of Type II CSI feedback to rank >2.*

*In this sub-topic, based on the test scope discussion in 1st round, RAN4 should discuss the test case design to verify the functionality of CSI enhancement for MU-MIMO.*

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: Test Case design under interference (if agree to define enhanced Type II Codebook requirement)**

* Proposals
  + Option 1: Define the test cases covering CSI-RS interference from neighbouring cells and/or sectors (Ericsson)
* Recommended WF
  + Collect views from more companies

**Issue 2-2-2: Test Case design for type II (if agree to define enhanced Type II Codebook requirement)**

* Proposals
  + Option 1: Similar assumptions as that of the test case for Rel-15 Type II codebook (QC)
* Recommended WF
  + Collect views from more companies

**Issue 2-2-2-1: Number of CSI-RS ports**

* Proposals
  + Option 1: 16 ports with (N1,N2) =(4,2) and (O1,O2)=(4,4) (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-2: numberofPMISubbandsPerCQISubband**

* Proposals
  + Option 1: R=2 (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**~~Issue 2-2-2-3: numberofPMISubbandsPerCQISubband~~**

* ~~Proposals~~
  + ~~Option 1: R=2 (Samsung)~~
* ~~Recommended WF~~
  + ~~Considering it is first time to discuss the simulation assumption, more companies’ view should be collection~~

**Issue 2-2-2-3: Codebook parameter configuration for and**

* Proposals
  + Option 1: paramCombination-r16: 6, with L =4, pv =1/2, (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-4: Test Metric**

* Proposals
  + Option 1: Relative Throughput ration between following PMI and random PMI (Samsung)
  + Option 2: Relative Throughput ratio with following PMI between enhanced Type II codebook and Rel-15 type II codebook (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-5: Beam-steering model**

* Proposals
  + Option 1: Taking beam steering approach as specified in B.2.3B.4A of TS 36.101 as staring point with further extension applicable for number of L beams (Samsung)
* Recommended WF
  + Agreed above proposals

**Issue 2-2-2-6: MCS and Rank**

* Proposals
  + Option 1: 16 QAM 1/2 (MCS=13)with Rank 2 (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-7: Other test parameters**

* Proposals
  + Option 1: Reuse test parameters from Rel-15 NR PMI test cases as starting points (Samsung, QC)
* Recommended WF
  + Agree above proposals

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |
| Samsung | Sub topic 2-1:  Issue 2-1-1: Enhanced Type II Codebook requirement  Prefer option1: Define the PMI reporting requirement for Enhanced of Type II Codebook  An enhanced codebook based on Rel-15 Type II codebook was introduced for Rel-16 eMIMO WI which taking into account the trade-off between performance and overhead. New PMI test cases required to verify UE PMI reporting accuracy for enhanced Type II codebook.  Issue 2-1-2: Enhanced Rel-15 Type II codebook with Rank3/4  Prefer option 1: Not to define performance requirements for L=6 and rank3/4 in CSI enhancement.  Based on RAN1 agreement, performance requirements for rank3/4 is optional, we prefer to focus the requirement with mandatory UE capability feature for CSI requirement.  Issue 2-1-3: UCI omission in CSI enhancement  Prefer option 1: Not to define performance requirements for UCI omission in CSI enhancement |
| Qualcomm | Sub topic 2-1:  Issue 2-1-1: Ok with Option 1.  Issue 2-1-2: Ok with Option 1.  Issue 2-1-3: Ok with Option 1. |
| Intel | **Sub topic 2-1:**  **Issue 2-1-1: Enhanced Type II Codebook requirement**  Agree with WF  **Issue 2-1-2: Enhanced Rel-15 Type II codebook with Rank3/4**  Agree with WF  **Issue 2-1-3: UCI omission in CSI enhancement**  Agree with WF |
| DOCOMO | Sub topic 2-1:  Issue 2-1-1: Agree with recommended WF |

### 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#2-1** | *Tentative agreements:*  Issue 2-1-1  Define the PMI reporting requirement for Enhanced of Type II Codebook  Issue 2-1-2  No performance requirements for L=6 and rank3/4 in CSI enhancement  Issue 2-1-3  No performance requirements for UCI omission in CSI enhancement  *Candidate options:*  *Recommendations for 2nd round:* |
| **Sub-topic#2-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:*  Discuss the test setup of PMI reporting requirement for Enhanced of Type II Codebook |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on PMI reporting requirement for NR eMIMO | [QC] |

### 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)

**Issue 2-2-1: Test Case design under interference (if agree to define enhanced Type II Codebook requirement)**

* Proposals
  + Option 1: Define the test cases covering CSI-RS interference from neighbouring cells and/or sectors (Ericsson)
* Recommended WF
  + Collect views from more companies

**Issue 2-2-2: Test Case design for type II (if agree to define enhanced Type II Codebook requirement)**

* Proposals
  + Option 1: Similar assumptions as that of the test case for Rel-15 Type II codebook (QC)
* Recommended WF
  + Collect views from more companies

**Issue 2-2-2-1: Number of CSI-RS ports**

* Proposals
  + Option 1: 16 ports with (N1,N2) =(4,2) and (O1,O2)=(4,4) (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-2: numberofPMISubbandsPerCQISubband**

* Proposals
  + Option 1: R=2 (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-3: Codebook parameter configuration for and**

* Proposals
  + Option 1: paramCombination-r16: 6, with L =4, pv =1/2, (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-4: Test Metric**

* Proposals
  + Option 1: Relative Throughput ratio between following PMI and random PMI (Samsung)
  + Option 2: Relative Throughput ratio with following PMI between enhanced Type II codebook and Rel-15 type II codebook (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-5: Beam-steering model**

* Proposals
  + Option 1: Taking beam steering approach as specified in B.2.3B.4A of TS 36.101 as staring point with further extension applicable for number of L beams (Samsung)
* Recommended WF
  + Agreed above proposals

**Issue 2-2-2-6: MCS and Rank**

* Proposals
  + Option 1: 16 QAM 1/2 (MCS=13)with Rank 2 (Samsung)
* Recommended WF
  + Considering it is first time to discuss the simulation assumption, more companies’ view should be collection

**Issue 2-2-2-7: Other test parameters**

* Proposals
  + Option 1: Reuse test parameters from Rel-15 NR PMI test cases as starting points (Samsung, QC)
* Recommended WF
  + Agree above proposals

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2  …. |
| Samsung | **Issue 2-2-1: Test Case design under interference (if agree to define enhanced Type II Codebook requirement)**  Normally, the PMI test is based on single UE in RAN4 both LTE and NR, since PMI is functionality test. Whether the interference is existing or not, there is no impact on the receiver processing on PMI reporting. We prefer to follow LTE/NR approach without considering interference for PMI test.  The interference can be considering with PDSCH requirement with CSI-RS colliding or not. |
| Intel | **Issue 2-2-1: Test Case design under interference (if agree to define enhanced Type II Codebook requirement):**  Prefer Option 2: do not define test in interference limited scenario |
| Ericsson | **Issue 2-2-1:**  **In our view we would like to configure requirements under CSI-RS interference. This is due to observing OTA testing problems for CSI feedback with two gNBs configured with Cell ID 470, and 960. Two UEs from different vendors observed a phenomenom with “false PMI reporting” reporting the CSI for the interfereing cell instead of the serving cell. Due to seeing real chipsets performance degradation, we’d like to ensure test cases in RAN4 to mitigate this problem.**  **So far, we have not covered test cases under intereference, and due to observing OTA results with poor performance we see a need to introduce new requirements covering these test cases to ensure real world performance. More detailed analysis can be found in R1-2000427.**  **Issue 2-2-2:**  **We can agree to Option 1**  **Issue 2-2-2-1:**  **We would like to test with 32 ports for Rel-16 Type II**  **Issue 2-2-2-2:**  **We would like to keep this option open until next meeting**  **Issue: 2-2-2-3:**  **Same as 2-2-2-2, keep open**  **Issue: 2-2-2-4:**  **Due to the complexity of CSI testing metric, we think we need to evaluate different options and keep test metric open until next meeting.**  **Furthermore, If we go with option 2, that would imply we’re testing both Rel-15, and Rel-16 Type II. Rel-15 Type II CSI capability being a mandatory feature, and Rel-16 Type II CSI caoability being optional might cause scenarios where certain UEs will not support the testing framework for Option 2.**  **Issue 2-2-2-5:**  **We are ok to take Option 1 as baseline but not preclude other options.**  **Issue 2-2-2-6:**  **If we want to align the testing between Rel-15 Type II, and Rel-16 Type II we should test with MCS 20 (64 QAM CR=1/2) rank2.**  **Issue 2-2-2-7:**  **We are ok with Option 1.** |

### 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 2st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| **R4-2002421** | Samsung:  Page 6:  In order to align with type II PMI test in Rel-16, we prefer use MCS 20, rank 2 at this stage  Could you add more page to indicate the simulation assumption for facilitating simulation alignment in next meeting, either using a reference or inserting the test parameters table is fine for us, if we agree to reuse remaining parameters from Rel-15 type II requirement |
| Huawei, HiSilicon:  To page 2, we would prefer option 2  To page 7, we would prefer either option 1 or 2  To other parameters listed in the WF, we are fine to use those configurations to do the investigations and initial simulations. |
| **Intel**  *Page 7 Test metric:*  We also would like to include the test metric used in LTE for advanced CSI requirements as an option.  *Page 5 MIMO correlation:*  For MIMO correlation we also propose XP-Medium |

## 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”* |