**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**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

|  |  |  |
| --- | --- | --- |
| **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/Pannnel tranmssion(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)
* 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-PDSCH scheduling based on multi-TRP/multi-panel transmission (Samsung, Intel, QC)
* Recommended WF
  + Agree above proposal

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

* Proposals
  + Option 1: FFS to define requirements for Multi-TRP in URLLC (HW, Ericsson)
  + Option 2: Deprioritize URLLC requirements with Multi-TRP pending on the progress on performance requirements of Rel-16 URLLC WI (Samsung)
  + Option 3: Define requirements for Multi-TRP in URLLC (Intel)
* Recommended WF
  + Discuss above proposals

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

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

### Sub-topic 1-2: Test setup of Enhancement on Multi-TRP/Pannnel tranmssion(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: 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 1-2-2-5: 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)
* 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)
* 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)
* 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)
  + Option 3: Not to define new performance requirement for PDSCH enhancement in DMRS sequence generation(Huawei, Ericsson)
* Recommended WF
  + Discussion above proposals

**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)
  + Option 2 (Intel):
  + Define one UL CP-OFDM test to verify the receive processing from one of existing Rel-15 PUSCH requirement (Intel)
  + 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)
* Recommended WF
  + Discussion above proposals

**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)
  + 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)
  + Option 3: Do not define UL requirements to verify receive processing of Rel-16 DMRS for scenarios with DFT-S-OFDM waveform (Intel)
* Recommended WF
  + Discussion above proposals

### 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)
* 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 |

### CRs/TPs comments collection

*Major close-to-finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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

## Summary for 1st round

### Open issues

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

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

*Recommendations on WF/LS assignment*

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

### 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)

## 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)
* Recommended WF
  + Agreed above proposals

**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 (HW)
* Recommended WF
  + Collect views from more companies

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

* Proposals
  + Option 1: Not to define performance requirements for UCI omission in CSI enhancement (Huawei)
* Recommended WF
  + Collect views from more companies

### 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 2-2-2-4: 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 2-2-2-5: 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 2-2-2-6: 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 2-2-2-7: 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 2-2-2-8: 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 |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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

## Summary for 1st round

### Open issues

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

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

*Suggestion on WF/LS assignment*

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

### 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)

## 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”* |