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

**Electronic Meeting, 17 - 28 Aug, 2020**

**Agenda item:** 7.16

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [96e][324] NR\_perf\_enh\_Demod

**Document for:** Information

# Introduction

This email thread discusses the NR Rel-16 demodulation performance requirements in agenda 7.16. Note that no tdoc has been submitted for BS demodulation in agenda 7.16.2 in this meeting.

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

* 1st round: Invite companies to review the recommended WF in section 1~5, and provide comments (if any) in section 1.3, 2.3, 3.3, 4.3 and 5.3.
* 2nd round: TBA

# Topic #1: General issue for UE requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2010482 | Ericsson | Observation 1: Rel-15 PMI type II codebook reporting requirement can be release independent from Rel-15.  Observation 2: Supporting Rel-15 PMI type II codebook is optional according to TS38.306.  Proposal: Rel-15 PMI type II codebook reporting requirement should be release independent from Rel-15. |
| R4-2011016 | Huawei | Proposal 5: Enable PMI reporting test for Rel-15 type II codebook to be release independent from Release 15. |

## Open issues summary

### Sub-topic 1-1: Release independent issue

**Issue 1-1: Release independent issue for type II PMI**

* *Agreement in RAN4 #95e (R4-2008837, WF)*
  + *PMI reporting requirements for Rel-15 type II codebook*
    - *Option 1: Release independent from Rel-15*
    - *Option 2: Not release independent from Rel-15*
    - *Note: conclusion will be reached in next RAN4# 96-e meeting*
* Proposals
  + PMI reporting requirements for Rel-15 type II codebook
    - Option 1: Release independent from Rel-15 (Ericsson, Huawei)
* Recommended WF
  + Taking into account companies’ views in the recent meetings, can we agree with option 1?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Issue 1-1: Release independent issue for type II PMI |
| Company B | Issue 1-1: Release independent issue for type II PMI |
|  |  |
|  |  |

## 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: UE CA PDSCH requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2009579 | China Telecom | TDD-FDD CA and TDD-TDD CA with different SCSs  **Proposal 1:** For Pcell configuration for the test, use the following general rule:   * For scenarios with different capabilities defined for different Pcell configurations, if Pcell in both carriers are supported, configure the Pcell which resulting in larger number of HARQ processes. * For scenarios with no different capabilities defined for different Pcell configurations, configure any one of the CC as PCell.   **Proposal 2:** Based on proposal 1, if Pcell in both carriers are supported for TDD 15 kHz + TDD 30 kHz, use option 1 for the Pcell configuration for testing, i.e., configure 15 kHz SCS cell as Pcell.  **Proposal 3:** For HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CA, both option are ok, and option 2 of 8 HARQ processes is slightly preferred.  **Proposal 4:** Since it was agreed that A/N feedback of all CCs are carried on Pcell’s PUCCH,K1 values should be based on Pcell’s SCS in scenarios with mixed SCSs, and the table on the detailed K1 values needs to be updated as follows:   |  |  |  |  | | --- | --- | --- | --- | |  | | **CCs with the same duplex mode & SCS with Pcell** | **CCs with different duplex mode / SCS with Pcell** | | **FDD 15 kHz +  TDD 30 kHz CA** | FDD PCell | 2 | {2} | | TDD PCell | {8,7,6,5,5,4,3,2} | {7,6,4,11,9~~,7,6,4~~} | | **FDD 15 kHz +  TDD 15 kHz CA** | FDD PCell | {2} | {2} | | TDD PCell | {4,3,2,6~~,5~~} | {4,3,2,6,5} | | **TDD 15 kHz +  TDD 30 kHz CA** | 15kHz PCell | {4,3,2,6} | {4,4,3,3,2,2,6,6} | | 30kHz PCell | {8,7,6,5,5,4,3,2} | {7,5,4,11} |   Test applicability  **Observation 1:** For NR FR1 RF, in the latest version of TS 38.101-1, FR1 inter-band CA requirements with different numbers of bands are specified in different sub-clauses; for NR FR2, the UE RF requirements for inter-band DL CA are still under discussion in Rel-16.  **Proposal 5:** For CA capability categorization, it is important to align with LTE demod spec and NR RF spec, i.e., define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands.  **Proposal 6:** Follow LTE approach and test all the supported CA capabilities, including intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands.  **Proposal 7:** Selection of CA configuration(s) and CBW combination:  For FR1, for each supported CA duplex mode and each supported CA capability,   * Step 1: Select the CA configuration(s) satisfying the following conditions:   + For each CC, single carrier performance requirement is specified for any one of the supported SCS(s).   + For each CC, the supported maximum modulation order is not lower than 16 QAM.   + For each CC, the supported maximum number of MIMO layers is not lower than 2.   + For each band, the supported max data rate (calculated according to 4.1.2 of TS 38.306) is not lower than the date rate corresponding to using 2-layer and MCS 13 on the largest (aggregated) channel bandwidth on the band. * Step 2: Select any one of the CA configuration(s) with the largest aggregated CA bandwidth among the selected the CA configuration(s) based on step 1.   For FR2, for each supported CA duplex mode and each supported CA capability,   * Step 1: Select the CA configuration(s) satisfying the following conditions:   + For each CC, single carrier performance requirement is specified for any one of the supported SCS(s)   + For each CC, the supported maximum modulation order is not lower than 16 QAM   + For each CC, the supported maximum number of MIMO layers is not lower than 2   + For each band, the supported max data rate (calculated according to 4.1.2 of TS 38.306) is not lower than the date rate corresponding to using 2-layer and MCS 10 on the largest (aggregated) channel bandwidth on the band. * Step 2: Calculate the largest aggregated CA bandwidth for the selected the CA configuration(s) based on step 1, denoted as CBWlargest. * Step 3: Calculate the maximum aggregated channel bandwidth that can be testable in the test system, denoted as CBWtestable. * Step 4:   + If CBWlargest <= CBWtestable, select any one of the CA configuration(s) with the largest aggregated CA bandwidth among the selected the CA configuration(s) based on step 1.   + If CBWlargest > CBWtestable, select any one of the CA configuration(s) with the aggregated channel bandwidth no smaller than CBWtestable among the selected the CA configuration(s) based on step 1.   Requirement values  **Proposal 8:** Capture the proposed requirements in the simulation result summary at RAN4 #95e, i.e., in R4-2008840/8841/6531, into the draft CRs in this meeting. |
| R4-2010106 | CMCC | Proposal 1: If Pcell in both carriers are supported for TDD 15 kHz + TDD 30 kHz, configure 15 kHz SCS cell as Pcell.  Proposal 2: It is proposed to define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands.  Proposal 3: Test all the supported CA capabilities, including intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands. |
| R4-2010182 | CMCC | draftCR: Introduction of NR PDSCH FR1 CA 2Rx performance requirements |
| R4-2011010 | Huawei, HiSilicon | Observation 1: No performance impact by scheduling the initial transmission and retransmission in different types of slots.  Observation 2: No further specification maintenance is needed for Option 2.  Proposal 1: Configure TDD cell with 30 kHz SCS as PCell in TDD 15kHz + TDD 30kHz CA.  Proposal 2: Not restrict the scheduling on the initial transmission and retransmission on the type of TDD slots.  Proposal 3: Adopt Option 1 for the K1 values definition, i.e.  Proposal 4: Adopt Option 2 for CA capability definition, with definition:  Table X2-1: Definition of CA capability (Option 2)   |  |  | | --- | --- | | CA Capability | CA Capability Description | | CA\_C | Intra-band contiguous CA | | CA\_NC | Intra-band non-contiguous CA | | CA\_A | Inter-band CA | | NOTE 1: CA\_C corresponds to NR CA configurations and bandwidth combination sets defined in section 5.5A.1 [6~7], for intra-band contiguous CA.  CA\_N2 corresponds to NR CA configurations and bandwidth combination sets defined in section 5.5A.2 [6~7] for intra-band non-contiguous CA.  CA\_A corresponds to NR CA configurations and bandwidth combination sets defined in section 5.5A.3 [6, 8] for inter-band CA. | |   Proposal 6: Adopt the following test applicability rule for selection of CA configurations and CBW combination for test:   * + For intra-band contiguous CA and intra-band non-contiguous CA with same numerology, for each supported SCS     - Select any one of the supported CA configurations with the largest aggregated CA bandwidth combination for certain selected CA duplex mode     - If more than one CA configurations with the same largest aggregated CA bandwidth combination, select the CA configurations with the largest number of CCs   + For intra-band contiguous CA and intra-band non-contiguous CA with different numerology, as per the PCell configuration for the test     - Select any one of the supported CA configurations with the largest aggregated CA bandwidth combination for certain selected CA duplex mode     - If more than one CA configurations with the same largest aggregated CA bandwidth combination, select the CA configurations with the largest number of CCs   + For inter-band CA, as per the PCell configuration for the test     - Select any one of the supported CA configurations with the largest number of bands aggregated |
| R4-2011011 | Huawei, HiSilicon | draftCR: Introduction of performance requirements for NR FR1 PDSCH CA with 4Rx |
| R4-2009730 | Intel Corporation | Proposal 1: No need to differentiate the two HARQ scheduling options for 30 kHz CCs for TDD 15 kHz + TDD 30 kHz CA scenarios with 15 kHz PCell in TS 38.101-4.  Proposal 2: Use 8 HARQ process for 15 kHz CCs for TDD 15 kHz + TDD 30 kHz CA scenarios with 30 kHz PCell.  Proposal 3: Align categorizing of CA capabilities for NR Normal CA requirements with RF specifications. Use references to sections with CA configurations descriptions in RF specifications (for example, 5.2A and 5.5A) for definition of CA capabilities to avoid regular maintenance of TS 38.101-4.  Proposal 4: Consider the following CA capabilities for NR Normal CA testing: Intra-band contiguous CA, Intra-band non-contiguous CA and Inter-band CA with the largest number of bands  Proposal 5: Use the following approach for selection of CA configuration for NR FR1 Normal CA testing:   * Step 1: Select CA configurations with maximum number of CCs, on which UE capability field *supportedSubCarrierSpacingDL* is equal to SCSreq, among all supported CA configurations * Step 2: Select CA configurations with maximum number of CCs, on which UE capability field *maxNumberMIMO-LayersPDSCH* is higher or equal to νLayersreq, among all the selected CA configurations from Step 1 * Step 3: Select any one of CA configurations, which contain CBW combination with the largest data rate not exceeding *DataRatereq*, among all the selected CA configurations from Step 2.   Proposal 6: Use the following approach for selection of CA configuration for NR FR2 Normal CA testing:   * Step 1: Select CA configurations, which contain CBW combinations with SNRTEmax higher or equal to SNRreq, among all supported CA configurations * Step 2: Select CA configurations with maximum number of CCs, on which UE capability field *supportedSubCarrierSpacingDL* is equal to SCSreq, among all the selected CA configurations from Step 1 * Step 3: Select CA configurations with maximum number of CCs, on which UE capability field *maxNumberMIMO-LayersPDSCH* is higher or equal to νLayersreq, among all the selected CA configurations from Step 2 * Step 4: Select any one of CA configurations, which contain CBW combination with the largest data rate not exceeding *DataRatereq* and aggregated bandwidth with SNRTEmax higher or equal to SNRreq, among all the selected CA configurations from Step 3. |
| R4-2009731 | Intel Corporation | Draft CR on FRC for Normal NR CA demodulation requirements |
| R4-2011043 | NTT DOCOMO, INC. | Proposal 1: Use the following approach on CA test applicability  Categorizing of CA capabilities   * Define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands.   Test of different CA capabilities   * Test all the supported CA capabilities, including intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands. |
| R4-2011413 | Qualcomm Incorporated | Draft CR on FR2 PDSCH CA Requirements |
| R4-2011436 | Qualcomm Incorporated | Observation 1: Initial transmission and retransmission should happen on the same type of slot. Otherwise, it will degrade the HARQ performance.  Proposal 1: In case of TDD 15kHz + TDD 30kHz CA with TDD 15kHz as PCell, different RTTs (10 or 20 slots) are used for different HARQ processes, and initial transmission and retransmission are scheduled on the same type of TDD slot.  Proposal 2: In case of TDD 15kHz + TDD 30kHz CA with TDD 30kHz as PCell, use 8 HARQ processes.  Proposal 3: If PCell in both carriers are supported, configure 30 kHz SCS cell as PCell in TDD 15kHz+30kHz SCS CA. |

## Open issues summary

### Sub-topic 2-1: Pcell configuration

**Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CA**

* *Agreement in RAN4 #95e (R4-2008838, WF)*
  + *Pcell configuration for performance requirements*
    - *Define requirements for both 15kHz Pcell and 30kHz Pcell (for CA with different SCSs) and both FDD 15 kHz Pcell and TDD 15 kHz Pcell (for FDD + TDD CA with 15 kHz SCS)*
  + *Pcell configuration for the test*
    - *The test coverage can be considered fulfilled if UE passes any one of scenario with one of the CC as PCell for FDD 15 kHz + TDD 15 kHz*
    - *If Pcell in both carriers are supported for FDD 15 kHz + TDD 30 kHz, configure TDD cell as Pcell*
    - *If Pcell in both carriers are supported for TDD 15 kHz + TDD 30 kHz, configure* 
      * *Option 1: 15 kHz SCS cell as Pcell*
      * *Option 2: 30 kHz SCS cell as Pcell*
* Proposals on Pcell configuration for TDD 15 kHz + TDD 30 kHz CA
  + Option 1: 15 kHz SCS cell as Pcell (CTC, CMCC)
    - CTC: As a general rule, for scenarios with different capabilities defined for different Pcell configurations, if Pcell in both carriers are supported, configure the Pcell which resulting in larger number of HARQ processes.
    - CMCC: By testing the worst case, the demodulation performance for the other PCell configuration can be guaranteed.
  + Option 2: 30 kHz SCS cell as Pcell (HW, QC)
    - HW, QC: TDD 30kHz PCell is more widely deployed.
* Recommended WF
  + TBA based on more discussion. Make decision in this meeting.

### Sub-topic 2-2: HARQ process number

**Issue 2-2: HARQ process number for TDD-FDD CA and TDD-TDD CA with different SCSs**

* *Agreement in RAN4 #95e (R4-2008838, WF)*

|  |  |  |  |
| --- | --- | --- | --- |
| HARQ process number | | CCs with the *same* duplex mode & SCS with Pcell | CCs with *different* duplex mode / SCS with Pcell |
| FDD 15 kHz +  TDD 30 kHz CA | FDD PCell | 4 | 8 |
| TDD PCell | 8 | 8 |
| FDD 15 kHz +  TDD 15 kHz CA | FDD PCell | 4 | 4 |
| TDD PCell | 8 | 8 |
| TDD 15 kHz +  TDD 30 kHz CA | 15kHz PCell | 8 | 12 (Note 1) |
| 30kHz PCell | 8 | Option 1: 6  Option 2: 8 |
| Note 1: FFS scheduling details:   * Option 1: different RTTs (10 or 20 slots) are used for different HARQ processes, and initial transmission and retransmission are scheduled on the same type of TDD slot. * Option 2: initial transmission and retransmission can be scheduled on different types of TDD slot | | | |

* + *Companies are encouraged to check the performance difference of scheduling options for TDD 15 kHz + TDD 30 kHz CA with 12 HARQ processes*
    - *if no simulation results show there is performance impact by scheduling the initial transmission and retransmission in different types of slots, then no need to differentiate the two options in TS 38.101-4.*

**Issue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CA**

* Proposals
  + Option 1: 12, different RTTs (10 or 20 slots) are used for different HARQ processes, and initial transmission and retransmission are scheduled on the same type of TDD slot. (QC)
    - QC: Initial transmission and retransmission should happen on the same type of slot. Otherwise, it will degrade the HARQ performance.
  + Option 2: 12, initial transmission and retransmission can be scheduled on different types of TDD slot (HW)
    - HW: No performance impact by scheduling the initial transmission and retransmission in different types of slots.
  + Option 3: No need to differentiate the two HARQ scheduling options, i.e., as usual, not define the K3 values (DL NACK to DL re-tx grant) in TS 38.101-4 (Intel, [HW])
    - Intel: Performance difference is around 0.3 dB for 2 Rx and 4 Rx scenarios. Such difference is very negligible.
* Recommended WF
  + Can we go with option 3?

**Issue 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CA**

* Proposals
  + Option 1: 6 (CTC)
  + Option 2: 8 (CTC, Intel, QC)
    - CTC: 8 HARQ process is slightly preferred
    - Intel, CTC: the same HARQ process number for 15 kHz SCell is used as when it is configured as Pcell.
* Recommended WF
  + Can we go with option 2?

**Issue 2-2-3: K1 values**

* *Agreement in RAN4 #95e (R4-2008838, WF)*
  + *Option 1: K1 values are provided based on Pcell’s SCS in scenarios with mixed SCSs.*

|  |  |  |  |
| --- | --- | --- | --- |
| K1 | | CCs with the *same* duplex mode & SCS with Pcell | CCs with *different* duplex mode / SCS with Pcell |
| FDD 15 kHz +  TDD 30 kHz CA | FDD PCell | 2 | {2} |
| TDD PCell | {8,7,6,5,5,4,3,2} | {7,6,4,11,9,7,6,4} |
| FDD 15 kHz +  TDD 15 kHz CA | FDD PCell | {2} | {2} |
| TDD PCell | {4,3,2,6,5} | {4,3,2,6} |
| TDD 15 kHz +  TDD 30 kHz CA | 15kHz PCell | {4,3,2,6} | {4,4,3,3,2,2,6,6} |
| 30kHz PCell | {8,7,6,5,5,4,3,2} | {7,5,4,11} |

* + *Option 2: K1 values are based on each cell’s own SCS*
  + *Other options are not precluded*
  + *Companies are encouraged to check RAN1 procedure for considered scenarios.*
* Proposals
  + Option 1: K1 values are provided based on Pcell’s SCS in scenarios with mixed SCSs (CTC, HW)
    - Option 1a: update the detailed K1 values as follows (CTC)

|  |  |  |  |
| --- | --- | --- | --- |
|  | | ***CCs with the same duplex mode & SCS with Pcell*** | ***CCs with different duplex mode / SCS with Pcell*** |
| ***FDD 15 kHz +  TDD 30 kHz CA*** | *FDD PCell* | *2* | *{2}* |
| *TDD PCell* | *{8,7,6,5,5,4,3,2}* | *{7,6,4,11,9~~,7,6,4~~}* |
| ***FDD 15 kHz +  TDD 15 kHz CA*** | *FDD PCell* | *{2}* | *{2}* |
| *TDD PCell* | *{4,3,2,6~~,5~~}* | *{4,3,2,6,5}* |
| ***TDD 15 kHz +  TDD 30 kHz CA*** | *15kHz PCell* | *{4,3,2,6}* | *{4,4,3,3,2,2,6,6}* |
| *30kHz PCell* | *{8,7,6,5,5,4,3,2}* | *{7,5,4,11}* |

* + Option 2: K1 values are based on each cell’s own SCS
* Recommended WF
  + Can we agree option 1a?

### Sub-topic 2-3: Performance requirement values

**Issue 2-3: Performance requirements for FR1 and FR2**

* Proposal
  + Proposal 1: Capture the proposed requirements in the simulation result summary at RAN4 #95e, i.e., in R4-2008840/8841/6531, into the draft CRs in this meeting. (CTC)
    - Note: In R4-2008840/8841/6531, 5 companies provided simulation results for all the cases, and both alignment and impairment simulation results are well aligned.
* Recommended WF
  + Can we agree the above proposal 1?

### Sub-topic 2-4: CA capabilities

**Issue 2-4-1: Categorizing of CA capabilities**

* *Agreement in RAN4 #95e (R4-2008838, WF)*
  + *Option 1: Define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands.*
  + *Option 2: Define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA.*
  + *Companies to bring proposals on the demod spec structure for CA, with the motivation to minimize future maintenance.*
* Proposal
  + Option 1: Define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands. (CTC, CMCC, Intel, DCM)
    - CMCC: some companies have concern on the increasing number of carrier numbers in CA, but NR support 100MHz maximum single carrier, and the number of carrier numbers for CA would be easier to be handled than LTE.
    - CTC: For NR FR1 RF, in the latest version of TS 38.101-1, FR1 inter-band CA requirements with different numbers of bands are specified in different sub-clauses; for NR FR2, the UE RF requirements for inter-band DL CA are still under discussion in Rel-16.
    - Intel: Align categorizing of CA capabilities for NR Normal CA requirements with RF specifications. Use references to sections with CA configurations descriptions in RF specifications (for example, 5.2A and 5.5A) for definition of CA capabilities to avoid regular maintenance of TS 38.101-4.
    - DCM: We do not see any motivation to modify and/or simplify the LTE approach
  + Option 2: Define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA. (HW)
    - HW: not need to differentiate the inter-band CA with different number of bands, the section number of configurations for CA in TS 38.101-1, TS 38.101-2 and TS 38.101-3 is same, and it is convenient and future proof to just refer to the section number
* Recommended WF
  + Can we go with option 1?

**Issue 2-4-2: Test of different CA capabilities**

* *Agreement in RAN4 #95e (R4-2008838, WF)*
  + *Option 1: Test intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with the largest number of bands.*
  + *Option 2: Test all the supported CA capabilities, including intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands.*
* Proposals
  + Option 1: Test intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with the largest number of bands. (HW, Intel)
    - HW: if UE can support inter-band CA with larger number of bands, it definitely can support and pass the related performance requirements for inter-band CA with smaller number of bands.
    - Intel: it is redundant to test UE for multiple Inter-band CA scenarios with different number of bands
  + Option 2: Test all the supported CA capabilities, including intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with different numbers of bands. (CMCC, CTC, DCM)
    - CMCC: In LTE, different CA capabilities supported by UE are at least tested in one test.
    - CTC: There would some problems with option 1. For example, one UE supports CA configurations CA\_n78A-n79A with 200MHz max aggregated CBW and CA\_n1A-n3A-n78A with 150 MHz max aggregated CBW. If only the CA capability with the largest number of bands, i.e., CA configuration CA\_n1A-n3A-n78A is tested, there will be no tests for CA\_n78A-n79A with 200MHz aggregated CBW.
* Recommended WF
  + Given the long-time discussion and unchanged views form operators/vendors, can we go with the following compromised approach?
    - Intra-band CA: test intra-band contiguous CA, and intra-band non-contiguous CA (aligned with both option 1 and option 2)
    - Inter-band CA: test inter-band CA with the largest number of bands, and inter-band CA with the largest aggregated CBW (compromise between option 1 and option 2)
      * The details are to be discussed and reflected in issue 2-5.
      * If the selection of “inter-band CA with the largest number of bands” and “inter-band CA with the largest aggregated CBW” results in the same CA configuration(s), only one inter-band CA configuration will be tested; otherwise, two inter-band CA configurations will be tested.

### Sub-topic 2-5: Selection of CA configuration(s) and CBW combination

**Issue 2-5: Selection of CA configuration(s) and CBW combination**

* *Agreement in RAN4 #94e-bis (R4-2005546, WF)*
  + *Numerology in each CA duplex mode*
    - *Test #1: FDD 15 kHz + FDD 15 kHz*
    - *Test #2: FDD 15 kHz + TDD 30 kHz, in case UE supports different SCS on different carriers for FDD-TDD CA, otherwise FDD 15 kHz + TDD 15 kHz*
    - *Test #3: TDD 30 kHz + TDD 30 kHz, in case UE supports it, otherwise TDD 15 kHz + TDD 30 kHz*
* *Agreement in RAN4 #95e (R4-2008838, WF)*
  + *Further discuss by taking into account:*
    - *The supportedSubCarrierSpacingDL, maxNumberMIMO-LayersPDSCH and supportedModulationOrderDL are reported for each CC and scalingFactor are reported per band for FR1 and FR2.*
    - *The testable SNR for FR2.*
* Proposals
  + Option 1 (China Telecom):

For FR1, for each supported CA duplex mode and each supported CA capability,

* Step 1: Select the CA configuration(s) satisfying the following conditions:
  + For each CC, single carrier performance requirement is specified for any one of the supported SCS(s).
  + For each CC, the supported maximum modulation order is not lower than 16 QAM.
  + For each CC, the supported maximum number of MIMO layers is not lower than 2.
  + For each band, the supported max data rate (calculated according to 4.1.2 of TS 38.306) is not lower than the date rate corresponding to using 2-layer and MCS 13 on the largest (aggregated) channel bandwidth on the band.
* Step 2: Select any one of the CA configuration(s) with the largest aggregated CA bandwidth among the selected the CA configuration(s) based on step 1.

For FR2, for each supported CA duplex mode and each supported CA capability,

* Step 1: Select the CA configuration(s) satisfying the following conditions:
  + For each CC, single carrier performance requirement is specified for any one of the supported SCS(s)
  + For each CC, the supported maximum modulation order is not lower than 16 QAM
  + For each CC, the supported maximum number of MIMO layers is not lower than 2
  + For each band, the supported max data rate (calculated according to 4.1.2 of TS 38.306) is not lower than the date rate corresponding to using 2-layer and MCS 10 on the largest (aggregated) channel bandwidth on the band.
* Step 2: Calculate the largest aggregated CA bandwidth for the selected the CA configuration(s) based on step 1, denoted as CBWlargest.
* Step 3: Calculate the maximum aggregated channel bandwidth that can be testable in the test system, denoted as CBWtestable.
* Step 4:
  + If CBWlargest <= CBWtestable, select any one of the CA configuration(s) with the largest aggregated CA bandwidth among the selected the CA configuration(s) based on step 1.
  + If CBWlargest > CBWtestable, select any one of the CA configuration(s) with the aggregated channel bandwidth no smaller than CBWtestable among the selected the CA configuration(s) based on step 1.
  + Option 2 (Intel)

Use the following approach for selection of CA configuration for NR FR1 Normal CA testing:

* Step 1: Select CA configurations with maximum number of CCs, on which UE capability field *supportedSubCarrierSpacingDL* is equal to SCSreq, among all supported CA configurations
* Step 2: Select CA configurations with maximum number of CCs, on which UE capability field *maxNumberMIMO-LayersPDSCH* is higher or equal to νLayersreq, among all the selected CA configurations from Step 1
* Step 3: Select any one of CA configurations, which contain CBW combination with the largest data rate not exceeding *DataRatereq*, among all the selected CA configurations from Step 2.

Use the following approach for selection of CA configuration for NR FR2 Normal CA testing:

* Step 1: Select CA configurations, which contain CBW combinations with SNRTEmax higher or equal to SNRreq, among all supported CA configurations
* Step 2: Select CA configurations with maximum number of CCs, on which UE capability field *supportedSubCarrierSpacingDL* is equal to SCSreq, among all the selected CA configurations from Step 1
* Step 3: Select CA configurations with maximum number of CCs, on which UE capability field *maxNumberMIMO-LayersPDSCH* is higher or equal to νLayersreq, among all the selected CA configurations from Step 2
* Step 4: Select any one of CA configurations, which contain CBW combination with the largest data rate not exceeding *DataRatereq* and aggregated bandwidth with SNRTEmax higher or equal to SNRreq, among all the selected CA configurations from Step 3.
  + Option 3 (HW)
    - For intra-band contiguous CA and intra-band non-contiguous CA with same numerology, for each supported SCS
      * Select any one of the supported CA configurations with the largest aggregated CA bandwidth combination for certain selected CA duplex mode
      * If more than one CA configurations with the same largest aggregated CA bandwidth combination, select the CA configurations with the largest number of CCs
    - For intra-band contiguous CA and intra-band non-contiguous CA with different numerology, as per the PCell configuration for the test
      * Select any one of the supported CA configurations with the largest aggregated CA bandwidth combination for certain selected CA duplex mode
      * If more than one CA configurations with the same largest aggregated CA bandwidth combination, select the CA configurations with the largest number of CCs
    - For inter-band CA, as per the PCell configuration for the test
      * Select any one of the supported CA configurations with the largest number of bands aggregated
* Recommended WF
  + Taking into account the UE capability, FR2 testability and the CA capability for testing, can we use the following modified option 1 as baseline?

For FR1, for each CA duplex mode and each CA capability selected for testing (i.e., intra-band contiguous CA, intra-band non-contiguous CA, inter-band CA, inter-band CA with the largest number of bands)

* Step 1: Select the CA configuration(s) satisfying the following conditions:
  + For each CC, the supported maximum modulation order is not lower than 16 QAM.
  + For each CC, the supported maximum number of MIMO layers is not lower than 2.
  + For each band, the supported max data rate (calculated according to 4.1.2 of TS 38.306) is not lower than the date rate corresponding to using 2-layer and MCS 13 on the largest (aggregated) channel bandwidth on the band.
* Step 2: Select any one of the CA configuration(s) with the largest aggregated CA bandwidth among the selected the CA configuration(s) based on step 1.

For FR2, for each CA duplex mode and each CA capability selected for testing (i.e., intra-band contiguous CA, intra-band non-contiguous CA, inter-band CA, inter-band CA with the largest number of bands)

* Step 1: Select the CA configuration(s) satisfying the following conditions:
  + For each CC, the supported maximum modulation order is not lower than 16 QAM
  + For each CC, the supported maximum number of MIMO layers is not lower than 2
  + For each band, the supported max data rate (calculated according to 4.1.2 of TS 38.306) is not lower than the date rate corresponding to using 2-layer and MCS 10 on the largest (aggregated) channel bandwidth on the band.
* Step 2: Calculate the largest aggregated CA bandwidth for the selected the CA configuration(s) based on step 1, denoted as CBWlargest.
* Step 3: Calculate the maximum aggregated channel bandwidth that can be testable in the test system, denoted as CBWtestable.
* Step 4:
  + If CBWlargest <= CBWtestable, select any one of the CA configuration(s) with the largest aggregated CA bandwidth among the selected the CA configuration(s) based on step 1.
  + If CBWlargest > CBWtestable, select any one of the CA configuration(s) containing the aggregated channel bandwidth equals to CBWtestable among the selected the CA configuration(s) based on step 1.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CA  Issue 2-2: HARQ process number  Issue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CA  Issue 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CA  Issue 2-2-3: K1 values  Issue 2-3: Performance requirements for FR1 and FR2  Issue 2-4: CA capability  Issue 2-4-1: Categorizing of CA capabilities  Issue 2-4-2: Test of different CA capabilities  Issue 2-5: Selection of CA configuration(s) and CBW combination |
| Company B | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CA  Issue 2-2: HARQ process number for TDD-FDD CA and TDD-TDD CA with different SCSs  Issue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CA  Issue 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CA  Issue 2-2-3: K1 values  Issue 2-3: Performance requirements for FR1 and FR2  Issue 2-4: CA capability  Issue 2-4-1: Categorizing of CA capabilities  Issue 2-4-2: Test of different CA capabilities  Issue 2-5: Selection of CA configuration(s) and CBW combination |
| Huawei, HiSilicon | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CA  Prefer Option 2.  Issue 2-2: HARQ process number  Issue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CA  As per our evaluation, no performance difference by scheduling the initial transmission and retransmission on different types of TDD slots, so it is not necessary to differentiate the two HARQ scheduling options, so we think Option 2 and Option 3 have the same meaning, not very sure about if it is the correct understanding.  Issue 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CA  As stated in our contribution R4-2007221, as per the analysis from 3 companies, 6 HARQ processes is feasible, but if companies insist on use the same number of 8 HARQ process as single carrier, Option 2 is fine for us.  Issue 2-2-3: K1 values  Recommend WF is fine.  Issue 2-3: Performance requirements for FR1 and FR2  Recommend WF is fine.  Issue 2-4: CA capability  Issue 2-4-1: Categorizing of CA capabilities  As compromise, recommend WF is fine for us.  Issue 2-4-2: Test of different CA capabilities  The testing for the largest aggregated CBW will be reflected in the test applicability of CA configurations and CBW combination, we can select the inter-band CA with the largest aggregated CBW among the selected inter-band CA with the largest number of bands.  Issue 2-5: Selection of CA configuration(s) and CBW combination  Firstly, we want to clarify that WF R4-2008838 just suggested RAN4 consider those factors, not mandate RAN4 to take into account them during last meeting.  Based on our understanding, *maxNumberMIMO-LayersPDSCH, supportedModulationOrderDL* and *scalingFactor* are considered in the SDR for CA tests, it is not necessary to further consider them in CA normal PDSCH performance testing. Also MIMO layer and MCS are fixed in the test. |
|  |  |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2010182, CMCC, FR1 2Rx | Company A |
| Company B |
|  |
| R4-2011011, Huawei, HiSilicon, FR1 4Rx | Company A |
| Company B |
|  |
| R4-2011413, Qualcomm, FR2 | Company A |
| Company B |
|  |
| R4-2009731, Intel, FRC | Company A |
| Company B |
|  |

Note: To save time on typing the comments one by one, companies can also directly revise the draft CR and upload the revisions in the draft inbox.

## 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”* |

# Topic #3: UE PMI reporting requirements with larger number of Tx ports

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2009580 | China Telecom | For Type I PMI:  Proposal 1: For 32 Tx type I wideband, set gamma (gain) values as 5.0 and 8.0 for 2Rx and 4Rx respectively.  Proposal 2: For 16 Tx type I subband, set gamma (gain) values as 2.5 and 3.5 for 2Rx and 4Rx respectively.  For Type II PMI:  Observation 1: Since the PMI calculation processing will not change with and without co-scheduled UE, there is no need to involve MU-MIMO test setup.  Observation 2: MU-MIMO setup brings much more workload in test design, and the test feasibility has not been checked by the TE vendors.  Proposal 3: Only use SU-MIMO test setup, i.e., one tested UE.  Proposal 4: Use 16Tx ports with (N1, N2) = (4,2), (O1, O2) = (4,4) to reduce the test complexity.  Proposal 5: Configure only two beams in beam steering model for Rel-15 Type II codebook test.  Proposal 6: For specifying beam steering model into specification, use Equation 1 to support more than 2 beams. |
| R4-2009581 | China Telecom | Simulation results. |
| R4-2009610 | Apple Inc. | Test Setup  Observation #1: For link level assessment, no performance improvement would be observed with MU-MIMO compared to SU-MIMO test setup.  Observation #2: There is no impact on UE PMI reporting based on no knowledge of co-scheduled UE and baseline receiver as MMSE-IRC with MU-MIMO setup compared to SU-MIMO.  Observation #3: MU-MIMO setup is more complicated compared to SU-MIMO, involving aligning scheduling mode with co-scheduled UE.  Proposal #1: Use SU-MIMO test setup for requirements for PMI reporting with Type II codebook.  Test Parameters  Observation #4: With both SB and WB PMI reporting, better performance is observed with medium correlation, subband amplitude set to TRUE and Npsk = 8.  Observation #5: SB PMI reporting has better performance compared to WB PMI  Proposal #2: For Type II codebook, introduce requirements with SU-MIMO test setup with the following assumptions:  Number of CSI-RS ports: 16 ports with (N1,N2) = (4,2) and (O1,O2)=(4,4)  Channel Model: TDLA30-5Hz  Antenna Correlation: XP-Medium  PMI format Indicator: Subband  Subband Amplitude: TRUE  Npsk: 8 |
| R4-2009732 | Intel Corporation | Simulation results |
| R4-2010104 | CMCC | Simulation results (not available yet) |
| R4-2010142 | Samsung | Performance requirements for Type I codebook  Proposal 1: Introduce requirement gamma as 4.5 for 32 ports wideband PMI test cases with Type I codebook for both FDD mode /TDD mode and 2Rx/4Rx cases;  Proposal 2: Introduce requirement gamma as 2.0 for 16 ports sub-band PMI test cases with Type I codebook for both FDD mode /TDD mode and 2Rx/4Rx cases;  Test case design for PMI requirements with R15 Type II codebook  SU-MIMO set-up Vs MU-MIMO set-up:  Proposal 3-SU-MIMO vs MU-MIMO: Introducing Type II codebook PMI requirements with MU-MIMO Set-up only if RAN4 can reach consensus on test feasibility and detailed test set-up for MU-MIMO set-up in RAN4#96e; otherwise, introducing Type II codebook PMI requirements in Rel-16 with SU-MIMO Set-up and further evaluate and introducing Type II codebook PMI requirements with MU-MIMO set-up in future release.  Common parameters:  Proposal 4-Number of ports: introduce Rel-15 Type II codebook PMI test cases with 16 Tx ports considering test complexity and test coverage.  Proposal 5-codebook parameter: Introduce Type II codebook test case with Npsk = 8, SubbandAmplitude as”TRUE” and PMI-FormatIndicator as “Sub-band”.  Proposal 6-Beam steering: Introduce a generic beam steering model into specification in a future proof manner which the number of beams configurable.  Other parameters for SU-MIMO set-up:  Proposal 7-Propagation condition: Introduce test case with MIMO correlation -XP Medium and TDLA30-5  Proposal 8-MCS&Rank: It’s feasible to use MCS20 (64QAM), Rank2 for introducing test cases. |
| R4-2011015 | Huawei, HiSilicon | Simulation results |
| R4-2011016 | Huawei, HiSilicon | We can conclude that from the observation of SNR point for ‘Follow PMI’, there is:   * Maximum 0.6dB gain brought by subband PMI reporting * Maximum 0.4dB gain brought by 8PSK * Maximum 0.16 gain brought by setting the SubbandAmplitude to ‘true’   Meanwhile, more obvious SNR difference has been observed under XP medium correlation. Therefore, we propose the following:  Proposal 1: Use the same codebook construction as Rel-16 eType II codebook PMI reporting test  Proposal 2: Use QPSK for Npsk configuration  Proposal 3: Use ‘false’ for SubbandAmplitude configuration  Proposal 4: Companies can see if the situation of SNR differences between configurations are more obvious when using XP medium is a common issue, before making any decision on this  Observation 1: A common way of doing random PMI for Type II codebook simulation might need to be agreed in order to reach sufficient randomization and meanwhile avoid uncertainty and unexpected results brought by infinite random parameters |
| R4-2011365 | Ericsson | Observation 1: A SU-MIMO test cannot be used for Type II CSI reporting since the performance benefit of Type II feedback is not visible. This is due to that SU-MIMO doesn’t take advantage of the rich channel feedback of Type II reporting  Observation 2: In MU-MIMO scenario with rich channel environment (CDL) employing ZF precoding with Type II CSI feedback provides the gNB with sufficient information to schedule multiples UEs close to each other with high MCS and rank.  Observation 3: Type I CSI feedback does not provide sufficient information for the ZF algorithm to correctly calculate the most suitable precoders to achieve FRC maximum throughput.  Observation 4: Zero-forcing algorithm is needed to properly cancel out interference in between the two scheduled UEs.  Proposal 1: Use Rank1 MCS7 for MU-MIMO PMI testing  Proposal 2: Configure Rel-15 Type II codebook with L=4, PhaseAlphabetSize = 8, SubbandAmplitude = true.  Proposal 3: Use 32Tx ports, Subband size 4 (Subband size 8 for TDD), TDLC300-5 channel model  Proposal 4: No impairment model needed for MU-MIMO PMI testing  Observation 5: Zero-forcing follow PMIa with random PMIb yields a higher achievable maximum throughput (MCS13) than zero-forcing follow PMIa with follow PMIb.  Proposal 5: Use Option 1a: (Xa, Xb) = (PMIa, PMIb) as the zero-forcing method.  Proposal 6: Set a gain requirement with Type II PMI divided by Type I PMI. |
| R4- 2011437 | Qualcomm Incorporated | Proposal 1: Use SU-MIMO test setup for defining Type II PMI reporting tests.  Proposal 2: Use subband PMI reporting for defining Type II PMI reporting tests.  Proposal 3: Define Type II PMI reporting requirements with N\_PSK = 8 and subbandAmplitude = true  Proposal 4: Define Type II PMI reporting requirements for only 16Tx ports.  Proposal 5: Define Type II PMI reporting requirements for XP High MIMO correlation.  Proposal 6: Discuss extension of beam steering approach to more than 2 clusters in future releases and use the 2 cluster beam steering approach from 36.101 for defining Type II PMI reporting requirements under NR performance enhancement WI. |

## Open issues summary

### Sub-topic 3-1: Type I PMI test

**Issue 3-1-1: Gamma (gain) values**

* *Previous Agreements* 
  + *Agreements in RAN4 #92bis (R4-1912834, WF)*
    - *Test metric: Relative throughput ratio between following PMI and random PMI at SNR point corresponding to 90% TP with follow PMI*
  + *Agreement in RAN4 #95e (R4-2008846, WF)*
    - *Set gamma (gain) values based on simulation results in RAN4#96-e*
* Summary of relative TP ratios for 16 Tx subband

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Duplex Mode | Rx number | Relative TP Ratio (gamma) | | | | | | |
| CTC | QC | Huawei | Ericsson | Samsung | Apple | Intel |
| FDD | 2 | 3.9 | 3.24 | 4.4 | 4.3 | 4.6 | 3.2 | 3.0 |
| 4 | 4.6 | 3.95 | 4.9 | 6.0 | 5.2 | 3.4 | 3.8 |
| TDD | 2 | 2.6 |  | 4.8 | 4.9 | 4.2 | 3.2 |  |
| 4 | 3.8 |  | 4.7 | 4.4 | 5.0 | 3.6 |  |

* Summary of the relative TP ratios for 32 Tx wideband

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Duplex Mode | Rx number | Relative TP Ratio (gamma) | | | | | |
| CTC | QC | Huawei | Ericsson | Samsung | Intel |
| FDD | 2 | 7.5 | 6.55 | 9.1 | 10.17 | 9.2 | 6.0 |
| 4 | 12.5 | 11.13 | 18.2 | 15.32 | 11.35 | 6.0 |
| TDD | 2 | 17.1 | 5.29 | 11.3 | 9.62 | 9.3 |  |
| 4 | 25.6 | 9.56 | 21.4 | 13.35 | 14 |  |

* Proposals on Gamma (gain) values
  + For 16 Tx subband:
    - Option 1: 2.5 for 2Rx, 3.5 for 4Rx (CTC)
    - Option 2: 2.0 for 2Rx and 4Rx (Samsung)
  + For 32 Tx wideband:
    - Option 1: 5.0 for 2Rx, 8.0 for 4Rx (CTC)
    - Option 2: 4.5 for 2Rx and 4Rx (Samsung)
* Recommended WF
  + Encourage companies to provide feedback on the above proposals during the 1st round discussion.

### Sub-topic 3-2: Type II PMI test setup

**Issue 3-2-1: Test setup for type II**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *Test setup:*
    - *Option 1: Only use SU-MIMO test setup, i.e., one tested UE*
    - *Option 2: MU-MIMO based test setup, i.e., one tested UE + one co-scheduled UE (generated by TE)*
    - *Keep these two options open and make decision among option 1 and option 2 in Q3 2020.*
    - *Proponents for each option need to provide technical analysis for how the test set-up can guarantee UE PMI reporting requirements with type II codebook for its intended purpose.*
  + *The baseline receiver assumption is UE without interference cancellation capability with/without co-scheduled UE.*
  + *Under the baseline UE receiver assumption, the PMI calculation processing will not change with and without co-scheduled UE.*
  + *TE vendors are encouraged to provide feedback for the test feasibility of MU-MIMO test setup.*
* Proposals
  + Option 1: Only use SU-MIMO test setup, i.e., one tested UE (CTC, Apple, Huawei, Qualcomm)
    - CTC: 1) The PMI calculation processing will not change with and without co-scheduled UE; 2) MU-MIMO setup brings much more workload in test design, and the test feasibility has not been checked by the TE vendors.
    - Apple: 1) For link level assessment, no performance improvement would be observed with MU-MIMO compared to SU-MIMO test setup. 2) There is no impact on UE PMI reporting based on no knowledge of co-scheduled UE and baseline receiver as MMSE-IRC with MU-MIMO setup compared to SU-MIMO. 3) MU-MIMO setup is more complicated compared to SU-MIMO, involving aligning scheduling mode with co-scheduled UE.
    - Huawei: For SU-MIMO test setup, the performance of Follow PMI for Type II has an obvious gain over Follow PMI for Type I single panel
    - Qualcomm: Regardless of the setup, UE reported precoder is not going to change.
  + Option 2: MU-MIMO based test setup, i.e., one tested UE + one co-scheduled UE (generated by TE) (Ericsson)
    - Ericsson: 1) A SU-MIMO test cannot be used for Type II CSI reporting since the performance benefit of Type II feedback is not visible. This is due to that SU-MIMO doesn’t take advantage of the rich channel feedback of Type II reporting. 2) In MU-MIMO scenario with rich channel environment (CDL) employing ZF precoding with Type II CSI feedback provides the gNB with sufficient information to schedule multiples UEs close to each other with high MCS and rank. 3) Type I CSI feedback does not provide sufficient information for the ZF algorithm to correctly calculate the most suitable precoders to achieve FRC maximum throughput. 4) Zero-forcing algorithm is needed to properly cancel out interference in between the two scheduled UEs.
  + Option 3: Use MU-MIMO setup only if consensus on test feasibility and detailed test set-up can be reached in this meeting; otherwise, use SU-MIMO setup in Rel-16 and further evaluate MU-MIMO setup in future release. (Samsung)
  + Option 4: Use SU-MIMO setup for Type II codebook PMI reporting test, and consider having a MU-MIMO setup based PDSCH demodulation test with test metric of either follow PMI based or random PMI based Throughput (Huawei)
* Recommended WF
  + Reuse the agreement from Rel-16 eMIMO demod

### Sub-topic 3-3: SU-MIMO Type II PMI test parameters

**Issue 3-3-0: Summary of companies’ Type II PMI simulation results**

* Summary of companies’ Type II FDD 16T2R PMI simulation results under TDLA30-5 (for information)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Duplex Mode | MIMO Correlation | NPSK | subbandAmplitude | PMI-FormatIndicator | SNR point @90%TP (dB) / TP ratio | | | |
| Huawei | Qualcomm | Apple |  |
| FDD | XP Medium | 8 | False | Subband | 9.9/ |  | 12.23/4.94 |  |
| XP Medium | 4 | False | Subband | 10.28/ |  | 12.78/4.50 |  |
| XP Medium | 8 | True | Subband | 9.82/ |  | 11.99/5.20 |  |
| XP Medium | 4 | True | Subband | 10.16/ |  | 12.46/4.74 |  |
| XP High | 8 | False | Subband | 10.86/ |  | 13.86/4.98 |  |
| XP High | 4 | False | Subband | 11.22/ |  | 13.99/4.74 |  |
| XP High | 8 | True | Subband | 10.8/ |  | 13.87/4.99 |  |
| XP High | 4 | True | Subband | 11.04 |  | 13.91/4.77 |  |
| XP Medium | 8 | False | Wideband | 10.12/ |  | 13.15/4.39 |  |
| XP Medium | 4 | False | Wideband | 10.36/ |  | 13.46/3.95 |  |
| XP Medium | 8 | True | Wideband |  |  | 13.15/4.38 |  |
| XP Medium | 4 | True | Wideband |  |  | 13.46/3.94 |  |
| XP High | 8 | False | Wideband | 11.06/ |  | 13.99/4.84 |  |
| XP High | 4 | False | Wideband | 11.2/ |  | 14.09/4.56 |  |
| XP High | 8 | True | Wideband |  |  | 13.97/4.85 |  |
| XP High | 4 | True | Wideband |  |  | 14.08/4.62 |  |
| TDD | XP High | 8 | False | Subband |  | 10.29/5.49 |  |  |
| XP High | 4 | False | Subband |  | 13.80/2.99 |  |  |
| XP High | 8 | True | Subband |  | 10.04/5.88 |  |  |
| XP High | 4 | True | Subband |  | 13.57/3.04 |  |  |
| XP Medium | 8 | True | Subband |  | 11.13/3.19 |  |  |

**Issue 3-3-1: Type II codebook construction**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *Codebook construction*
    - *Option 1: 16Tx ports (N1,N2) = (4,2), (O1, O2) = (4,4)*
    - *Option 2: 32Tx ports (N1,N2) = (4,4), (O1, O2) = (4,4)*
* Proposals
  + Option 1: 16Tx ports (N1, N2) = (4,2), (O1, O2) = (4,4) (CTC, Apple, Samsung, Huawei, Qualcomm)
    - Samsung: 1) It’s better to align the number of Tx ports with PMI test case of LTE eFD-MIMO advanced codebook to provide comparable performance. In LTE Rel-14 eFD-MIMO WI, 16 tx ports was used for PMI test case with advanced codebook. 2) The test complexity especially the number of required individual MIMO channel faders also needs to be considered.
    - Huawei: 16 Tx ports has been decided to be the baseline codebook construction configuration in Rel-16 eType II codebook PMI reporting test under SU-MIMO test setup.
    - QC: 32Tx ports provide too large throughput ratios compared to 16Tx ports.
* Recommended WF
  + Use option 1.

**Issue 3-3-2: Npsk  (phaseAlphabetSize) for type II codebook construction**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *Npsk (phaseAlphabetSize)*
    - *Option 1: 4*
    - *Option 2: 8*
* Proposals
  + Option 1: 4 (Huawei)
    - HW: From the simulation results, we observed that performance difference between QPSK and 8PSK is rather small (maximum 0.4dB gain brought by 8PSK), no matter wideband or subband.
  + Option 2: 8 (Apple, Samsung, Qualcomm)
    - Apple: With both SB and WB PMI reporting, better performance is observed with Npsk = 8.
    - Samsung: we can maximize number of candidate codebooks and number of sub-band for PMI reporting, which requires maximum UE calculation complexity and acts like a pressure test.
    - QC: We can clearly see that N\_PSK = 8 provide the better throughput ratios.
* Moderator’s observation:
  + Note that Issue 3-3-2, Issue 3-3-3, Issue 3-3-4 and Issue 3-3-5 have been discussed for 4 meetings and no consensus can be reached, so we do encourage companies to make compromise on these issues.
* Recommended WF
  + Can we go with option 2 based on majority companies’ view?

**Issue 3-3-3: subbandAmplitude for type II codebook construction**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *SubbandAmplitude*
    - *Option 1: False*
    - *Option 2: True*
* Proposals
  + Option 1: False (Huawei)
    - HW: Maximum 0.16 dB gain brought by setting the SubbandAmplitude to ‘true’
  + Option 2: True (Apple, Samsung, Qualcomm)
    - Apple: With both SB and WB PMI reporting, better performance is observed with subband amplitude set to TRUE.
    - QC: We can clearly see that subbandAmplitude = true provide the better throughput ratios.
* Recommended WF
  + Given the similar situation with issue 3-3-2 (i.e., different simulation observations from companies and no consensus for 4 meetings), can we go with option 2 based on majority companies’ view?

**Issue 3-3-4: PMI-FormatIndicator for type II codebook**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *PMI-FormatIndicator*
    - *Option 1: Wideband*
    - *Option 2: Subband*
* Proposals
  + Option 1: Wideband
  + Option 2: Subband (Apple, Samsung, Qualcomm)
* Recommended WF
  + Can we go with option 2?

**Issue 3-3-5: MIMO correlation for type II codebook**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *MIMO correlation*
    - *Option 1: XP High*
    - *Option 2: XP Medium*
* Proposals
  + Option 1: XP High (Qualcomm, HW)
    - Qualcomm: We have defined other PMI reporting tests with XP High correlation, and XP High provides better performance than XP Medium correlation.
  + Option 2: XP Medium (Apple, Samsung, HW)
    - Apple: With both SB and WB PMI reporting, better performance is observed with medium correlation.
    - Samsung: there are more performance difference among Rel-16 Type II codebook, Rel-15 Type II and Rel-15 Type I codebook under XP medium correlation compared to XP high correlation.
    - Huawei: Don’t have any strong preference on choosing any of these two correlations. Companies can see if the situation of SNR differences between configurations are more obvious when using XP medium is a common issue, before making any decision on this.
* Recommended WF
  + Can we go with option 2 based on majority companies’ view?

**Issue 3-3-6: MCS and rank for type II codebook**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *MCS and rank*
    - *As baseline, use MCS 20, rank 2*
* Proposals
  + MCS 20, rank 2 (Samsung)
* Recommended WF
  + Confirm the baseline agreed in the last meeting, i.e., use MCS 20 rank 2.

**Issue 3-3-7: Beam steering model for Type II Codebook**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *Beam steering model*
    - *Option 1: Reusing beam steering approach with dual-cluster beams as specified in B.2.3B.4A of TS 36.101*
    - *Option 2: Use Equation 1 as beam steering model for Type II codebook performance requirements.*
* Proposals
  + For Rel-15 Type II codebook test:
    - Option 1: Configure only two beams in beam steering model for Rel-15 Type II codebook test. (CTC, Qualcomm)
  + For specifying beam steering model into specification:
    - Option 1: Reusing beam steering approach with dual-cluster beams as specified in B.2.3B.4A of TS 36.101 (Qualcomm)
    - Option 2: Use Equation 1 as beam steering model for Type II codebook performance requirements (CTC)

|  |
| --- |
| **Equation 1**  And the steering matrix is further expressed as following:    where  - , are independent channels for the first beam and the consecutive i beams with the N­rx Ntchannel matrix per subcarrier.  - is the relative power difference from the first beam.  - , are the steering matrix for first beam and consecutive i number of beams  -  is the steering matrix in first dimension with same polarization,  -  is the steering matrix in second dimension with same polarization,  -  is the number of antenna elements in first dimension with same polarization,  -  is the number of antenna elements in second dimension with same polarization, |

* + - Option 3: The extension of beam steering approach with dual-cluster beams as specified in B.2.3B.4A of TS 36.101 to apply for L beams (Samsung)

|  |
| --- |
| **Beam steering model proposed by Samsung**     * beam index * ， relative power of the l beam compared to first beam * , total power scaling factor   For simplicity, the power of beams can be fixed as equivalent to first beams then beam steering model can as follow |

* Recommended WF
  + For Rel-15 Type II codebook test:
    - Configure only two beams in beam steering model for Rel-15 Type II codebook test.
  + For specifying beam steering model into specification:
    - Reuse the agreement from Rel-16 eMIMO demod.

**Issue 3-3-8: Implementation of Random type II PMI**

* Proposals
  + Proposal 1: A common way of doing random PMI for Type II codebook simulation might need to be agreed in order to reach sufficient randomization and meanwhile avoid uncertainty and unexpected results brought by infinite random parameters. (Huawei)
    - One possible way for random Type II PMI from Huawei
      * Step 1: Random beam combination selection: Randomly select a beam combination from a set which include all possible beam combinations;
      * Step 2: Randomize weighting coefficient: For each weighting coefficient, independently and randomly chose an amplitude quantization gear and a phase quantization gear. To at least ensure one of the weighting coefficients is quantized as the highest grade, phase quantization is 0 gear and its position at 2L is randomly generated.
      * Note: The set is limited due to the limitation of quantization gears.
* Recommended WF
  + Encourage feedback from companies.

### Sub-topic 3-4: MU-MIMO Type II PMI test parameters

**Issue 3-4-1: Test metric for MU-MIMO Type II PMI**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *Test metric*
    - *Option 1: TP ratio between following PMI and random PMI*
    - *Option 2: TP ratio between following Type II codebook and following SP Type I codebook*
    - *Other options are not precluded*
* Proposals
  + Option 2: TP ratio between following Type II codebook and following SP Type I codebook (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-2: Codebook construction for MU-MIMO Type II PMI**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *codebook construction*
    - *Option 1: 32Tx ports (N1, N2) = (4,4), (O1, O2) = (4,4)*
    - *Other options are not precluded*
* Proposals
  + Option 1: 32Tx ports (N1, N2) = (4,4), (O1, O2) = (4,4) (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-3: Npsk (phaseAlphabetSize) for MU-MIMO Type II PMI**

* *Agreement in RAN4 #95e (R4-2008846, WF)*
  + *Npsk (phaseAlphabetSize)* 
    - *Option 1: 8*
    - *Other options are not precluded*
* Proposals
  + Option 1: 8 (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-4: L for MU-MIMO Type II PMI**

* Proposals
  + Option 1: 4 (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-5: SubbandAmplitude for MU-MIMO Type II PMI**

* Proposals
  + Option 1: true (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-6: Subband size for MU-MIMO Type II PMI**

* Proposals
  + Option 1: 4 for FDD and 8 for TDD (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-7: Channel model for MU-MIMO Type II PMI**

* Proposals
  + Option 1: TDLC300-5 (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-8: Impairment model for MU-MIMO Type II PMI**

* Proposals
  + Option 1: Not introducing impairment model (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-9: Rank and MCS for MU-MIMO Type II PMI**

* Proposals
  + Option 1: Rank 1 MCS7 (Ericsson)
* Recommended WF
  + TBA

**Issue 3-4-10: ZF-precoding model for MU-MIMO Type II PMI**

* Proposals
  + Option 1: (Xa, Xb) = (PMIa, PMIb) as the zero-forcing method (Ericsson)
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Sub-topic 3-1: Type I PMI test**  Issue 3-1-1: Gamma (gain) values  **Sub-topic 3-2: Type II PMI test setup**  Issue 3-2-1: Test setup for type II  **Sub-topic 3-3: SU-MIMO Type II PMI test parameters**  Issue 3-3-1: Type II codebook construction  Issue 3-3-2: Npsk (phaseAlphabetSize) for type II codebook construction  Issue 3-3-3: subbandAmplitude for type II codebook construction  Issue 3-3-4: PMI-FormatIndicator for type II codebook  Issue 3-3-5: MIMO correlation for type II codebook  Issue 3-3-6: MIMO correlation for type II codebook  Issue 3-3-7: Beam steering model for Type II Codebook  Issue 3-3-8: Implementation of random type II PMI  **Sub-topic 3-4: MU-MIMO Type II PMI test parameters**  Issue 3-4-1: Test metric for MU-MIMO Type II PMI  Issue 3-4-2: Codebook construction for MU-MIMO Type II PMI  Issue 3-4-3: Npsk (phaseAlphabetSize) for MU-MIMO Type II PMI  Issue 3-4-4: L for MU-MIMO Type II PMI  Issue 3-4-5: SubbandAmplitude for MU-MIMO Type II PMI  Issue 3-4-6: Subband size for MU-MIMO Type II PMI  Issue 3-4-7: Channel model for MU-MIMO Type II PMI  Issue 3-4-8: Impairment model for MU-MIMO Type II PMI  Issue 3-4-9: Rank and MCS for MU-MIMO Type II PMI  Issue 3-4-10: ZF-precoding model for MU-MIMO Type II PMI |
| Huawei, HiSilicon | Issue 3-1-1: Prefer option 1 for 16Tx and 32 Tx.  Issue 3-2-1: Agree with recommended WF to avoid duplicate discussion.  Issue 3-3-1: Agree with recommended WF.  Issue 3-3-2: It has been observed in our simulation results that the gain brought by seting *Npsk* = 8 is limited as a maximum 0.4dB. But if other companies insist on option 2, we are fine to compromise.  Issue 3-3-3: Prefer option1. It has been observed in our simulation results that the gain brought by seting *SubbandAmplitude* = True is limited as a maximum 0.16dB, which can be negligible.  Issue 3.3-4: It has been observed in our simulation results that the gain brought by subband is limited as a maximum 0.6dB. According to the UE capability parameters codebookParameters clarified in TS 38.306: Parameters for type II codebook (type2) supported by the UE, which are optional: the “amplitudeScalingType indicates the amplitude scaling type supported by the UE (wideband or both wideband and sub-band);”. This is to say that wideband should be supported if UE supports Type II codebook while subband can be optional. Thus, using wideband for testing can cover more UEs.  Issue 3-3-5: As SNR differences between configurations are more obvious when using XP medium, we slightly prefer option 2.  Issue 3-3-6: Agree with recommended WF.  Issue 3-3-7: Agree with recommended WF.  Issue 3-3-8: Companies can further discuss the need for a common way of doing random PMI for simulation results alignment.  Issue 3-4-1: We prefer option 2. Option 1 has potential impact (degradation) on UE using advanced receiver in testing.  Issue 3-4-2: We propose another option of 16Tx ports (N1, N2)= (4,2), (O1,O2) = (4,4) to at least reduce the test complexity and to cover more UEs.  Issue 3-4-10: We propose another option of (Xa, Xb) = (PMIa, fixed PMIb) to reduce the test complexity. |
|  |  |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2011014, Huawei, CR on Applicability | Company A |
| Company B |
|  |
| R4-2011367, Ericsson, CR on tests, FRCs, correlation matrices | Company A |
| Company B |
|  |

Note: To save time on typing the comments one by one, companies can also directly revise the draft CR and upload the revision in the draft inbox.

## 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”* |

# Topic #4: UE power imbalance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2009582 | China Telecom | On FR1 intra-band contiguous CA:  **Proposal 1:** It is feasible to define bandwidth agnostic requirements for power imbalance test.  **Proposal 2:** If there is no CBW combination with the same BWs in each carrier, the carrier with the smaller CBW will be used for test.  **Proposal 3:** Reuse the following applicability rule from LTE CA power imbalance test:   * For FDD or TDD CA power imbalance tests, if they are tested with FDD or TDD intra-band contiguous CA configurations with 2 DL CCs, the test coverage can be considered fulfilled with FDD or TDD intra-band contiguous CA configurations with 3 or more DL CCs supported by the UE. * For FDD or TDD 2 DL CCs, only test the supported intra-band contiguous CA configurations covering the lowest and highest operating bands.   **Observation 1:** Based on our simulation results, 100% relative throughput can be achieved for 1T2R with MCS 27 and 1T4R with MCS 28.  **Proposal 4:** Use MCS 27 for 2Rx and MCS 28 for 4Rx.  On FR1 intra-band contiguous and non-contiguous EN-DC:  **Proposal 5:** For the CBW combination for defining performance requirements, we propose to reuse the agreement from FR1 intra-band contiguous CA.  **Proposal 6:** For EN-DC, to select the CBW combination for testing, use the following approach modified based on the CA approach:   * Step 1: First select the CBW combinations with the same BWs in each carrier   + If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers~~, and the carrier with smaller CBW will be used for test~~. * Step 2: Among the CBW combinations selected from step 1, select the CBW combinations where the NR carrier has smaller CBW than the LTE carrier; if no such CBW combination, directly go to step 3. * Step 3: Among the CBW combinations selected from step 2, select the CA combination with largest aggregated CBW   **Proposal 7:** For the other test parameters and applicability rules, if not explicitly discussed, reuse the same agreements from CA power imbalance test. |
| R4-2010102 | CMCC | Proposal 1 : Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations.  Proposal 2: If there is no CBW combinations with the same BWs in each carrier, the carrier with smaller CBW will be used for test.  Proposal 3: All PDSCH RBs of both CCs are allocated.  Proposal 4: We prefer to use Test #2b: LTE TDD + NR TDD 30 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 15 kHz.  Proposal 5: We support to use Option1: TDD pattern DSU+DD for 15kHz SCS (if needed).  Proposal 6: Option2 is slightly preferred, and whether to consider “ interBandContiguousMRDC” can be discussed based on further input:   * UE supports only intra-band contiguous EN-DC, i,e., if UE does not indicate “intraBandENDC-Support”,   + power imbalance requirement for intra-band contiguous EN-DC is applied * UE supports only intra-band non-contiguous EN-DC, i.e., if UE indicates “non-contiguous” in “intraBandENDC-Support”   + power imbalance requirement for intra-band non-contiguous EN-DC is applied * UE supports both intra-band contiguous and non-contiguous EN-DC, i.e., if UE indicates “both” in “intraBandENDC-Support”   + power imbalance requirement for FR1 intra-band contiguous EN-DC   Proposal 7: It is proposed to allocate the test RBs on NR carrier for intra-band non-contiguous EN-DC.  Proposal 8: A test design for intra-band non-contiguous CA is proposed:   * Step 1: First select the CBW combinations with the same BWs between LTE carrier (single carrier or aggregated carriers) and NR carrier   + If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers.     - If frequency range of NR carrier is higher than LTE carrier, then the test RBs will be allocated on the highest part of NR carrier.     - If frequency range of NR carrier is lower than LTE carrier, then the test RBs will be allocated on the lowest part of NR carrier. * Step 2: Among the CBW combinations selected from step 1, select the CA combination with largest aggregated CBW. |
| R4-2011025 | Huawei, HiSilicon | FR1 intra-band contiguous CA:  Proposal 1: Define the requirements as bandwidth agnostic way (full PDSCH RB allocation) with following test approach:   * Step 1: First select the CBW combinations with the same BWs in each carrier * If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers, and the carrier with smaller CBW will be used for test. * Step 2: Among the CBW combinations selected from step 1, select the CA combination with largest aggregated CBW   Proposal 2: Use 3dB of margin (Simulating at 16dB), highest MCS with 64QAM.  For intra-band contiguous EN-DC:  Proposal 3: For TDD, use SCS 30 kHz.  Proposal 4: For test applicability rules, use option 1.  Proposal 5: Define the requirements as bandwidth agnostic way (full PDSCH RB allocation) with following test approach:   * + Step 1: First select the CBW combinations with the same BWs in each carrier     - If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers and the CBW of NR carrier must be smaller than LTE carrier.   + Step 2: Among the CBW combinations selected from step 1, select the CA combination with largest aggregated CBW |
| R4-2009733 | Intel Corporation | Proposal 1: For NR CA power imbalance test, use carrier with smallest CBW for testing in scenarios with different CBWs for selected CBW combination.  Proposal 2: Use 64QAM with MCS 27 for 2 Rx and 64QAM with MCS 28 for 4 Rx for NR CA power imbalance requirements.  Proposal 3: Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations for NR CA power imbalance requirements.  Proposal 4: Use the following testing rule for intra band contiguous EN-DC requirements:   * Test #1: LTE FDD + NR FDD 15 kHz * Test #2:   + Option 1: LTE TDD + NR TDD 15 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 30 kHz   + Option 2: LTE TDD + NR TDD 30 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 15 kHz   Proposal 5: Use DDDSU TDD UL/DL pattern for 15 kHz SCS  Proposal 6: Do not consider *interBandContiguousMRDC* capability as a part of test applicability rule for EN-DC power imbalance requirements. |
| R4-2011040 | NTT DOCOMO, INC. | draft CR: Addition of FR1 EN-DC power imbalance requirements. |
| R4-2011045 | NTT DOCOMO, INC. | Proposal 1: Regarding power imbalance test for intra-band contiguous EN-DC, the following test parameters should be applied.   |  |  | | --- | --- | | Parameters | Value | | Reference testing point | 85% of maximum throughput | | PDSCH DMRS configurations | DMRS type: Type 1  Number of additional DMRS: 1 (i.e., 1+1) | | Transmission rank | Rank 1 | | MCS | Same value as FR1 intra-band contiguous NR CA | | Max number of HARQ transmission | 1 (RV = {0}) | | Precoding configuration | SP Type I, Random per slot with PRB bundling granularity | | PRB bundling size | WB |   Proposal 2: Reuse the test designs, i.e. channel bandwidth combination for defining performance requirements and testing, from NR CA requirements to define intra-band contiguous EN-DC requirements  Proposal 3: Introduce test applicability rules (option 1) according to UE capability as follows:   * UE supports only intra-band contiguous EN-DC, i,e., if UE does not indicate “intraBandENDC-Support”   + power imbalance requirement for intra-band contiguous EN-DC is applied * UE supports only intra-band non-contiguous EN-DC, i.e., if UE indicates “non-contiguous” in “intraBandENDC-Support” or UE does not indicate “interBandContiguousMRDC”   + power imbalance requirement for intra-band non-contiguous EN-DC is applied * UE supports both intra-band contiguous and non-contiguous EN-DC, i.e., if UE indicates “both” in “intraBandENDC-Support” or UE indicates “interBandContiguousMRDC”   + power imbalance requirement for FR1 intra-band contiguous EN-DC   Observation 1: Most of the intra-band non-contiguous EN-DC combinations have the configuration with same BWs. If the same method, i.e. channel bandwidth combination for testing of intra-band CA, is applied for intra-band non-contiguous EN-DC, Rx images can be properly observed in NR channel bandwidth in most of test cases.  Observation 2: The frequency range of NR channel bandwidth applied during the test is not so different from test to test since the NR channel bandwidth for testing is basically not larger than 20MHz. Thus, we consider that it is feasible to define bandwidth agnostic requirements.  Proposal 4. Reuse the test designs, i.e. channel bandwidth combination for defining performance requirements and testing, from NR CA requirements to define intra-band non-contiguous EN-DC requirements is baseline. |
| R4-2011438 | Qualcomm Incorporated | Proposal 1: Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations by choosing the same bandwidth for both the carriers.  Proposal 2: Use full RB PDSCH allocation for defining FR1 intra-band contiguous CA power imbalance tests with both carriers having same bandwidth.  Observation 1: Requirement SNR for 64QAM MCS25 is very close to 19dB, as desired for power imbalance test cases.  Observation 2: As CBW changes, requirement SNR does not change significantly for 64QAM MCS25, Rank1.  Proposal 3: Use 64QAM MCS25, Rank1 to define the power imbalance requirements.  Proposal 4: It is feasible to define bandwidth agnostic requirements for generic methodology of selecting CBW combinations.  Proposal 5: Define TDD EN-DC power imbalance requirements for only 30kHz SCS. |

## Open issues summary

### Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA

**Issue 4-1-1: Channel bandwidth combination for defining performance requirements**

* *Agreement in RAN4 #95e (R4-2008848, WF)*
  + *Option 2: Define requirements for 5+5 MHz bandwidth for FDD+FDD CA, 10+10 MHz bandwidth for TDD+TDD CA, with the following test applicability*
    - *Option 2a*
      * *The test is done for any one of the supported bandwidth combination, by using performance requirement for 5+5 MHz FDD+FDD CA or 10+10 MHz TDD+TDD CA.*
      * *The tested PRBs shall be placed in the lowest part for the CC with lower carrier frequency, and placed in the highest part for the CC with higher carrier frequency.*
    - *Option 2b*
      * *The test is done for any one of the supported bandwidth combination, by using performance requirement for 5+5 MHz FDD+FDD CA or 10+10 MHz TDD+TDD CA.*
      * *The tested PRBs shall be placed in the highest part for the CC with lower carrier frequency, and placed in the lowest part for the CC with higher carrier frequency.*
      * *Select the CA combination with largest bandwidth, and select the CA configuration with the same BWs in each carrier for power imbalance test*
      * *If there is no supported CA configuration with the same BWs, additional power imbalance test can be considered if necessary.*
      * *Note that from 38.101-1, we can observe that most of the CA combinations have the configuration with same BWs, except CA\_n71B and CA\_n78B.*
  + *Option 3: Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations*
  + *RAN4 uses option 3 if it is feasible to define bandwidth agnostic requirements for option 3.*
* Proposals
  + Option 3: Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations, and define bandwidth agnostic requirements (CTC, CMCC, HW, Intel, QC)
    - Intel: From our results, PDSCH performance difference for difference CBW/SCS combinations is within the 0.5 dB range.
    - QC: Based on our simulation results, as CBW changes, requirement SNR does not change significantly for 64QAM MCS25, Rank1.
* Recommended WF
  + Agree the above option 3, i.e., define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations, and define bandwidth agnostic requirements

**Issue 4-1-2: Channel bandwidth combination for testing**

* *Agreement in RAN4 #95e (R4-2008848, WF)*
  + *As baseline, use the following approach*
    - *Step 1: First select the CBW combinations with the same BWs in each carrier*
      * *If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers, and the carrier with [larger or smaller] CBW will be used for test.*
    - *Step 2: Among the CBW combinations selected from step 1, select the CA combination with largest aggregated CBW*
  + *Following topic will be discussed further*
    - *In step 1, if there is no CBW combinations with the same BWs in each carrier, whether the carrier with larger or smaller CBW will be used for test?*
* Proposals
  + Option 1: In step 1, if there is no CBW combination with the same BWs in each carrier, the carrier with the smaller CBW will be used for test. (CTC, CMCC, HW, Intel)
* Recommended WF
  + Agree option 1

**Issue 4-1-3: PDSCH RB allocation**

* *Agreement in RAN4 #95e (R4-2008848, WF)*
  + *To be decided after the channel bandwidth combination is agreed*
* Proposals
  + Option 1: Full RB allocation (CMCC, HW, QC)
* Recommended WF
  + Agree option 1

**Issue 4-1-4: MCS**

* *Agreement in RAN4 #95e (R4-2008848, WF)*
  + *FFS whether to use 64QAM or 256QAM based on more simulation results for 1x2 and 1x4*
  + *Assumptions related to the target SNR point for simulation*
    - *Power difference between two CCs*
      * *6dB*
    - *Impairment margin + extra margin*
      * *Option 1: 3dB*
      * *Option 2: lower than 3dB*
* Proposals
  + Modulation order
    - Option 1: 64QAM for 2Rx and 4Rx (CTC, Intel, HW, QC)
  + MCS
    - Option 1: MCS 27 for 2Rx, MCS 28 for 4Rx (CTC, Intel)
      * CTC: 100% relative throughput can be achieved for 1T2R with MCS 27 and 1T4R with MCS 28.
      * Intel: SNR operating point for MCS27 for 2 RX and MCS 28 for 4 Rx is around 19 dB.
    - Option 2: MCS 28 for 2Rx and 4Rx (HW)
      * HW: even if the margin of 3dB has been considered and SNR is set to 16dB, the relative throughput is still 100% with the highest MCS.
    - Option 3: MCS 25 for 2Rx (QC)
      * QC: Requirement SNR for 64QAM MCS25 is very close to 19dB.
* Recommended WF
  + Modulation order: 64QAM for 2Rx and 4Rx
  + MCS: with different simulation results from companies, different proposals are given. Encourage further checking on the simulation results during the meeting.

**Issue 4-1-5: Other test applicability aspects**

* Proposals
  + Proposal 1: Reuse the following applicability rule from LTE CA power imbalance test (CTC)
    - For FDD or TDD CA power imbalance tests, if they are tested with FDD or TDD intra-band contiguous CA configurations with 2 DL CCs, the test coverage can be considered fulfilled with FDD or TDD intra-band contiguous CA configurations with 3 or more DL CCs supported by the UE.
    - For FDD or TDD 2 DL CCs, only test the supported intra-band contiguous CA configurations covering the lowest and highest operating bands.
* Recommended WF
  + Encourage feedback on the above proposal 1.

### Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC

**Issue 4-2-1: Tested carrier**

* Proposals
  + Option 1: Allocate the test RBs on NR carrier (CMCC, aligned with the WID in RP-200472)
* Recommended WF
  + Confirm the above option 1, which is aligned with the WID.

**Issue 4-2-2: Channel bandwidth combination for defining performance requirements**

* Proposals
  + Option 1: Reuse the agreement from FR1 intra-band contiguous CA (CTC, HW, DCM)
* Recommended WF
  + Can we agree option 1?

**Issue 4-2-3: Channel bandwidth combination for testing**

* Proposals
  + Option 1 (CTC)
    - Step 1: First select the CBW combinations with the same BWs in each carrier
      * If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers.
    - Step 2: Among the CBW combinations selected from step 1, select the CBW combinations where the NR carrier has smaller CBW than the LTE carrier; if no such CBW combination, directly go to step 3.
    - Step 3: Among the CBW combinations selected from step 2, select the CA combination with largest aggregated CBW
  + Option 2 (CMCC)
    - Step 1: First select the CBW combinations with the same BWs between LTE carrier (single carrier or aggregated carriers) and NR carrier
      * If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers.
        + If frequency range of NR carrier is higher than LTE carrier, then the test RBs will be allocated on the highest part of NR carrier.
        + If frequency range of NR carrier is lower than LTE carrier, then the test RBs will be allocated on the lowest part of NR carrier.
    - Step 2: Among the CBW combinations selected from step 1, select the CA combination with largest aggregated CBW.
  + Option 3 (HW)
    - Step 1: First select the CBW combinations with the same BWs in each carrier
      * If there is no such CBW combination, select the CBW combinations with smallest CBW difference between the two carriers and the CBW of NR carrier must be smaller than LTE carrier.
    - Step 2: Among the CBW combinations selected from step 1, select the CA combination with largest aggregated CBW
  + Option 4: Reuse the agreement from FR1 intra-band contiguous CA (DCM)
* **Moderator’s observation**
  + In general, all companies suggest to reuse the agreement from FR1 CA as much as possible.
  + Compared to FR1 CA, the main difference for EN-DC is that: only the NR carrier is tested, so we cannot directly choose the carrier with smaller CBW for testing, and some adjustment is needed.
* Recommended WF
  + In the 1st round, encourage feedback on the above options.
  + In the 2nd round, aim to agree one baseline approach.

**Issue 4-2-4: SCS**

* *Agreement in RAN4 #95e (R4-2008848, WF)*
  + *FDD: 15kHz*
  + *TDD:*
    - *Option 1: 30kHz*
    - *Option 2: 15kHz and 30kHz*
      * *Test #2a: LTE TDD + NR TDD 15 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 30 kHz*
      * *Test #2b: LTE TDD + NR TDD 30 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 15 kHz*
* Proposals on SCS for TDD
  + Option 1: 30kHz (HW, QC)
  + Option 2: 15kHz and 30kHz (CMCC, Intel)
    - Test #2a: LTE TDD + NR TDD 15 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 30 kHz (Intel)
    - Test #2b: LTE TDD + NR TDD 30 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 15 kHz (CMCC, Intel)
      * CMCC: For TDD, since NR spectrum (e.g. band n41) has relative larger bandwidth, it is more suitable to use 30KHz SCS for NR TDD and the LTE TDD + NR TDD 30 kHz case is more common.
* Recommended WF
  + Further discuss and down-select one of the two options in this meeting.
  + If option 2 is adopted, use Test #2b.

**Issue 4-2-5: TDD pattern**

* *Agreement in RAN4 #95e (R4-2008848, WF)*
  + *TDD pattern for 30kHz SCS*
    - *7D1S2U*
  + *TDD pattern for 15kHz SCS (if needed)*
    - *Option 1: DSU+DD*
    - *Other options are not precluded.*
* Proposals on TDD pattern for 15kHz SCS (if needed)
  + Option 1: DSU+DD (CMCC)
    - CMCC: The LTE TDD configuration DSUDD is widely used in LTE deployment.
  + Option 2: DDDSU (Intel)
* Recommended WF
  + Encourage more feedback

**Issue 4-2-6: Test applicability and special inter-band EN-DC**

* *Agreement in RAN4 #95e (R4-2008848, WF)*
  + *Option 1*
    - *UE supports only intra-band contiguous EN-DC, i,e., if UE does not indicate “intraBandENDC-Support”,* 
      * *power imbalance requirement for intra-band contiguous EN-DC is applied*
    - *UE supports only intra-band non-contiguous EN-DC, i.e., if UE indicates “non-contiguous” in “intraBandENDC-Support” or UE does not indicate “interBandContiguousMRDC”,* 
      * *power imbalance requirement for intra-band non-contiguous EN-DC is applied*
    - *UE supports both intra-band contiguous and non-contiguous EN-DC, i.e., if UE indicates “both” in “intraBandENDC-Support” or UE indicates “interBandContiguousMRDC”,* 
      * *power imbalance requirement for FR1 intra-band contiguous EN-DC*
  + *Option 2* 
    - *UE supports only intra-band contiguous EN-DC, i,e., if UE does not indicate “intraBandENDC-Support”,* 
      * *power imbalance requirement for intra-band contiguous EN-DC is applied*
    - *UE supports only intra-band non-contiguous EN-DC, i.e., if UE indicates “non-contiguous” in “intraBandENDC-Support”* 
      * *power imbalance requirement for intra-band non-contiguous EN-DC is applied*
    - *UE supports both intra-band contiguous and non-contiguous EN-DC, i.e., if UE indicates “both” in “intraBandENDC-Support”* 
      * *power imbalance requirement for FR1 intra-band contiguous EN-DC*
  + *Other options are not precluded.*
* Proposals
  + Select Option 1 (HW, DCM)
    - HW: RAN4 agreed that some inter-band EN-DC combinations like B42-n77 are treated as "intra-band EN-DC".
    - DCM: some inter-band EN-DC combinations such as B42 (3400-3600MHz) and n77 (3300-4200MHz) are treated as "intra-band EN-DC” since these LTE and NR frequency bands are fully overlapped in frequency range. By introducing intra-band EN-DC requirements based on WID, the same requirements should be applied to the special inter-bands.
  + Select Option 2 (CMCC, Intel)
    - CMCC: Option 2 is slightly preferred, and whether to consider “ interBandContiguousMRDC” can be discussed based on further input.
    - Intel: inter-band (NG)EN-DC/NE-DC combination is out of scope of this work item.
* Recommended WF
  + Encourage more discussion on:
    - Is it common understanding RAN4 agreed that some inter-band EN-DC combinations like B42-n77 are treated as "intra-band EN-DC"? If yes, is it feasible to go with option 1?

**Issue 4-2-7: Other test parameters**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *Generally ok to reuse simulation assumptions from NR CA requirements to define EN-DC requirements with power imbalance for the following parameters: PDSCH configuration, PDCCH allocation, antenna configuration and propagation conditions.*
* Proposals
  + Proposal 1: For the other test parameters and applicability rules, if not explicitly discussed, reuse the same agreements from CA power imbalance test. (CTC)
  + Proposal 2: the following test parameters should be applied for EN-DC (DCM, aligned with the agreed parameters for NR CA)

|  |  |
| --- | --- |
| Parameters | Value |
| Reference testing point | 85% of maximum throughput |
| PDSCH DMRS configurations | DMRS type: Type 1  Number of additional DMRS: 1 (i.e., 1+1) |
| Transmission rank | Rank 1 |
| MCS | Same value as FR1 intra-band contiguous NR CA |
| Max number of HARQ transmission | 1 (RV = {0}) |
| Precoding configuration | SP Type I, Random per slot with PRB bundling granularity |
| PRB bundling size | WB |

* Recommended WF
  + Can we agree both proposal 1 and proposal 2?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA**  Issue 4-1-1: Channel bandwidth combination for defining performance requirements  Issue 4-1-2: Channel bandwidth combination for testing  Issue 4-1-3: PDSCH RB allocation  Issue 4-1-4: MCS  Issue 4-1-5: Other test applicability aspects  **Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC**  Issue 4-2-1: Tested carrier  Issue 4-2-2: Channel bandwidth combination for defining performance requirements  Issue 4-2-3: Channel bandwidth combination for testing  Issue 4-2-4: SCS  Issue 4-2-5: TDD pattern  Issue 4-2-6: Test applicability and special inter-band EN-DC  Issue 4-2-7: Other test parameters |
| Company B | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA**  Issue 4-1-1: Channel bandwidth combination for defining performance requirements  Issue 4-1-2: Channel bandwidth combination for testing  Issue 4-1-3: PDSCH RB allocation  Issue 4-1-4: MCS  Issue 4-1-5: Other test applicability aspects  **Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC**  Issue 4-2-1: Tested carrier  Issue 4-2-2: Channel bandwidth combination for defining performance requirements  Issue 4-2-3: Channel bandwidth combination for testing  Issue 4-2-4: SCS  Issue 4-2-5: TDD pattern  Issue 4-2-6: Test applicability and special inter-band EN-DC  Issue 4-2-7: Other test parameters |
| Huawei, HiSilicon | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA**  Issue 4-1-1: Channel bandwidth combination for defining performance requirements  OK with recommended WF  Issue 4-1-2: Channel bandwidth combination for testing  OK with recommended WF  Issue 4-1-3: PDSCH RB allocation  OK with recommended WF  Issue 4-1-4: MCS  We support option 1  We update our simulation results as follows:  Ideal simulation results   |  |  |  | | --- | --- | --- | | MCS | 27 | 28 | | 1T2R | 15.48 | 17.48 | | 1T4R | 12.62 | 14.57 |   With 3dB margin, the impairment simulation results are shown as follows:  Impairment simulation results   |  |  |  | | --- | --- | --- | | MCS | 27 | 28 | | 1T2R | 18.48 | 20.48 | | 1T4R | 15.62 | 17.57 |   From the simulation results, for 1T2R, SNR operating point for MCS27 is close to 19dB and for 1T4R, SNR operating point for MCS28 is close to 19dB.  We support MCS 27 for 2Rx and MCS 28 for 4Rx  Issue 4-1-5: Other test applicability aspects  Proposal 1 is OK for us.  **Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC**  Issue 4-2-1: Tested carrier  OK with option 1.  Issue 4-2-2: Channel bandwidth combination for defining performance requirements  OK with recommended WF  Issue 4-2-3: Channel bandwidth combination for testing  Compared to CA, the difference is the NR carrier under test should be no larger than LTE carrier. Updated option 3 is as following:   * + - Step 1: First select the CBW combinations with the same BWs in each carrier. If there is no such CBW combination, go to Step 1a and Step 1b, otherwise Step 2.       * Step 1a: Select the CBW combinations that the BW of NR carrier is smaller than the BW of LTE carrier       * Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between the two carriers     - Step 2: Among the CBW combinations selected from Step 1, select the CA combination with the largest aggregated CBW   For Option 1, maybe the selected CBW combinations with the smallest CBW difference between the two carriers don’t include the combinations that NR carrier is smaller than LTE carrier, so we should firstly ensure the selected CBW combinations that the BW of NR carrier is smaller than that of LTE.  Issue 4-2-4: SCS  Still prefer 30kHz SCS only for TDD.  Issue 4-2-5: TDD pattern  We support 7D1S2U for 30kHz and no need for 15kHz SCS  Issue 4-2-6: Test applicability and special inter-band EN-DC  Both Option 1 and Option 2 are ok for us.  Issue 4-2-7: Other test parameters  OK with proposal 1 and proposal 2 if no further technical issues will be figured out. |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2011040, EN-DC power imbalance requirements, DCM | Company A |
| Company B |
|  |

Note: To save time on typing the comments one by one, companies can also directly revise the draft CR and upload the revision in the draft inbox.

## 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”* |

# Topic #5: NR CA CQI reporting requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2009583 | China Telecom | Proposal 1: For the performance requirements, use option 1, i.e., to reuse the duplex mode and SCS combination of PDSCH normal CA requirements.  Proposal 2: For the test applicability, test 2 of the 3 cases below, and FFS on the detailed applicability rule:   * + Test #1: FDD 15 kHz + FDD 15 kHz   + Test #2: FDD 15 kHz + TDD 30 kHz, in case UE supports different SCS on different carriers for FDD-TDD CA, otherwise FDD 15 kHz + TDD 15 kHz   + Test #3: TDD 30 kHz + TDD 30 kHz, in case UE supports it, otherwise TDD 15 kHz + TDD 30 kHz   Proposal 3: Define CA CQI performance requirements in a bandwidth agnostic way.  Proposal 4: For the applicability rule, use option 1 to align with the applicability for LTE CA CQI test, i.e.,   * For each agreed duplex mode and SCS combination for testing:   + CA capability where the tests apply: Test any of one of the supported CA capabilities with largest aggregated CA bandwidth combination   + CA configuration from the selected CA capability where the tests apply: Test any one of the supported CA configurations with largest aggregated CA bandwidth combination   Observation 1: The two options on TDD pattern for 120 kHz SCS have no impact on CQI reporting performance. If option 1 of 3D1S1U is used, some parameters such as CQI reporting delay need to be further discussed.  Proposal 5: For the TDD pattern for 120kHz SCS, either option 1 or option 2 is ok for us, and option 2 of 2D1S1U is slightly preferred.  Proposal 6: For the SNR configuration for 2DL CA CQI test, use SNRPcell = 10dB and SNRScell = 4dB.  Proposal 7: For the SNR configuration for 3 or more DL CA CQI test, use SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB.  Proposal 8: For the delta CQI for 2 or more DL CA CQI test, use thr = 2. |
| R4-2010483 | Ericsson | Proposal 1: For CA CQI reporting test, define the test cases with:   * FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS * FR2: TDD + TDD with 120 kHz SCS   Proposal 2: Configure 2D1S1U with S=11:3:0 for TDD SCS=120kHz.  Proposal 3: Set antenna configuration as follows:   * FR1: 2T2R and 2T4R * FR2: 2T2R   Proposal 4: For FR1 CA CQI tests, set   * SNRPcell = 16dB and SNRScell = 10dB * SNRPcell = 18dB, SNRScell1 = 12dB, SNRScell2, 3,… = 6dB * thr = 2 for 2 or more DL CA ​   Proposal 5: For FR2 CA CQI tests, set   * SNRPcell = 14dB and SNRScell = 8dB * SNRPcell = 16dB, SNRScell1 = 10dB, SNRScell2, 3,… = 4dB * thr = 2 for 2 or more DL CA ​   Proposal 6: For 4Rx requirements, confirm to reduce the signal power density by 3dB compared to 2Rx. |
| R4-2011026 | Huawei, HiSilicon | *Proposal 1: Use Duplex mode and SCS combinations as following:*   * FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS * FR2: TDD + TDD with 120 kHz SCS   *Proposal 2: Define the CA CQI performance requirements in bandwidth way and reuse the test applicability rule of LTE approach.*  *Proposal 3: Use DDDSU as TDD pattern for 120 kHz SCS*  *Proposal 4: General principle*   * + *Following the methodology used in LTE, the difference between the wideband CQI indices of Pcell and the first Scell as well as the difference between the wideband CQI indices of the first Scell and the other Scell(s) (if any) shall be not smaller than a threshold, for more than 90% of the time*   *SNR configuration for 2DL CA CQI test*   * + *SNRPcell = 10dB and SNRScell = 4dB*   *SNR configuration for 3 or more DL CA CQI test*   * + *Option 1: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB*   *Delta CQI threshold for CA CQI test*   * + *thr = 2* |
| R4-2011395 | Qualcomm Incorporated | Proposal 1: Define the CA CQI requirements for following cases:   * FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS * FR2: TDD + TDD with 120 kHz SCS   Proposal 2: For defining FR2 CA CQI requirements, use DDSU (S = 11D+3G) TDD Pattern and CSI reporting periodicity of 8 slots.  Proposal 3: Define CA CQI reporting requirements with the following configuration:   * SNR configuration for 2DL CA CQI test: SNRPcell = 10dB and SNRScell = 4dB. * SNR configuration for 3 or more DL CA CQI test: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB. * Delta CQI threshold for CA CQI test = 2 for 2 or more DL CA.   Proposal 4: For 4Rx requirements, reduce the SNRs by 3dB compared to that for 2Rx. |

## Open issues summary

### Sub-topic 5-1: Duplex mode and SCS combinations

**Issue 5-1: Duplex mode and SCS combinations**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *For the performance requirements:* 
    - *Option 1: Reuse the combinations from PDSCH normal*
    - *Option 2:*
      * *FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS*
      * *FR2: TDD + TDD with 120 kHz SCS*
  + *Applicability rule if option 1 for the performance requirements is agreed:*
    - *Option 1: Test 2 of the 3 cases below, and FFS on the detailed applicability rule:*
      * *Test #1: FDD 15 kHz + FDD 15 kHz*
      * *Test #2: FDD 15 kHz + TDD 30 kHz, in case UE supports different SCS on different carriers for FDD-TDD CA, otherwise FDD 15 kHz + TDD 15 kHz*
      * *Test #3: TDD 30 kHz + TDD 30 kHz, in case UE supports it, otherwise TDD 15 kHz + TDD 30 kHz*
    - *Other options are not precluded*
* Proposals
  + For the performance requirements:
    - Option 1: Reuse the duplex mode and SCS combination of PDSCH normal CA requirements (CTC)
      * CTC: At least FDD-TDD CA is also one of the typical CA scenarios which need to be covered. Otherwise, if one UE only supports FDD-TDD CA, there will be no requirements for the UE.
    - Option 2: (Ericsson, Huawei, Qualcomm)
      * FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS
      * FR2: TDD + TDD with 120 kHz SCS
* Ericsson: The difference between option 1 and option 2 is TDD with SCS=15kHz is included in FR1 (Option 1) or not (Option 2). Since the CQI definition test uses static channel, we don’t expect the performance difference between TDD SCS=15kHz and TDD SCS=30kHz.
  + For the applicability rule:
    - Option 1: If option 1 for the performance requirement is agreed, Test 2 of the 3 cases below, and FFS on the detailed applicability rule (CTC)
      * Test #1: FDD 15 kHz + FDD 15 kHz
      * Test #2: FDD 15 kHz + TDD 30 kHz, in case UE supports different SCS on different carriers for FDD-TDD CA, otherwise FDD 15 kHz + TDD 15 kHz
      * Test #3: TDD 30 kHz + TDD 30 kHz, in case UE supports it, otherwise TDD 15 kHz + TDD 30 kHz
* CTC: As a compromised solution, we propose to test 2 of the 3 cases, which means the test case number is not increased and all typical CA scenarios are covered at the same time.
* Recommended WF
  + TBA based on further discussion.

### Sub-topic 5-2: Channel bandwidth and test applicability rule

**Issue 5-2: Channel bandwidth and test applicability rule**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *Decide in the next meeting on whether it is feasible to define CA CQI performance requirements in a bandwidth agnostic way.*
  + *For the applicability rule:*
    - *Option 1:*
      * *For each agreed duplex mode and SCS combination for testing:*
* *CA capability where the tests apply: Test any of one of the supported CA capabilities with largest aggregated CA bandwidth combination*
* *CA configuration from the selected CA capability where the tests apply: Test any one of the supported CA configurations with largest aggregated CA bandwidth combination*
* Proposals
  + Is it feasible to define CA CQI performance requirements in a bandwidth agnostic way:
    - Option 1: Yes (CTC, Huawei)
  + For the test applicability rule:
    - Option 1 (CTC, Huawei)
      * For each agreed duplex mode and SCS combination for testing:
* CA capability where the tests apply: Test any of one of the supported CA capabilities with largest aggregated CA bandwidth combination
* CA configuration from the selected CA capability where the tests apply: Test any one of the supported CA configurations with largest aggregated CA bandwidth combination
* Recommended WF
  + Define CA CQI performance requirements in a bandwidth agnostic way.
  + Agree with option 1 for the test applicability rule.

### Sub-topic 5-3: TDD UL-DL pattern

**Issue 5-3: TDD UL-DL pattern for 120 kHz SCS**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *TDD pattern* 
    - *For 120kHz SCS*
      * *Option 1: 3D1S1U with S=10:2:2*
      * *Option 2: 2D1S1U with S=11:3:0*
* Proposals
  + Option 1: 3D1S1U with S=10:2:2 (Huawei, CTC)
    - Huawei: 3D1S1U is the most typical pattern. UL PUSCH performance requirements only consider DDDSU pattern for 120 kHz SCS.
  + Option 2: 2D1S1U with S=11:3:0 (CTC, Ericsson, Qualcomm)
    - CTC: Slightly prefer option 2. The two options on TDD pattern for 120 kHz SCS have no impact on CQI reporting performance. If option 1 of 3D1S1U is used, some parameters such as CQI reporting delay need to be further discussed
    - Ericsson: Option 2 is used for single carrier CQI reporting test and therefore we can reuse the scheduling configuration for CA CQI reporting tests. We are also fine to configure DDDSU if there is more benefit than the reuse of scheduling configuration.
    - Qualcomm: In 38.101-4, all the existing FR2 CQI requirements are defined with TDD pattern DDSU.
* Recommended WF
  + Can we go with option 2 based on majority’s view?

### Sub-topic 5-4: Antenna configuration

**Issue 5-4-1: Antenna configuration for 2Rx and 4Rx test**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *1T2R and 1T4R*
* Proposals
  + Option 1: Keep the previous agreement
  + Option 2: 2T2R and 2T4R for FR1, and 2T2R for FR2 (Ericsson)
    - Ericsson: single carrier CQI reporting test (TS38.101-4 6.2.2/6.2.3 For FR1 and TS38.101-4 8.2.2.2.1 for FR2), antenna configuration is **2T**2R and **2T**4R for FR1 and **2T**2R for FR2, instead of 1Tx
* Recommended WF
  + Can we keep the previous meeting, and further clarify that only 1T2R is applied to FR2?

**Issue 5-4-2: Signal power density for 2Rx and 4Rx bands**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *Option 1: For 4Rx requirements, reduce the signal power density by 3dB compared to that for 2Rx*
  + *Use Option 1 as baseline, and it can be confirmed in the next RAN4 meeting if no technical concern will be observed.*
* Proposals
  + Confirm the baseline agreed in the last meeting (Ericsson, Qualcomm)
* Recommended WF
  + Confirm the baseline agreed in the last meeting, i.e., for 4Rx requirements, reduce the signal power density by 3dB compared to that for 2Rx

### Sub-topic 5-5: Test metric

**Issue 5-5-1: SNR configuration for 2DL CA CQI test**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *Option 1: SNRPcell = 10dB and SNRScell = 4dB*
  + *Other options are not precluded*
  + *Make decision in the next meeting*
* Proposals
  + For FR1
    - Option 1: SNRPcell = 10dB and SNRScell = 4dB (CTC, Huawei, Qualcomm)
    - Option 2: SNRPcell = 16dB and SNRScell = 10dB (Ericsson)
      * Ericsson: Since RAN4 has agreed to use CQI table 2 for FR1, we think SNRPcell = 10dB and SNRScell = 4dB are low considering the NR single carrier CQI test requirements.
  + For FR2
    - Option 1: SNRPcell = 10dB and SNRScell = 4dB (CTC, Huawei, Qualcomm)
    - Option 2: SNRPcell = 14dB and SNRScell = 8dB (Ericsson)
      * Ericsson: Based on the single carrier result and considering the achievable SNR levels over-the-air, we propose to set higher SNR test point for Pcell such as 14-16dB.
* Recommended WF
  + TBA

**Issue 5-5-2: SNR configuration for 3DL CA CQI test**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *Option 1: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB*
  + *Other options are not precluded*
  + *Make decision in the next meeting*
* Proposals
  + For FR1
    - Option 1: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB (CTC, Huawei, Qualcomm)
    - Option 2: SNRPcell = 18dB, SNRScell1 = 12dB, SNRScell2, 3,… = 6dB (Ericsson)
  + For FR2
    - Option 1: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB (CTC, Huawei, Qualcomm)
    - Option 2: SNRPcell = 16dB, SNRScell1 = 10dB, SNRScell2, 3,… = 4dB (Ericsson)
* Recommended WF
  + TBA

**Issue 5-5-3: Delta CQI threshold**

* *Agreement in RAN4 #95e (R4-2008849, WF)*
  + *Option 1: thr = 2 for 2 or more DL CA*
  + *Other options are not precluded*
  + *Make decision in the next meeting*
* Proposals
  + Option 1: *thr* = 2 for 2 or more DL CA in FR1 and FR2 (CTC, Ericsson, Huawei, Qualcomm)
* Recommended WF
  + Agree with option 1

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Sub-topic 5-1: Duplex mode and SCS combinations**  Issue 5-1: Duplex mode and SCS combinations **Sub-topic 5-2: Channel bandwidth and test applicability rule** Issue 5-2: Channel bandwidth and test applicability rule **Sub-topic 5-3: TDD UL-DL pattern**  Issue 5-3: TDD UL-DL pattern for 120 kHz SCS **Sub-topic 5-4: Antenna configuration**  Issue 5-4-1: Antenna configuration for 2Rx and 4Rx test  Issue 5-4-2: Signal power density for 2Rx and 4Rx bands **Sub-topic 5-5: Test metric**  Issue 5-5-1: SNR configuration for 2DL CA CQI test  Issue 5-5-2: SNR configuration for 3DL CA CQI test  Issue 5-5-3: Delta CQI threshold |
| Huawei, HiSilicon | **Sub-topic 5-1: Duplex mode and SCS combinations**  Issue 5-1: Duplex mode and SCS combinations  We support Option 2. **Sub-topic 5-2: Channel bandwidth and test applicability rule** Issue 5-2: Channel bandwidth and test applicability rule  OK with recommended WF **Sub-topic 5-3: TDD UL-DL pattern**  Issue 5-3: TDD UL-DL pattern for 120 kHz SCS  We support Option 1 considering that it is more typical pattern for FR2 deployment. But we can compromise Option 2 by following majority’s view. **Sub-topic 5-4: Antenna configuration**  Issue 5-4-1: Antenna configuration for 2Rx and 4Rx test  We support Option 1 to keep the previous agreement.  Issue 5-4-2: Signal power density for 2Rx and 4Rx bands  OK with recommended WF. **Sub-topic 5-5: Test metric**  Issue 5-5-1: SNR configuration for 2DL CA CQI test  We support Option 1  Issue 5-5-2: SNR configuration for 3DL CA CQI test  We support Option 1.  Issue 5-5-3: Delta CQI threshold  OK with recommended WF. |
|  |  |

## 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*

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| --- | --- | --- |
|  | **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*

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| **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”* |