**3GPP TSG-RAN WG4 Meeting #95-e R4-200xxxx**

**Electronic Meeting, 25 May - 5 June, 2020**

**Agenda item:** 6.18.1

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [95e][323] NR\_perf\_enh\_Demod\_UE

**Document for:** Information

# Introduction

This email thread discusses the NR Rel-16 UE performance requirements in agenda 6.18.1.

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, 5.3 and 6.3.
* 2nd round: TBA

# Topic #1: General issue for UE requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2006036 | China Telecom | Updated CR work split for NR performance requirement enhancement WI |
| R4-2007220 | Huawei, HiSilicon | Proposal 1: PMI reporting test for Rel-15 type II codebook can be release independent from Release 15.  Proposal 2:   * Rel-15 UE: there is a mature mechanism to ensure that only UEs compliant with related conformance requirements can indicate supporting the respective capabilities * Rel-16 UE: if needed, UE capability and test applicability rule can be introduced to indicate support a feature or not, but no additional features/capabilities shall be introduced to inform gNB that UE can fulfil the respective requirements. |

## Open issues summary

### Sub-topic 1-1: Updated CR work split

**Issue 1-1: Updated CR work split**

* Proposal (China Telecom, R4-2006036)
  + Based on the approved CR work split in R4-1915864, the CR responsibilities for UE CA CQI and power imbalance requirements have been added in the updated version in R4-2006036.
* Recommended WF
  + Approve the updated CR work split in R4-2006036.

### Sub-topic 1-2: Release independent issue

**Issue 1-2-1: Release independent issue for type II PMI**

* *Agreement in RAN4 #94e-bis (R4-2005545, 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*
  + *CA CQI reporting requirements*
    - *Delay the discussion after RAN4 decides the specific test scopes for CA CQI reporting requirements*
* Proposals
  + PMI reporting requirements for Rel-15 type II codebook
    - Option 1: Release independent from Rel-15 (Huawei)
* Recommended WF
  + Taking into account companies’ views in the recent two meetings, can we agree with option 1?

**Issue 1-2-2: Requirements applicability rule / additional capabilities**

* *Agreement in RAN4 #94e-bis (R4-2005545, WF)*
  + *For all topics under NR performance requirement enhancement WI*
    - *Whether requirements applicability needs to be defined*
      * *Option 1: In general, Rel-15 UEs are already expected to support the respective features but the performance may not be guaranteed. In case the requirements are defined from Rel-15 it is important to ensure a mechanism that only UEs compliant with the newly defined conformance requirements can indicate the respective capabilities. In case the requirements are defined from Rel-16, additional features/capabilities shall be introduced to inform gNB that UE can fulfill the respective requirements.*
      * *Option 2: Define test applicability rule if needed, no additional features/capabilities needs to be defined*
* Proposals
  + Option 1 (Huawei)
    - Rel-15 UE: there is a mature mechanism to ensure that only UEs compliant with related conformance requirements can indicate supporting the respective capabilities
    - Rel-16 UE: if needed, UE capability and test applicability rule can be introduced to indicate support a feature or not, but no additional features/capabilities shall be introduced to inform gNB that UE can fulfil the respective requirements.
* Moderator’s observation
  + This is a general issue related to all the features which are introduced in Rel-15 but the requirements are defined in Rel-16.
* Recommended WF
  + Encourage companies to provide:
    - Views on the above options
    - Whether to discuss this issue in each individual WI, or alternatively, discuss together as a common issue in UE feature list thread.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Issue 1-1: Updated CR work split  Issue 1-2-1: Release independent issue for type II PMI  Issue 1-2-2: Requirements applicability rule / additional capabilities |
| Company B | Issue 1-1: Updated CR work split  Issue 1-2-1: Release independent issue for type II PMI  Issue 1-2-2: Requirements applicability rule / additional capabilities |
|  |  |
|  |  |

## 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** |
| R4-2006037 | China Telecom | TDD-FDD CA and TDD-TDD CA with different SCSs  **Proposal 1:** For performance requirement definition:   * For CA with different SCSs, define requirements for both 15kHz Pcell and 30kHz Pcell. * For FDD + TDD CA with 15 kHz SCS, define requirements for both FDD 15 kHz Pcell and TDD 15 kHz Pcell, or alternatively, only for TDD 15 kHz Pcell.   **Proposal 2:** Select option 2 for the test applicability, i.e.,   * Option 2: If Pcell in both carriers are supported, configure TDD cell as Pcell in TDD-FDD CA, configure 15 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA. (scenarios with larger number of HARQ processes)   **Proposal 3:** For HARQ process for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CA,   * With 12 HARQ processes, both options on the scheduling details are ok. * Considering that the K3 values are different for the two options, discuss whether to define the K3 values in TS 38.101-4 for CA PDSCH demodulation requirements.   **Proposal 4:** For HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CA, both option are ok, and option 1 is slightly preferred.  Test applicability  **Proposal 5:** Reuse the LTE approach for CA capability categorization, 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:** 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 and CRs  **Proposal 8:** Decide the requirement values in this meeting, and agree the CRs in the next meeting. |
| R4-2006530 | Intel Corporation | Proposal 1: Define TDD-FDD CA and TDD-TDD CA with different SCSs for all PCell configurations (i.e. both FDD Pcell and TDD Pcell; both 15kHz Pcell and 30kHz Pcell) and test UE for any one PCell configuration.  Proposal 2: Consider the following HARQ process configuration for TDD-TDD CA with different SCSs:   * PCell TDD 15kHz + SCell TDD 30kHz: PCell – 8, SCell – 12 (same RTT for all HARQ processes) * PCell TDD 30kHz + SCell TDD 15kHz: PCell – 8, SCell – 8   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. |
| R4-2006531 | Intel Corporation | Summary of Normal CA simulation results (FR2) |
| R4-2006628 | Qualcomm Incorporated | Simulation Results for NR CA PDSCH Demodulation Performance Tests |
| R4-2006629 | 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 FDD cell as PCell in TDD-FDD CA, configure 30 kHz SCS cell as PCell in TDD 15kHz+30kHz SCS CA. |
| R4-2006808 | CMCC | Observation 1: There is no UE capability to indicate support of TDD PCell or FDD PCell  Observation 2: There is UE capability to indicate the support of SCS for each DL in a CA band combination.  Proposal 1: It is proposed that:   * For FDD 15 kHz + TDD 30 kHz: Configure TDD 30KHz as PCell * For FDD 15KHz + TDD 15KHz: Configure TDD 30KHz as PCell * For TDD 15KHz + TDD 30KHz: Configure TDD 15KHz 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. |
| R4-2007139 | NTT DOCOMO, INC. | Proposal 1: The following options should be supported for Pcell configuration for TDD-FDD CA and TDD CA with different SCSs  Pcell configuration for performance requirements  • (Option 3) Decide after conclusion on “Pcell configuration for the test” will be reached  Pcell configuration for the test  – (Option 5) If Pcell in both carriers are supported, both FDD and TDD cell should be tested as Pcell for TDD-FDD CA and configure 30 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA  Proposal 2: 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. |
| R4-2007221 | Huawei, HiSilicon | Observation 1: From the Figure 2.1.1-1 shown above, 6 HARQ processes are feasible for SCell TDD 15kHz SCS.  Observation 2: From the Figure 8 from R4-2000359 shown above, 6 HARQ processes for SCell TDD 15kHz are analysed.  Observation 3: From Figure 2-2 from R4-2001419 shown above, 6 HARQ processes for SCell TDD 15kHz are analyzed.  Proposal 1: No scheduling restriction should be imposed on the initial transmission and retransmission on the type of TDD slots.  Proposal 2: Not use UL symbols in special slot for HARQ-ACK feedback in PUCCH.  Proposal 3: Adopt 6 HARQ processes for SCell TDD 15kHz for TDD 30kHz + 15kHz CA with TDD 30kHz PCell.  Proposal 4: Use the following number of HARQ process and K1 values for CA with different duplex mode or mixed numerology:  Table 2.1-2: Number of HARQ process and K1 value for CA with different duplex mode or mixed numerology   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Scenario | PCell | Number of HARQ process for PCell | K1 for PCell | SCell | Number of HARQ process for SCell | K1 for SCell | | FDD 15kHz SCS + TDD 30kHz SCS | FDD 15kHz | 4 | 2 | TDD 30kHz | 8 | {2} | | TDD 30kHz | 8 | {8,7,6,5,5,4,3,2} | FDD 15kHz | 8 | {7,6,4,11,9,7,6,4} | | FDD 15kHz SCS + TDD 15kHz SCS | FDD 15kHz | 4 | {2} | TDD 15kHz | 4 | {2} | | TDD 15kHz | 8 | {4,3,2,6,5} | FDD 15kHz | 8 | {4,3,2,6} | | TDD 15kHz SCS + TDD 30kHz SCS | TDD 15kHz | 8 | {4,3,2,6} | TDD 30kHz | 12 | {4,4,3,3,2,2,6,6} | | TDD 30kHz | 8 | {8,7,6,5,5,4,3,2} | TDD 15kHz | 6 | {7,5,4,11} | |
| R4-2007222 | Huawei, HiSilicon | Observation 1: The performance requirements can be defined agnostic to the specific PCell or SCell.  Observation 2: No essential difference for Option 1 and Option 2 for CA capability categorizing if specification reference method is used and CA capability definition is not combined with test of different CA capabilities.  Proposal 1: Adopt Option 4, i.e. If PCell in both carriers are supported, configure FDD 15kHz cell as PCell in FDD 15kHz + TDD 15kHz CA, configure 30kHz SCS cell as PCell in both FDD 15kHz + TDD 30kHz CA and TDD 15kHz + TDD 30kHz CA.  Proposal 2: Choose Option 1, i.e. test intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with the largest number of bands for test of different CA capabilities.  Proposal 3: 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     - 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     - Select any one of the supported CA configurations with the largest number of bands aggregated |
| R4-2007223 | Huawei, HiSilicon | draftCR for NR FR1 PDSCH CA normal demodulation requirements with 4Rx. |

## Open issues summary

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

**Issue 2-1: Pcell configuration for TDD-FDD CA and TDD-TDD CA with different SCSs**

* *Agreement in RAN4 #94e-bis (R4-2005546, WF)*
  + *Pcell configuration for performance requirements*
    - *Option 1: Reuse single carrier performance for CA, and no matter which cell is Pcell for the requirements.*
    - *Option 2:* 
      * *For CA with different SCSs, define requirements for both 15kHz Pcell and 30kHz Pcell.*
      * *For FDD + TDD CA with 15 kHz SCS, define requirements for both FDD 15 kHz Pcell and TDD 15 kHz Pcell*
    - *Option 3: Decide after conclusion on “Pcell configuration for the test” will be reached*
  + *Pcell configuration for the test*
    - *Option 1: The test coverage can be considered fulfilled if UE passes one of scenario with one of the CC as PCell as per the real testing request*
    - *Option 2: If Pcell in both carriers are supported, configure TDD cell as Pcell in TDD-FDD CA, configure 15 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA. (scenarios with larger number of HARQ processes)*
    - *Option 3: If Pcell in both carriers are supported, configure FDD cell as Pcell in TDD-FDD CA, configure 30 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA. (scenarios with less number of HARQ processes)*
    - *Option 4: If PCell in both carriers are supported, configure FDD 15kHz cell as PCell in FDD 15kHz + TDD 15kHz CA, configure 30kHz SCS cell as PCell in both FDD 15kHz + TDD 30kHz CA and TDD 15kHz + TDD 30kHz CA*
    - *Option 5: If Pcell in both carriers are supported, both FDD and TDD cell should be tested as Pcell for TDD-FDD CA and configure 30 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA*
    - *Note: Companies are encouraged to check if there are UE capability signalling which allows to check*

**Issue 2-1-1: Pcell configuration for performance requirements**

* Summary of understanding on Rel-15 UE capability signalling
  + View #1 (China Telecom, Huawei)
    - For CA with different SCSs, different capabilities are defined for Pcell on larger SCS (i.e., *diffNumerologyWithinPUCCH- GroupLargerSCS*) and Pcell on smaller SCS (i.e., *diffNumerologyWithinPUCCH-GroupSmallerSCS*), where Pcell is the cell carrying PUCCH.
    - For FDD + TDD CA with 15 kHz SCS, there is no UE capability defined for TDD Pcell and FDD Pcell.
  + View #2 (CMCC)
    - There is no UE capability to indicate support of TDD PCell or FDD PCell.
    - There is UE capability to indicate the support of SCS for each DL in a CA band combination, i.e. *supportedSubCarrierSpacingDL*.
  + View #3 (Intel)
    - There is no UE capability on support of TDD PCell or FDD PCell and 15 kHz PCell or 30 kHz PCell.
* Proposals
  + Option 1: Reuse single carrier performance for CA, and no matter which cell is Pcell for the requirements.
  + Option 2 (CTC, Intel)
    - For CA with different SCSs, define requirements for both 15kHz Pcell and 30kHz Pcell.
    - For FDD + TDD CA with 15 kHz SCS, define requirements for both FDD 15 kHz Pcell and TDD 15 kHz Pcell
  + Option 3: Decide after conclusion on “Pcell configuration for the test” will be reached (DCM)
* Recommended WF
  + It looks that the 3 options are not conflicting with each other. Given that the same single carrier performance is reused, and the Pcell for testing is discussed separately, can we agree with option 2 as baseline?

**Issue 2-1-2: Pcell configuration for the test**

* Proposals
  + Option 1: The test coverage can be considered fulfilled if UE passes one of scenario with one of the CC as PCell as per the real testing request (Intel)
  + Option 2: If Pcell in both carriers are supported, configure TDD cell as Pcell in TDD-FDD CA, configure 15 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA. (scenarios with larger number of HARQ processes). (CTC, CMCC)
  + Option 3: If Pcell in both carriers are supported, configure FDD cell as Pcell in TDD-FDD CA, configure 30 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA. (scenarios with less number of HARQ processes) (QC)
  + Option 4: If PCell in both carriers are supported, configure FDD 15kHz cell as PCell in FDD 15kHz + TDD 15kHz CA, configure 30kHz SCS cell as PCell in both FDD 15kHz + TDD 30kHz CA and TDD 15kHz + TDD 30kHz CA (HW)
  + Option 5: If Pcell in both carriers are supported, both FDD and TDD cell should be tested as Pcell for TDD-FDD CA and configure 30 kHz SCS cell as Pcell in TDD 15+30kHz SCS CA (DCM)
* Moderator’s observations
  + The main difference due to different Pcell configurations is the HARQ process number. So the question is: if the test is conducted for one of the Pcell configurations, can we guarantee the demodulation performance for the other Pcell configuration?
  + Not sure if it is feasible to select the Pcell based on the real deployment scenarios, since the deployment scenario can be different for different operators. Even for one operator, the Pcell configuration can be different in different cities and scenarios, and can also change with the time.
* Recommended WF
  + Given 5 different options are proposed, encourage companies to re-consider their positions: in addition to the favourite option, are there any other options also acceptable?
  + Aim to 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 #94e-bis (R4-2005546, 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 | | | |

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

* Proposals
  + Down-selection of the options
    - 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. (CTC, 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 (CTC, Intel, HW)
      * Huawei, Intel: Based on our simulations, there is no performance difference in case initial transmission and retransmission are scheduled in the same or different type of slots
  + Additional issue: Is it necessary to differentiate the two options in TS 38.101-4?
    - China Telecom: Considering that the K3 values are different for the two options, discuss whether to define the K3 values (DL NACK to DL re-tx grant) in TS 38.101-4 for CA PDSCH demodulation requirements.
* Recommended WF
  + Down-selection of the options
    - Allow more time for simulation, and make decision in the next meeting
    - In the next meeting, if no simulation results show there is performance impact by scheduling the initial transmission and retransmission in different types of slots, then option 2 will be selected.
  + Encourage feedback on whether it is necessary to differentiate the two options in TS 38.101-4.

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

* Proposals
  + Option 1: 6 (CTC, HW)
  + Option 2: 8 (CTC, Intel, QC)
    - CTC: 8 HARQ process is slightly preferred, since the same HARQ process number for 15 kHz SCell is used as when it is configured as Pcell.
    - QC: Initial transmission and retransmission should happen on the same type of slot. Otherwise, it will degrade the HARQ performance.
* Recommended WF
  + Can we go with option 2?

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

* Proposals
  + Option 1 (Huawei)

|  |  |  |  |
| --- | --- | --- | --- |
| 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} |

* Recommended WF
  + Encourage feedback on the above option 1

### Sub-topic 2-3: Simulation results and performance requirements

**Issue 2-3-1: Performance requirements for FR1**

* Summary (submitted in RAN4 #94e-bis)
  + R4-2004554 Summary of Normal CA simulation results (FR1 15 kHz FDD and TDD)
  + R4-2004555 Summary of Normal CA simulation results (FR1 30 kHz TDD)
* Observations
  + 5 companies provided alignment and impairment simulation results for all the cases.
  + Both alignment and impairment simulation results are well aligned, with the span less than 2dB.
  + No company updated the simulation results in this meeting
* Recommended WF
  + Agree the proposed requirements in R4-2004554 and R4-2004555

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

* Summary
  + R4-2006531 Summary of Normal CA simulation results (FR2) (to be uploaded)
* Observations
  + Alignment simulation results: 5 companies provided results, which are well aligned.
  + Impairment simulation results: 2 companies (Intel, CTC) provided results in the last meeting, and 1 company (QC) provided results in this meeting.
* Recommended WF
  + If Huawei and Ericsson will provide impairment simulation results in this meeting, discuss the requirement values in this meeting;
  + If not, discuss and decide the requirement values in the next meeting.

### Sub-topic 2-4: CA capabilities, Selection of CA configuration(s) and CBW combination

**Issue 2-4: CA capabilities, Selection of CA configuration(s) and CBW combination**

* Moderators’ observations
  + Based on the tdocs submitted to RAN4 #95e, due to the short time for tdoc preparation, companies’ positions and arguments for the test applicability rule on different CA capabilities, selection of CA configuration(s) and CBW combination are generally the same as that in RAN4 #94e-bis.
* Recommended WF
  + For the test applicability rule on different CA capabilities, selection of CA configuration(s) and CBW combination
    - Further discuss and make decision in the next meeting.

### Sub-topic 2-5: Plan for CRs

**Issue 2-5: Plan for CRs**

* *Agreed CR work split for CA normal PDSCH*

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  | **CR Responsibility** |
| CA normal demodulation for NR CA, EN-DC, NE-DC, NR-DC | FR1 | Applicability | Intel |
| 2Rx requirements | CMCC |
| 4Rx requirements | Huawei |
| FRC | Intel |
| FR2 | Applicability | Intel |
| 2Rx requirements | Qualcomm |
| FRC | Intel |

* + In this meeting, Huawei provided draft CR for NR FR1 requirements with 4Rx.
* Recommended WF
  + Endorse the draft CR for NR FR1 requirements with 4Rx in this meeting
    - Encourage companies to provide comments for this draft CR in section 2.3.2.
  + Endorse all others CRs on requirements and FRCs in RAN4 #96e (Aug) meeting
    - For CMCC and QC’s CRs, align the structure with Huawei’s draft CR
  + Agree all the CRs for CA normal PDSCH together (including CRs requirements, FRCs and test applicability rules) in RAN4 #97e (Oct-Nov) meeting

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Issue 2-1: Pcell configuration for TDD-FDD CA and TDD-TDD CA with different SCSs  Issue 2-1-1: Pcell configuration for performance requirements  Issue 2-1-2: Pcell configuration for the test  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: Simulation results and performance requirements  Issue 2-3-1: Performance requirements for FR1  Issue 2-3-2: Performance requirements for FR2  Issue 2-4: CA capabilities, Selection of CA configuration(s) and CBW combination  Issue 2-5: Plan for CRs |
| Company B | Issue 2-1: Pcell configuration for TDD-FDD CA and TDD-TDD CA with different SCSs  Issue 2-1-1: Pcell configuration for performance requirements  Issue 2-1-2: Pcell configuration for the test  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: Simulation results and performance requirements  Issue 2-3-1: Performance requirements for FR1  Issue 2-3-2: Performance requirements for FR2  Issue 2-4: CA capabilities, Selection of CA configuration(s) and CBW combination  Issue 2-5: Plan for CRs |
|  |  |
|  |  |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2007223, Huawei, HiSilicon | 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 #3: UE PMI reporting requirements with larger number of Tx ports

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2006038 | China Telecom | For type I PMI:  Proposal 1:Concerning whether to introduce subband PMI requirements for 16 Tx ports, encourage companies to consider compromised proposals so as to make decision in this meeting.  Proposal 2: For 32 Tx wideband, set gamma (gain) values as 5.0 and 8.0 for 2Rx and 4Rx respectively.  For type II PMI:  Proposal 3: Use SU-MIMO test setup.  Proposal 4: Use 16Tx ports with (N1,N2) = (4,2), (O1, O2) = (4,4) to reduce the test complexity.  Proposal 5: For beam steering model, ok with either option 2 or option 3. |
| R4-2006318 | Samsung | Proposal 1: Define the PMI requirement of Rel-15 type II codebook construction as   * phaseAlphabeSize: Npsk= 4 * subbandAmpltitude: false * PMI-FormatIndicator: Wideband |
| R4-2006615 | Qualcomm Incorporated | Simulation results for Type I PMI  Proposal 1: Define subband Type -I PMI reporting requirements for 16 Tx ports.  Proposal 2: Use SU-MIMO test setup for defining Type II PMI reporting tests.  Proposal 3: Use subband PMI reporting for defining Type II PMI reporting tests.  Proposal 4: Define Type II PMI reporting requirements with N\_PSK = 8 and subbandAmplitude = true  Proposal 5: Define Type II PMI reporting requirements for only 16Tx ports.  Proposal 6: Define Type II PMI reporting requirements for XP High MIMO correlation.  Proposal 7: Discuss extension of beam steering approach to more than 2 clusters under eMIMO WI and use the 2 cluster beam steering approach from 36.101 for defining Type II PMI reporting requirements under NR performance enhancement WI. |
| R4-2007201 | Huawei, HiSilicon | Simulation results |
| R4-2007202 | Huawei, HiSilicon | Proposal 1:Prefer to use SU-MIMO for test setup  Proposal 2: Prefer only introduce 16 Tx ports requirements for Type II codebook  Proposal 3: Use (N1, N2) = (4, 2) and (O1, O2) = (4, 4) for 16 Tx ports  Proposal 4: Prefer to use equation listed in the last slide of the Way forward as beam steering model  Proposal 5: 4 for Npsk  Proposal 6: False for SubbandAmplitude  Proposal 7: Wideband for PMI-FormatIndicator |
| R4-2007203 | Huawei, HiSilicon | Proposal 1: Not to define Subband PMI requirements for 16Tx ports and covers 16 Tx port requirements with Wideband |
| R4-2007927 | Ericsson | Simulation results.  Observation 1: PMI reporting throughput curves do not differ between wideband and Subband PMI reporting.  Proposal 1: From a test coverage point of view, we think introducing subband PMI for 16Tx ports can be agreeable. |
| R4-2007928 | Ericsson | Summary of simulation results of NR UE CSI PMI with 16, and 32Tx antennas |
| R4-2007934 | Ericsson | Proposal 1: Use Equation 1 as beam steering model for Type II codebook performance requirements.  Observation 1: Gain metric Follow Type II PMI over Random Type II PMI does not verify that L number of beams are transmitted for MU-MIMO support.  Observation 2: there is marginal gain when comparing SP Type I with Type II codebook with the current SU-MIMO based test setup.  Observation 3: Gain test metric γ by following Type II PMI over SP Type I PMI does see marginal gain for few channel models and channel correlations.  Proposal 2: Design Type II tests to ensure UE CSI reporting with substantially better performance than Type I reporting for MU-MIMO, in line with the big performance benefits shown in RAN1 evaluations.  Proposal 3: If RAN4 agree to use multi-user scheduling for type-II PMI reporting test, RAN4 study further how to derive precoder based on the type-II PMI feedback from UE under test.  Proposal 4: Test parameters for Type II codebook may need to be tuned to properly suit MU-MIMO based test setup proposed. |
| R4-2007934  (Not available) | Ericsson |  |

## Open issues summary

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

**Issue 3-1-1: Whether to introduce subband PMI test for type I single-panel codebook**

* *Agreement in RAN4 #94e-bis (R4-2005549, WF)*
  + *PMI requirements for 16 Tx ports (decision in RAN4#95-e)*
    - *Option 1: Introduce subband PMI requirements for 16 Tx ports as baseline*
    - *Option 2: Not introduce subband PMI requirements for 16Tx ports and covers 16Tx port requirements with wideband PMI*
* Proposals
  + Option 1: Introduce subband PMI requirements for 16 Tx ports as baseline (Qualcomm, Ericsson)
  + Option 2: Not introduce subband PMI requirements for 16Tx ports and covers 16Tx port requirements with wideband PMI (Huawei)
* Recommended WF
  + Since it has been agreed to make decision in RAN4 #95-e, encourage companies to consider if one of the following compromised solutions is acceptable, and any other possible compromised solution are welcome:
    - Solution A: Define subband PMI requirement for type I 16Tx, and wideband PMI requirement for type II
      * Use TDLC300-5 channel for type I 16Tx subband
    - Solution B: Define wideband PMI requirement for type I 16Tx, and subband PMI requirement for type II
      * Use TDLA30-5 channel for type I 16Tx wideband

**Issue 3-1-2: Gamma (gain) values for Type I PMI test**

* *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 #94e-bis (R4-2005549, WF)*
    - *Set gamma (gain) values based on simulation results in RAN4#95-e*
* Summary of simulation results
  + R4-2007928, Summary of simulation results of NR UE CSI with 16, and 32Tx antennas
* Proposals on Gamma (gain) values
  + For 32 Tx wideband:
    - Option 1: 5.0 for 2Rx, 8.0 for 4Rx (CTC)
  + For 16 Tx wideband/subband:
    - FFS
* Recommended WF
  + For 32 Tx wideband:
    - Encourage companies to provide feedback on the above option 1.
  + For 16 Tx wideband/subband:
    - Discuss after issue 3-1-1 is addressed

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

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

* *Agreement in RAN4 #94e-bis (R4-2005549, WF)*
  + *Test setup:*
    - *Option 1: Use SU-MIMO test setup as baseline scenario*
    - *Option 2: MU-MIMO based test setup*
* Proposals
  + Option 1: Only use SU-MIMO test setup (CTC, Qualcomm, Huawei)
    - CTC: 1) UE processing will not be different if we change the test setup from SU-MIMO to MU-MIMO. 2) Practical MU-MIMO scenario is hard to be reflected in the test. 3) We will need to re-design many test parameters if MU-MIMO is agreed.
    - QC: RAN4 is discussing to define minimum requirements for UE and UE implementation is unaware of whether it is SU-MIMO setup or MU-MIMO setup.
    - Huawei: There is a similar scenario in the WI of LTE eFD-MIMO that MU-MIMO setup had been well discussed and finally not happened to the requirements.
  + Option 2: MU-MIMO based test setup (Ericsson)
    - Design Type II tests to ensure UE CSI reporting with substantially better performance than Type I reporting for MU-MIMO, in line with the big performance benefits shown in RAN1 evaluations.
    - If RAN4 agree to use multi-user scheduling for type-II PMI reporting test, RAN4 study further how to derive precoder based on the type-II PMI feedback from UE under test.
    - Test parameters for Type II codebook may need to be tuned to properly suit MU-MIMO based test setup proposed.
* Recommended WF
  + Taking into account the discussions in the recent two meetings, can we go with option 1?

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

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

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

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Duplex Mode | MIMO Correlation | NPSK | subbandAmplitude | PMI-FormatIndicator | SNR point @90%TP (dB) / TP ratio | | |
| Samsung | Qualcomm | Ericsson |
| FDD | XP Medium | 4 |  |  | 15.9 |  |  |
| XP Medium | 8 |  |  | 15.5 |  |  |
| XP Medium |  | False |  | 15.9 |  |  |
| XP Medium |  | True |  | 15.8 |  |  |
| XP Medium |  |  | Wideband | 16.8/3.997 |  |  |
| XP Medium |  |  | Subband | 15.9/1051.5 |  |  |
| XP High | 4 | False |  |  |  | 9.82/3.81 |
| TDD | XP Medium | 8 | True | Subband |  | 11.13/3.19 |  |
| XP High | 4 | True | Subband |  | 13.57/3.04 |  |
| XP High | 4 | False | Subband |  | 13.80/2.99 |  |
| XP High | 8 | True | Subband |  | 10.04/5.88 |  |
| XP High | 8 | False | Subband |  | 10.29/5.49 |  |

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

* *Agreement in RAN4 #94e-bis (R4-2005549, 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, Qualcomm, Huawei)
    - CTC: Ok with option 1 to reduce the test complexity.
    - QC: it was already agreed to define WB PMI test cases for 32 Tx ports, RAN4 should define subband PMI tests for 16Tx ports to have a good coverage and performance.
    - Huawei: 16 Tx ports is more typical than 32 Tx ports in practice, for it is supported by more UE and it was chosen to be defined requirements for LTE MIMO in Rel-14.
* Recommended WF
  + Select option 1

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

* *Agreement in RAN4 #94e-bis (R4-2005549, WF)*
  + *Npsk (phaseAlphabetSize)*
    - *Option 1: 4*
    - *Option 2: 8*
* Proposals
  + Option 1: 4 (Samsung, Huawei)
    - Samsung: The Type II performance have limited differences with ‘NPSK=4’ and ‘NPSK=8’
    - Huawei: QPSK is more typical and will be used much usual than 8PSK.
  + Option 2: 8 (Qualcomm)
    - QC: Based on simulation results, N\_PSK = 8 and subbandAmplitude = true provide the best throughput ratios.
* Moderator’s observation:
  + This issue has been discussed for 3 meetings.
  + 2 companies (Samsung, Qualcomm) provided simulation results from the last meeting, with different simulation observations and proposals; and no more simulation results provided in this meeting.
* Recommended WF
  + Can we make decision based on majority companies’ view after the 1st round discussion?

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

* *Agreement in RAN4 #94e-bis (R4-2005549, WF)*
  + *SubbandAmplitude*
    - *Option 1: False*
    - *Option 2: True*
* Proposals
  + Option 1: False (Samsung, Huawei)
    - Samsung: The gain is marginal if ‘SubbandAmplitude=True’ under TDL-A XP Medium correlation channel.
    - Huawei: Much more number of candidate codebooks and parameters are introduced for Random PMI when True is configured, which lead to bigger ratio than that of configuring False. Thus, we do not think configuring True for SubbandAmplitude will improve the performance.
  + Option 2: True (Qualcomm)
    - QC: Based on simulation results, N\_PSK = 8 and subbandAmplitude = true provide the best throughput ratios.
* Recommended WF
  + Similar situation as Npsk, can we make decision based on majority companies’ view after the 1st round discussion?

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

* *Agreement in RAN4 #94e-bis (R4-2005549, WF)*
  + *PMI-FormatIndicator*
    - *Option 1: Wideband*
    - *Option 2: Subband*
* Proposals
  + Option 1: Wideband (Samsung, Huawei)
    - Samsung: The corresponding TP ratio among following PMI and random PMI under sub-band PMI set-up is extremely high, which not feasible to introduce proper performance requirements.
    - Huawei: Configuring subband may result in bad performance for the throughput of Random PMI as the codebooks and parameters are significantly increased.
  + Option 2: Subband (Qualcomm)
    - QC: It makes more sense to have Subband PMI reporting for Type II codebook so that this codebook can be used to its full potential.
* Recommended WF
  + This can be discussed together with issue 3-1-1 on whether to test subband PMI for Type I codebook.
  + Regarding the issue of extremely high TP ratio for subband PMI raised by Samsung, companies are encouraged to check if this is a common issue for different simulators. If yes, potential solutions to address this issue can be discussed later, for example, use wideband random PMI as baseline.

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

* *Agreement in RAN4 #94e-bis (R4-2005549, WF)*
  + *MIMO correlation*
    - *Option 1: XP High*
    - *Option 2: XP Medium*
* Proposals
  + Option 1: XP High (Qualcomm, Huawei)
    - QC: We have defined other PMI reporting tests with XP High correlation and based on results, XP High provides better performance than XP Medium correlation.
    - Huawei: 1) XP High can achieve better performance gain between follow PMI and random PMI. 2) We have defined test cases with XP high before (in Type I codebook), and it is comparable for defining the same MIMO correlation in Type II codebook.
* Recommended WF
  + Can we agree to use option 1 as baseline?

**Issue 3-3-6: Beam steering model for Type II Codebook**

* *Agreement in RAN4 #94e-bis (R4-2005549, 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.*
    - *Option 3: Use option 1 if L = 2, and use option 2 if L > 2*

|  |
| --- |
| **Equation 1 (for information)**  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, |

* Proposals
  + Option 1: Reusing beam steering approach with dual-cluster beams as specified in B.2.3B.4A of TS 36.101 (Qualcomm)
    - QC: Propose to discuss extension of beam steering approach to more than 2 clusters under eMIMO WI.
  + Option 2: Use Equation 1 as beam steering model for Type II codebook performance requirements (CTC, Huawei, Ericsson)
    - Huawei: 1) The beam steering model should be suitable for more number of beams as introduced in Rel-15. 2) Extended beam steering model can be reused in Rel-16 NR eMIMO and easy for comparison in the future.
  + Option 3: Use option 1 if L = 2, and use option 2 if L > 2 (CTC)
* Recommended WF
  + Can we select option 2 by following majority’s view?

### 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 #94e-bis (R4-2005549, 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 1: TP ratio between following PMI and random PMI
  + Option 2: TP ratio between following Type II codebook and following SP Type I codebook
* Recommended WF
  + TBA

### Sub-topic 3-5: Plan for CRs

**Issue 3-5: Plan for CRs**

* *Agreed CR work split for PMI reporting requirements*

|  |  |  |
| --- | --- | --- |
|  |  | **CR Responsibility** |
| Tx ports larger than 8 and up to 32 | Applicability | Huawei |
| Requirements for type I single-panel codebook | Ericsson |
| Requirements for type II codebook | Samsung |
| FRC for type I single-panel codebook | Ericsson |
| FRC for type II codebook | Samsung |

* + In this meeting, Ericsson provided draft CR for type I tests, type I FRC and MIMO Correlation Matrices for 2D antenna arrays.
* Recommended WF
  + Endorse the draft CRs for type I tests, type I FRC and MIMO Correlation Matrices for 2D antenna arrays in this meeting
    - Encourage companies to provide comments for these draft CRs in section 3.3.2.
  + Endorse the draft CRs for type II and applicability in RAN4 #96e (Aug) meeting
  + Agree all the CRs for PMI reporting requirements together (including CRs for applicability, type I and type II) in RAN4 #97e (Oct-Nov) meeting

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Sub-topic 3-1: Type I PMI test**  Issue 3-1-1: Whether to introduce subband PMI test for type I single-panel codebook  Issue 3-1-2: Gamma (gain) values for Type I PMI test  **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: Beam steering model for Type II Codebook  **Sub-topic 3-4: MU-MIMO Type II PMI test parameters**  Issue 3-4-1: Test metric for MU-MIMO Type II PMI  **Sub-topic 3-5: Plan for CRs**  Issue 3-5: Plan for CRs |
| Company B | **Sub-topic 3-1: Type I PMI test**  Issue 3-1-1: Whether to introduce subband PMI test for type I single-panel codebook  Issue 3-1-2: Gamma (gain) values for Type I PMI test  **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: Beam steering model for Type II Codebook  **Sub-topic 3-4: MU-MIMO Type II PMI test parameters**  Issue 3-4-1: Test metric for MU-MIMO Type II PMI  **Sub-topic 3-5: Plan for CRs**  Issue 3-5: Plan for CRs |
|  |  |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2007924, Correlation matrices for 2D antenna arrays | Company A |
| Company B |
|  |
| R4-2007925, PMI FRC | Company A |
| Company B |
|  |
| R4-2007926, type I PMI tests | 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: TDD LTE-NR coexistence

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2006532 | Intel Corporation | CR to TS 38.101-4: CR on TDD LTE-NR coexistence requirements finalization |

## Open issues summary

No open issue.

## Companies views’ collection for 1st round

### Open issues

No open issue.

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2006532, Intel | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

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

*Suggestion on WF/LS assignment*

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

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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

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

# Topic #5: UE power imbalance requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2006039 | China Telecom | Propose 1: One candidate solution for option 3 of channel bandwidth combination:   * Decide the MCS based on the simulation results for 100MHz CBW * Apply the same MCS for the requirements for different CBW combinations * Select the CBW combination with the largest aggregated channel bandwidth for testing   Propose 2: For MIMO configuration, option 2 with 1x2 and 1x4 is preferred in order to simplify the test setup.  Propose 3: Option 1 with WB PRB bundling is slightly preferred, if it is agreed to use 1 Tx.  Observation 1: Based on our simulation results, 100% relative throughput can be achieved for 1T2R with MCS 27 and 1T4R with MCS 28.  Propose 4: Use MCS 27 for 2Rx and MCS 28 for 4Rx. |
| R4-2006533 | Intel Corporation | Proposal 1: Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations for NR CA power imbalance requirements. Consider selection of CBW combination with the largest aggregated channel bandwidth as one of candidate option.  Proposal 2: Use the following configuration for NR CA requirements with power imbalance:   * Full bandwidth allocation * PRB bundling size: WB * MIMO configuration: 1x2 and 1x4   Proposal 3: Define intra band contiguous EN-DC requirements for FDD and TDD duplex modes.  Proposal 4: Define intra band contiguous EN-DC requirements for the following NR SCS configuration:   * 15 kHz for FDD; * 15 and 30 kHz for TDD.   Proposal 5: Use the following testing rule for intra band contiguous EN-DC requirements:   * Test #1: LTE FDD + NR FDD 15 kHz * Test #2: LTE TDD + NR TDD 15 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 30 kHz   Proposal 6: Define intra band contiguous EN-DC requirements for NR TDD patterns fully aligned with LTE TDD UL/DL pattern 2 (i.e. DSU+DD for 15 kHz and 3DSU+4D for 30 kHz)  Proposal 7: Consider intra-band non-contiguous EN-DC requirements only for UE with *intraBandENDC-Support = non-contiguous.* Further discussion the details of test design to ensure that RX image rejection can be verified. |
| R4-2006809 | CMCC | *Proposal 1: It is proposed that:*   * *Define requirements for 5+5 MHz bandwidth for FDD+FDD CA, 10+10 MHz bandwidth for TDD+TDD CA, with the following test applicability*    + *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.*   *Proposal 2: Define FDD 15KHz and TDD 30KHz for intra-band contiguous EN-DC.* |
| R4-2007140 | NTT DOCOMO, INC. | Observation 1  Regarding intra-band EN-DC, three type of UEs can be considered.  1. Support only intra-band contiguous EN-DC, i,e., if UE does not indicate “intraBandENDC-Support”  2. Support only support intra-band non-contiguous EN-DC, i.e., if UE indicates “non-contiguous” in “intraBandENDC-Support  3. Support both intra-band contiguous and non-contiguous EN-DC, i.e., if UE indicates “both” in “intraBandENDC-Support”  Observation 2  Some inter-band EN-DC band combinations like DC\_B42-n78 are treated as “intra-band” EN-DC, and non-contiguous EN-DC is supported as mandatory.  Observation 3  Regarding special inter-band EN-DC like DC\_B42-n78, two type of UEs can be considered.  1. Support Oonly intra-band non-contiguous EN-DC, i,e., if UE does not indicate “interBandContiguousMRDC”  2. Support both intra-band contiguous and non-contiguous EN-DC, i,e., if UE indicates "“interBandContiguousMRDC”  Observation 4  Both contiguous EN-DC and non-contiguous EN-DC are possible scenario and some UEs only support non-contiguous EN-DC.  Observation 5  Only co-located scenario is assumed for both intra-band contiguous and non-contiguous EN-DC cases in RAN4 requirements. It derives that single RF chain is assumed to receive CCs.  Proposal 1:  15 kHz SCS for FDD and 30kHz SCS for TDD are applied to power imbalance test requirements  Proposal 2:  Introduce both contiguous and non-contiguous EN-DC requirements for power imbalance tests  Proposal 3:  Introduce test applicability rules 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”,   + apply either power imbalance requirement for FR1 intra-band contiguous EN-DC or FR1 intra-band non-contiguous EN-DC |
| R4-2007224 | Huawei, HiSilicon | Proposal 1: Updated option2: Define requirements for 5+5 MHz bandwidth for FDD+FDD CA, 10+10 MHz bandwidth for TDD+TDD CA, and the test applicability should be changed as follows:   * + - 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~~ lowest part for the CC with lower carrier frequency, and placed in the ~~lowest~~ highest part for the CC with higher carrier frequency.   Proposal 2: If choose one generic method: Select the largest channel bandwidth combination among all CBW combinations in supported CA configurations, all RBs of CC with larger bandwidth are allocated, the tested RBs are placed on the position of initial BWP of CC with smaller bandwidth and only define the performance of CC with smaller bandwidth.  Observation 1: When the SNR is 19dB for 1T4R, the normalized throughput will still be much higher than 85% even if the MCS reaches the maximum (256QAM, 948/1024). For other MIMO configurations, it is impossible to find a suitable MCS to make the normalized TP close to 85% (either 0 or 100%).  Proposal 3: Increase the power difference (larger than 6dB) between two CCs to make the SNR lower than 19dB and only define the performance requirement for Scell. To make normalized TP close to 85%, more simulation are needed to find the suitable SNR under the condition of a pre-selected MCS.  Proposal 4: Use 1x2 and 1x4 MIMO configuration.  Proposal 5: Use PRB bundling size 2 RPBs.  Proposal 6: Reuse the 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, both FDD and TDD need to be tested,use 15 kHz for FDD, 30 kHz for TDD. |
| R4-2007882 | Qualcomm Incorporated | Proposal 1: Do not define power imbalance requirements for non-contiguous intra-band EN-DC.  Proposal 2: Use MIMO configuration of 1x2 and 1x4 for defining power imbalance test cases.  Proposal 3: Use full RB PDSCH allocation for defining FR1 intra-band contiguous CA power imbalance tests with both carriers having same bandwidth. |

## Open issues summary

### Sub-topic 5-1: Requirements for FR1 intra-band contiguous CA

**Issue 5-1-1: Channel bandwidth combination for defining performance requirements**

* *Agreement in RAN4 #94e-bis (R4-2005547, 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* 
    - *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.*
  + *Option 3: Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations* 
    - *Methodology of Option 3 is to be clarified.*
* Proposals
  + 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 (HW, CMCC)
    - Test applicability for option 2:
      * 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.
    - Potential issue raised for option 2 (Intel):
      * Option 2 is mainly limited to verification of scenarios with same channel bandwidth.
      * For scenarios with different channel bandwidth on different CCs, UE may have different implementation of LO allocation, which will lead to different image level and, as result, verification for partial PRB allocation will be different in comparison to full PRB allocation.
    - **Improved solutions for option 2 to resolve the above issue:**
      * Option 2a (HW, changes are in red):
        + 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~~ lowest part for the CC with lower carrier frequency, and placed in the ~~lowest~~ highest part for the CC with higher carrier frequency.
      * Option 2b (CMCC, changes are in red):
        + 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 (Intel, QC, HW)
    - **Is it feasible to define bandwidth agnostic requirements for option 3?**
      * Yes (CTC)
        + For FR1 normal PDSCH CA simulation results in R4-2004554 and R4-2004555, based on the average impairment results from 5 companies:

For 2Rx FDD 15 kHz, the performance gap for different CBW (5-50MHz) is up to 0.8dB.

For 4Rx FDD 15 kHz, the performance gap for different CBW (5-50MHz) is up to 0.4dB.

For 2Rx TDD 30 kHz, the performance gap for different CBW (5-100MHz) is up to 1.2dB.

For 4Rx TDD 30 kHz, the performance gap for different CBW (5-100MHz) is up to 0.8dB

Rank 2 and fading channel are assumed in normal PDSCH CA test

* + - * + For power imbalance under rank 1 and AWGN channel, our simulation results in terms of relative TP for the minimal and maximal channel bandwidths for each SCS are similar.
* Recommended WF
  + In the 1st round, invite companies to provide feedback on:
    - For option 2, are the improved solutions feasible?
    - For option 3, is it feasible to define bandwidth agnostic requirements?

**Issue 5-1-2: Channel bandwidth combination for testing**

* Proposals
  + Option 1: First priority is to ensure both carriers have the same bandwidth. (QC, CMCC)
    - CMCC: 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 2: Select the CBW combination with the largest aggregated channel bandwidth (Intel, CTC, HW)
    - HW: all RBs of CC with larger bandwidth are allocated, the tested RBs are placed on the position of initial BWP of CC with smaller bandwidth and only define the performance of CC with smaller bandwidth.
* Recommended WF
  + 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

**Issue 5-1-3: PDSCH RB allocation**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *To be decided after the channel bandwidth combination is agreed*
* Proposals
  + Option 1: Full allocation (Intel)
* Recommended WF
  + TBA after the channel bandwidth combination is agreed

**Issue 5-1-4: MIMO configuration**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *Option 1: 2x2 and 2x4*
  + *Option 2: 1x2 and 1x4*
  + *Option 3: Simulation is needed* 
    - *Further evaluate the throughput at 19dB SNR point*
* Proposals
  + Option 1: 2x2 and 2x4
  + Option 2: 1x2 and 1x4 (CTC, Intel, HW, QC)
    - HW, QC: avoid the situation of 2TX under the condition of static channel, because this will make the signal energy on some antennas at the receiving side to zero.
  + Option 3: Simulation is needed
* Recommended WF
  + Agree with Option 2

**Issue 5-1-5: MCS**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *Simulation is needed* 
    - *Option A: use different MCSs for 2Rx and 4Rx.*
    - *Option B: use same MCS for 2 Rx and 4 Rx*
* Proposals
  + Option 1: Use MCS 27 for 2Rx and MCS 28 for 4Rx (CTC)
    - CTC: Based on our simulation results, at 16dB SNR (considering 2 dB impairment margin and 0.8 dB extra margin for 64QAM), 100% relative throughput can be achieved for 1T2R with MCS 27 and 1T4R with MCS 28.
  + Option 2: Increase the power difference (larger than 6dB) between two CCs to make the SNR lower than 19dB (HW)
    - HW: When the SNR is 19dB for 1T4R, the normalized throughput will still be much higher than 85% even if the MCS reaches the maximum (256QAM, 948/1024). For other MIMO configurations, it is impossible to find a suitable MCS to make the normalized TP close to 85% (either 0 or 100%).
* Recommended WF
  + Decide in the next meting based on more simulation results:
    - Encourage more simulations for 1T2R and 1T4R at [16] dB
    - Discuss whether to use 64QAM or 256QAM

**Issue 5-1-6: PRB bundling size**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *Option 1: WB*
  + *Option 2: 2 PRBs*
* Proposals
  + Option 1: WB (CTC, Intel)
    - CTC: WB PRB bundling is slightly preferred, if it is agreed to use 1 Tx.
  + Option 2: 2 PRBs (HW)
* Recommended WF
  + Agree with Option 1, since it has been recommended to use 1Tx

### Sub-topic 5-2: Requirements for intra-band contiguous EN-DC

* *Description in the WID (RP-200472)*
  + *FR1 intra-band EN-DC PDSCH demodulation performance requirement with power imbalance*
    - *Intra-band contiguous EN-DC with 6dB power imbalance is assumed.*
    - *Only the NR cell is configured as the weaker power cell and to be tested.*

**Issue 5-2-1: Duplex mode**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *Option 1: FDD and TDD*
  + *Option 2: FDD*
* Proposals
  + Option 1: FDD and TDD (Intel, DCM, HW, CMCC)
* Recommended WF
  + Agree with Option 1

**Issue 5-2-2: SCS**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *Option 1: 15kHz for both FDD and TDD*
  + *Option 2: 15kHz for FDD, 30kHz for TDD*
  + *Option 3: 15kHz for FDD*
* Proposals
  + Option 1: 15kHz for both FDD and TDD
  + Option 2: 15kHz for FDD, 30kHz for TDD (DCM, HW, CMCC)
  + Option 3: 15kHz for FDD
  + Option 4 (Intel)
    - Test #1: LTE FDD + NR FDD 15 kHz
    - Test #2: LTE TDD + NR TDD 15 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 30 kHz
* Recommended WF
  + Considering no operator has shown interest in TDD 15 kHz case, can we agree to use option 2?

**Issue 5-2-3: TDD pattern**

* *Agreement in RAN4 #94e-bis (R4-2005547, WF)*
  + *TDD pattern for 30kHz SCS*
    - *7D1S2U*
  + *TDD pattern for 15kHz SCS*
    - *Option 1: DSU+DD*
    - *Other options are not precluded.*
* Proposals
  + TDD pattern for 30kHz SCS
    - Option 1: 7D1S2U (agreement in the last meeting)
    - Option 2: 3DSU+4D (Intel)
  + TDD pattern for 15kHz SCS
    - Option 1: DSU+DD (Intel)
    - Other options are not precluded.
* Recommended WF
  + TDD pattern for 30 kHz SCS
    - Can we keep the agreement in the WF in the last meeting, i.e., option 1?

### Sub-topic 5-3: Requirements for intra-band non-contiguous EN-DC

**Issue 5-3-1: Whether to define power imbalance requirement for FR1 intra-band non-contiguous EN-DC**

* *Description in the WID (RP-200472)*
  + *FR1 intra-band EN-DC PDSCH demodulation performance requirement with power imbalance*
    - *Further study whether to introduce intra-band non-contiguous EN-DC requirements and applicable power imbalance level*
* *Agreement in GTW On-line session in RAN4 #94e-bis*
  + *FFS the requirements needed or not and further check the feasibility of single RF receiver chain to support intra-band Non-contiguous EN-DC (Co-location scenario).*
* Proposals
  + Option 1: Yes (DCM)
    - Both contiguous EN-DC and non-contiguous EN-DC are possible scenario and some UEs only support non-contiguous EN-DC.
    - Only co-located scenario is assumed for both intra-band contiguous and non-contiguous EN-DC cases in RAN4 requirements. It derives that single RF chain is assumed to receive CCs.
    - Introduce test applicability rules 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”,
        + apply either power imbalance requirement for FR1 intra-band contiguous EN-DC or FR1 intra-band non-contiguous EN-DC
  + Option 2: No (QC)
    - QC: Similar to CA requirements for power imbalance, only consider intra-band contiguous case
  + Option 3: More discussion is needed (Intel, HW)
    - Intel: Before agreement on definition of such requirements, further discuss the details of test design to ensure that RX image rejection can be verified.
      * Even if UE uses single RF chain then, depending on channel spacing and LO allocation, scenarios without image issue can be observed.
      * Consider intra-band non-contiguous EN-DC requirements only for UE with *intraBandENDC-Support* = *non-contiguous*.
    - HW: more discussion is needed whether it is reasonable to assume an RF chain receiver to receive two non-continuous carriers in co-located scenario.
* Recommended WF
  + In the 1st round, encourage more discussion on the two aspects:
    - Whether it is feasible to assume single RF chain to receive two non-continuous carriers in co-located scenario?
    - If UE uses single RF chain, depending on channel spacing and LO allocation, whether or not the image issue can be observed?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | **Sub-topic 5-1: Requirements for FR1 intra-band contiguous CA**  Issue 5-1-1: Channel bandwidth combination for defining performance requirements  Issue 5-1-2: Channel bandwidth combination for testing  Issue 5-1-3: PDSCH RB allocation  Issue 5-1-4: MIMO configuration  Issue 5-1-5: MCS  Issue 5-1-6: PRB bundling size  **Sub-topic 5-2: Requirements for intra-band contiguous EN-DC**  Issue 5-2-1: Duplex mode  Issue 5-2-2: SCS  Issue 5-2-3: TDD pattern  **Sub-topic 5-3: Requirements for intra-band non-contiguous EN-DC**  Issue 5-3-1: Whether to define power imbalance requirement for FR1 intra-band non-contiguous EN-DC |
| Company B | **Sub-topic 5-1: Requirements for FR1 intra-band contiguous CA**  Issue 5-1-1: Channel bandwidth combination for defining performance requirements  Issue 5-1-2: Channel bandwidth combination for testing  Issue 5-1-3: PDSCH RB allocation  Issue 5-1-4: MIMO configuration  Issue 5-1-5: MCS  Issue 5-1-6: PRB bundling size  **Sub-topic 5-2: Requirements for intra-band contiguous EN-DC**  Issue 5-2-1: Duplex mode  Issue 5-2-2: SCS  Issue 5-2-3: TDD pattern  **Sub-topic 5-3: Requirements for intra-band non-contiguous EN-DC**  Issue 5-3-1: Whether to define power imbalance requirement for FR1 intra-band non-contiguous EN-DC |
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## 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.*

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|  | **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*

|  |  |
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| **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 #6: NR CA CQI reporting requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2006040 | China Telecom | Proposal 1: For duplex mode and SCS, reuse the combinations and applicability rules from PDSCH normal CA.  Proposal 2: Use 2D1S1U with S=11:3:0 for 120kHz SCS.  Proposal 3: Use 8 slots for CSI reporting periodicity.  Proposal 4: 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 2, for more than 90% of the time.  Proposal 5: SNRPcell = 10dB and SNRScell = 4dB for 2DL CA CQI test.  Proposal 6: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB for 3 or more DL CA CQI test.  Proposal 7: Delta CQI threshold = 2 for 2 or more DL CA CQI test.  Proposal 8: Use 1T2R and 1T4R for CA CQI test.  Proposal 9: For 4Rx band, reduce the signal power density by 3dB compared to that for 2Rx. |
| R4-2007142 | NTT DOCOMO, INC. | Proposal 1: Adopt Option 1 for duplex mode and SCS, i.e. reuse the combinations and applicability rules from PDSCH CA  Proposal 2: Adopt Option 1 for 120 kHz SCS, i.e. assume TDD pattern as 3D1S1U (S=10:2:2) for CA CQI requirements |
| R4-2007225 | Huawei, HiSilicon | Proposal 1: For Duplex mode and SCS, use option2   * FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS * FR2: TDD + TDD with 120 kHz SCS   Proposal 2: For 120kHz SCS, use 3D1S1U, corresponding CSI reporting period is 10 slots.  Proposal 3: Use 1T2R and 1T4R and reduce the signal power density by 3dB compared to that for 2Rx.  Proposal 4: To find suitable SNR configuration and CQI threshold, more evaluations are needed based on common simulation assumption.  Proposal 5: More evaluation are needed to verify if the CA CQI performance requirements can be defined in a bandwidth agnostic way based on common simulation assumption. If it has been verified, only the largest bandwidth combination under all CA configurations supported by the UE should be tested. |
| R4-2008113 | 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: Reuse the test framework for CA CQI reporting tests in LTE for defining NR CA CQI reporting tests.  Proposal 4: Define FR1 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. |

## Open issues summary

### Sub-topic 6-1: Duplex mode and SCS combinations

**Issue 6-1: Duplex mode and SCS combinations**

* *Agreement in RAN4 #94e-bis*
  + *Agreed duplex mode and SCS for CA normal PDSCH (R4-2005546, WF on CA normal)*
    - *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*
  + *Options for duplex mode and SCS for CA CQI (R4-2005548, WF on CA CQI)*
    - *Option 1: Reuse the combinations and applicability rules from PDSCH CA*
    - *Option 2:*
      * *FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS*
      * *FR2: TDD + TDD with 120 kHz SCS*
* Proposals
  + Option 1: Reuse the combinations and applicability rules from PDSCH CA (CTC, DCM)
    - CTC: Some typical CA scenarios, such as FDD 15 kHz + TDD 30 kHz, are missing in option 2.
  + Option 2: (Huawei, Qualcomm)
    - FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS
    - FR2: TDD + TDD with 120 kHz SCS
      * Huawei: FDD + TDD and TDD with 15 kHz scenarios have been verified in the Rel-15 PDSCH CA CSI reporting test.
* Moderator’s observation
  + The duplex mode and SCS combinations for performance requirements and testing can be discussed separately.
  + For performance requirements:
    - The difference between the two options is: FDD 15 kHz + TDD 30 kHz, FDD 15 kHz + TDD 15 kHz and TDD 15 kHz + TDD 30 kHz are not covered in option 2.
    - If one UE only supports FDD 15 kHz + TDD 30 kHz CA (or only supports FDD 15 kHz + TDD 15 kHz, or TDD 15 kHz + TDD 30 kHz), there will be no requirements for the UE.
  + For applicability rule:
    - The number of tests can be further discussed, taking into account the main purpose of CA CQI test is to verify independent CQI calculation in each CC.
* Recommended WF
  + For the performance requirements, reuse the combinations from PDSCH normal CA.
  + For the applicability rule, discuss whether or not the number of tests can be reduced compared to PDSCH normal CA.

### Sub-topic 6-2: Channel bandwidth and test applicability rule

**Issue 6-2: Channel bandwidth and test applicability rule**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *Define performance requirements for all channel bandwidths listed in TS 38.101-1 and TS 38.101-2 for FR1 and FR2.*
  + *Further discuss the test applicability rule*
* Proposals
  + Option 1: If it is verified that CA CQI performance requirements can be defined in a bandwidth agnostic way based on common simulation assumption, only test the largest bandwidth combination under all CA configurations supported by the UE (Huawei)
* Recommended WF
  + TBA based on tshe feedback from more companies.

### Sub-topic 6-3: TDD UL-DL patterns and CSI reporting periodicity

**Issue 6-3-1: TDD UL-DL pattern for 120 kHz SCS**

* *Agreement in RAN4 #94e-bis (R4-2005548, 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 (DCM, Huawei)
    - DCM: align with CA PDSCH normal demodulation test
    - Huawei: For 120 kHz SCS, option 1 is the most typical scenario.
  + Option 2: 2D1S1U with S=11:3:0 (CTC, Qualcomm)
    - CTC, QC: Align with Rel-15 FR2 single carrier CQI test.
* Recommended WF
  + With AWGN channel assumed, the CQI reporting performance will not be impacted by the TDD pattern, so it is suggested to make discussion based on majority’s view after the 1st round email discussion.

**Issue 6-3-2: CSI reporting periodicity for 120 kHz SCS**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *CSI reporting periodicity*
    - *For 120kHz SCS*
      * *Option 1: 10 slots*
      * *Option 2: 8 slots*
* Proposals
  + Option 1: 10 slots (Huawei)
  + Option 2: 8 slots (CTC, Qualcomm)
* Recommended WF
  + Depend on the agreement on TDD pattern in issue 6-3-1
    - If TDD pattern of 3D1S1U is agreed, use option 1
    - If TDD pattern of 2D1S1U is agreed, use option 2

### Sub-topic 6-4: Antenna configuration

**Issue 6-4-1: Antenna configuration**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *Option 1: 1T2R and 1T4R (CTC, Ericsson, Intel, Huawei)*
  + *Other options are not precluded*
* Proposals
  + Option 1: 1T2R and 1T4R (CTC, Huawei)
* Recommended WF
  + Can we agree with option 1?

**Issue 6-4-2: Signal power density for 2Rx and 4Rx bands**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *Option 1: For 4Rx band, reduce the signal power density by 3dB compared to that for 2Rx*
  + *Other options are not precluded*
* Proposals
  + Option 1: For 4Rx band, reduce the signal power density by 3dB compared to that for 2Rx (CTC, Huawei)
* Recommended WF
  + Can we agree with option 1?

### Sub-topic 6-5: Test metric

**Issue 6-5-1: General principle for test metric**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *Following the methodology used in LTE, measure 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).*
  + *Other options are not precluded*
* Proposals
  + Option 1: 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 2, for more than 90% of the time. (CTC, Qualcomm)
    - To make it more clear, additional clarification is added for the option 1, which is marked in red.
* Recommended WF
  + TBA based on the feedback from more companies.

**Issue 6-5-2: SNR configuration for 2DL CA CQI test**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *Option 1: SNRPcell = 10dB and SNRScell = 4dB*
  + *Other options are not precluded*
* Proposals
  + For FR1
    - Option 1: SNRPcell = 10dB and SNRScell = 4dB (CTC, QC)
      * CTC, QC: have verified this proposal by simulation
    - Option 2: Need more time for simulation (HW)
  + For FR2
    - Option 1: SNRPcell = 10dB and SNRScell = 4dB (CTC)
    - Option 2: Need more time for simulation (QC, HW)
      * QC: may be able to confirm during the meeting
* Recommended WF
  + Considering the short time for tdoc preparation, it is suggested to keep the agreement in the last meeting, and make decision in the next meeting.

**Issue 6-5-3: SNR configuration for 3DL CA CQI test**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *Option 1: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB*
  + *Other options are not precluded*
* Proposals
  + For FR1
    - Option 1: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB (CTC, Qualcomm)
    - Option 2: Need more time for simulation (HW)
  + For FR2
    - Option 1: SNRPcell = 12dB, SNRScell1 = 6dB, SNRScell2, 3,… = 0dB (CTC)
    - Option 2: Need more time for simulation (QC, HW)
* Recommended WF
  + Similar situation as issue 6-5-2 for 2DL CA, it is suggested to keep the agreement in the last meeting, and make decision in the next meeting.

**Issue 6-5-4: Delta CQI threshold**

* *Agreement in RAN4 #94e-bis (R4-2005548, WF)*
  + *Option 1: thr = 2 for 2 or more DL CA*
  + *Other options are not precluded*
* Proposals
  + For FR1
    - Option 1: *thr* = 2 for 2 or more DL CA (CTC, Qualcomm)
    - Option 2: Need more time for simulation (HW)
  + For FR2
    - Option 1: *thr* = 2 for 2 or more DL CA (CTC)
    - Option 2: Need more time for simulation (QC, HW)
* Recommended WF
  + Similar situation as issue 6-5-2 and 6-5-3 for SNR configuration, it is suggested to keep the agreement in the last meeting, and make decision in the next meeting.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Company A | Issue 6-1: Duplex mode and SCS combinations  Issue 6-2: Channel bandwidth and test applicability rule  Issue 6-3-1: TDD UL-DL pattern for 120kHz SCS  Issue 6-3-2: CSI reporting periodicity for 120kHz SCS  Issue 6-4-1: Antenna configuration  Issue 6-4-2: Signal power density for 2Rx and 4Rx bands  Issue 6-5-1: General principle for test metric  Issue 6-5-2: SNR configuration for 2DL CA CQI test  Issue 6-5-3: SNR configuration for 3DL CA CQI test  Issue 6-5-4: Delta CQI threshold  Others: |
| Company B | Issue 6-1: Duplex mode and SCS combinations  Issue 6-2: Channel bandwidth and test applicability rule  Issue 6-3-1: TDD UL-DL pattern for 120kHz SCS  Issue 6-3-2: CSI reporting periodicity for 120kHz SCS  Issue 6-4-1: Antenna configuration  Issue 6-4-2: Signal power density for 2Rx and 4Rx bands  Issue 6-5-1: General principle for test metric  Issue 6-5-2: SNR configuration for 2DL CA CQI test  Issue 6-5-3: SNR configuration for 3DL CA CQI test  Issue 6-5-4: Delta CQI threshold  Others: |
|  |  |

## 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”* |