**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** |
| China Telecom | Issue 1-1: Release independent issue for type II PMISupport Option 1. |
| Qualcomm | Issue 1-1: Release independent issue for type II PMIPrefer not to make these requirements release independent. Otherwise, any Rel-15 UEs designed based on requirements in existing spec may not meet these requirements. |
| Apple | Issue 1-1: Release independent issue for type II PMISupport Option 2. We prefer not to define Type II codebook requirements as release independent from Rel-15. Some Rel-15 UEs might indicate capability of Type II codebook, but fail to meet requirements especially if test setup and/or test metric are not same as Type I.  |
| CMCC | Issue 1-1: Release independent issue for type II PMISupport to agree option 1. |
| Ericsson | Issue 1-1: Release independent issue for type II PMISupport the 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**  |
| **Topic #1: General issues** | *Candidate options:** Issue 1-1: Release independent issue for type II PMI requirements
	+ Option 1: Release independent from Rel-15 (Ericsson, Huawei, China Telecom, CMCC)
	+ Option 2: Not release independent from Rel-15 (Qualcomm, Apple)
* Issue 1-2: Release independent issue for CA/EN-DC power imbalance requirements
	+ Option 1: Release independent from Rel-15 (DCM)

Note: this issue was raised in the 1st round discussion. Encourage feedback from companies.*Recommendations for 2nd round:*Further discuss the candidate options above. |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Way forward on release independent aspect for UE demodulation and CSI reporting requirements | Huawei, HiSilicon |

### 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 bandsProposal 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 applicabilityCategorizing 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: 6Option 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** |
| Huawei, HiSilicon | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CAPrefer Option 2.Issue 2-2: HARQ process numberIssue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CAAs 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 CAAs 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 valuesRecommend WF is fine.Issue 2-3: Performance requirements for FR1 and FR2Recommend WF is fine.Issue 2-4: CA capabilityIssue 2-4-1: Categorizing of CA capabilitiesAs compromise, recommend WF is fine for us.Issue 2-4-2: Test of different CA capabilitiesThe 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 combinationFirstly, 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. |
| China Telecom | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CASupport option 1, given the justifications provided by CMCC and CTC, i.e., * 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.

Issue 2-2: HARQ process number for TDD-FDD CA and TDD-TDD CA with different SCSsIssue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CASupport the recommended WF to agree option 3, especially considering that the issue has been discussed for several meetings and the following agreement was reached in the last meeting. In this meeting, we have not seen the large performance impact based on the submitted tdocs. * + - *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 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CASupport the recommended WF and option 2.Issue 2-2-3: K1 valuesSupport the recommended WF and option 1a.Issue 2-3: Performance requirements for FR1 and FR2Support to agree proposal 1.Issue 2-4: CA capabilityIssue 2-4-1: Categorizing of CA capabilitiesSupport to agree option 1.Issue 2-4-2: Test of different CA capabilitiesAlthough option 2 is still our preference, we can accept the recommended WF as a compromise in order to complete all the CA normal PDSCH CRs in the next meeting.Issue 2-5: Selection of CA configuration(s) and CBW combinationSupport to use the recommended WF as baseline.To Huawei: We understand Huawei’s comment that, with the selected MIMO layer and MCS (i.e., rank 2 MCS 13 for FR1, and rank 2 MCS 10 for FR2), it might be not challenging to support those MIMO layer and MCS for any CC. Meanwhile, since the support of layer 2 and 16QAM are still up to UE capability reporting, it is not harm to first ensure that the those capabilities can be supported by each tested CC/band. |
| Qualcomm | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CAIt has already been shown that number of HARQ processes does not impact the performance much. So, we should pick the more widely deployed scenario. We already compromised to agree to having TDD 30kHz PCell for FDD 15kHz + TDD 30kHz case by picking higher number of HARQ processes. Therefore, we prefer TDD 30kHz carrier to be PCell in this case.Issue 2-2: HARQ process numberIssue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CAWe still prefer Option 1.Issue 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CAOk with Option 2.Issue 2-2-3: K1 valuesOk with Option 1a.Issue 2-3: Performance requirements for FR1 and FR2Ok with Proposal 1.Issue 2-4: CA capabilityIssue 2-4-1: Categorizing of CA capabilitiesOk with Option 1.Issue 2-4-2: Test of different CA capabilitiesPrefer Option 1. Based on option 1 in Issue 2-4-1, it seems that the focus is more on testing the max possible number of CCs rather than trying to test max throughput. So, in that case, we prefer to just choose largest number of bands and then choose maximum aggregated bandwidth within the combination of largest number of bands. Max aggregated CBW among all possible combinations will anyway be tested in SDR tests. So, there is no need to have 2 test cases.Issue 2-5: Selection of CA configuration(s) and CBW combinationWe are ok with recommended WF for FR1 but we prefer Option 2 for FR2 since that may have more band combinations that are testable rather than the method in recommended WF. |
| CMCC | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CASupport Option 1. The PCell configuration can change in real network, so it is difficult to select the PCell configuration based on deployment scenario. In this case, we support option 1 to consider the scenario with larger number of HARQ processes. By considering the worst case, we think the demodulation performance for the other PCell configuration can be guaranteed.Issue 2-2: HARQ process numberIssue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CAOK with the recommended WF.Issue 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CAOK with the recommended WF.Issue 2-4: CA capabilityIssue 2-4-1: Categorizing of CA capabilitiesSupport the recommended WF.Issue 2-4-2: Test of different CA capabilitiesSupport Option 2. Separate FFT may be used for inter-band CA. In LTE, different CA capabilities supported by UE are at least tested in one test. For NR, we also propose that each supported CA capability needs to be tested.Issue 2-5: Selection of CA configuration(s) and CBW combinationSupport bullet 1 and bullet 2 in Option3, as for bullet 3, we think it is related to issue 2-4-2, and in our view, the bullet 3 in Option3 can be as follows:* + - For inter-band CA with different number of bands, 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

As for recommended WF, we think 16QAM and 2 MIMO layers is mandatory for UE, there is no need to repeat this requirement in test condition. |
| Intel | **Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CA**Both options are fine for us. However, we slightly prefer Option 2 because it allows to test with smaller RTT**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**Prefer Option 3, because if we go with Option 1 then we need to specify all details of HARQ scheduling for all scenarios which overcomplicate spec content. Also, taking into account that performance is same for different HARQ scheduling options, we think that definition of such details is not needed.**Issue 2-2-3: K1 values**We are fine with Option 1a. However, we suggest slight modification for FDD 15 kHz + TDD 30 kHz CA with TDD PCell for second column: {7,5,4,11,9} instead of {7,6,4,11,9} to have consistency with TDD 15 kHz + TDD 30 kHz CA and 30kHz PCell.**Issue 2-3: Performance requirements for FR1 and FR2**Ok with recommended WF**Issue 2-4-2: Test of different CA capabilities**It is not clear why we need to consider scenarios with the largest aggregated CBW, taking into account that it is already covered by SDR requirements. Same time, as compromise, we are fine with recommended WF.**Issue 2-5: Selection of CA configuration(s) and CBW combination**FR1: We are fine with recommended WF. Same time, we think that it is not required to ensure that UE supports 16QAM or high modulation on each CC, because, based on our understanding of 38.306, this capability is used only for calculation of maximum supported data rate and high modulation order (in comparison to value in this field) can be used in case final data rate is not grater than supported data rate.FR2: We prefer Option 2, because it allows to excluded CA configurations, which can not be tested, in the initial stage of search procedure and reduce number of candidates for further checking.  |
| docomo | Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CAOur preference is Option 1. We have similar view as CMCC and CTC. We prefer to test the combination of large number of HAQR processes.Issue 2-3: Performance requirements for FR1 and FR2We are OK with the recommended WFIssue 2-4: CA capabilityIssue 2-4-1: Categorizing of CA capabilitiesWe are OK with the recommended WFIssue 2-4-2: Test of different CA capabilities Our preference is Option 2We think that the baseline of the discussion is to test each CA capabilities separately. Based on this understanding, the discussion point is to clarify whether the testing will be conducted “with the largest number of bands” or “with different numbers of bands”. We prefer to apply the same rules across CA capabilities to prevent the potential degradation of the quality of testing.To Huawei and IntelWe like to understand the reason why you are focusing on reducing the number of testing only for inter-band CA ? Is it because of the consideration of the mixed CA case (inter-band CA = intra-band + inter-band) ? |

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2010182, CMCC, FR1 2Rx | Qualcomm: Looks ok. |
| China Telecom: generally ok, and have some minor editorial suggestions to align with the updated CR for FR1 4Rx, and also avoid some duplicated part.An revised version has been uploaded in: https://www.3gpp.org/ftp/tsg\_ran/wg4\_Radio/TSGR4\_96\_e/Inbox/Drafts/%5B324%5D%20NR\_perf\_enh\_Demod/CR%20for%20CA%20normal%20PDSCH/Revised%20R4-2010182%20FR1%20CA%202Rx\_CTC.docx |
| Intel: Comment for Table 5.2A.2.1-2. We think that this table can contain information only on number of HARQ process. If it will be agreed to define specific HARQ scheduling procedure and specify it then such information can be captured in annex for all scenarios. |
| R4-2011011, Huawei, HiSilicon, FR1 4Rx | Qualcomm: Looks ok. |
| Ericsson: It looks test parameters and HARQ process settings are common between 2Rx and 4Rx, because both cases use 2 layers. For maintenance, we prefer the 4Rx section refers to the test parameters and HARQ settings specified in 2Rx CR R4-2010182 drafted by CMCC. |
| Intel: Same comment as for R4-2010182. |
| R4-2011413, Qualcomm, FR2 | Ericsson: Should be Cat B CR. Otherwise looks ok. |
| China Telecom: Starting symbol (S) should be 1 instead of 2 for FR2? The other part looks ok. |
| Intel: Looks fine |
| R4-2009731, Intel, FRC | Qualcomm: It may be better to add “CA” in the titles of tables to clarify that these FRCs are for CA, similar to what is done for other RMC tables. |
| Company B |
| Intel: Ok. We can add this information. |
| China Telecom: it looks that the same FRC can be used for single carrier and CA tests if the related parameters are the same. This CR does not include FRC for FR1 FDD 10MHz 15kHz and FR1 TDD 40MHz 30kHz, so the intention is to reuse the existing single carrier FRC (i.e., R.PDSCH.1-2.2 FDD and R.PDSCH.2-2.2 TDD)? This approach is ok to us. But in this case, we do not need to mention “CA” in the titles of tables? |

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.*

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| --- | --- |
|  | **Status summary**  |
| **Topic #2: UE CA PDSCH normal requirements** | * Issue 2-1: Pcell configuration for TDD 15 kHz + TDD 30 kHz CA
	+ Option 1: 15 kHz SCS cell as Pcell (CTC, CMCC, Intel, DCM)
		- 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: The PCell configuration can change in real network, so it is difficult to select the PCell configuration based on deployment scenario. 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, Intel)
		- HW, QC: TDD 30kHz PCell is more widely deployed.
		- Intel: Both options are fine for us. However, we slightly prefer Option 2 because it allows to test with smaller RTT.

*Recommendations for 2nd round:*Given the operators’ inputs, check if option 1 is acceptable in the 2nd round.* Issue 2-2-1: HARQ process number for 30kHz SCell in TDD 15 kHz + TDD 30 kHz CA
	+ 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 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, CTC, CMCC)
		- Intel: Performance difference is around 0.3 dB for 2 Rx and 4 Rx scenarios. Such difference is very negligible.
		- HW: No performance impact by scheduling the initial transmission and retransmission in different types of slots.

*Recommendations for 2nd round:* The following agreement was reached in the last meeting, so further check if option 3 is acceptable in the 2nd round.* + - *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 2-2-2: HARQ process number for 15kHz SCell in TDD 15 kHz + TDD 30 kHz CA
	+ Option 1: 6 (CTC, HW)
	+ Option 2: 8 (CTC, Intel, QC, HW, CMCC)

*Tentative agreement:* Agree option 2.* Issue 2-2-3: K1 values
	+ Option 1: K1 values are provided based on Pcell’s SCS in scenarios with mixed SCSs
		- Option 1a: update the detailed K1 values as follows (CTC, HW, QC, Intel)

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| --- | --- | --- |
|  | ***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 1b: update the detailed K1 values as follows (Intel)
			* Difference with option 1a is highlighted in yellow.
			* Intel: we suggest slight modification for FDD 15 kHz + TDD 30 kHz CA with TDD PCell for second column: {7,5,4,11,9} instead of {7,6,4,11,9} to have consistency with TDD 15 kHz + TDD 30 kHz CA and 30kHz PCell.

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|  | ***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}* | *{7,5,4,11,9~~,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}* |

*Recommendations for 2nd round:* Decide to select option 1a or option 1b in the 2nd round.* Issue 2-3: Performance requirements for FR1 and FR2
	+ 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, HW, QC, Intel, DCM)

*Tentative agreement:* Agree proposal 1.* Issue 2-4-1: Categorizing of CA capabilities
	+ 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, HW, QC)
	+ Option 2: Define different capabilities for intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA. (HW)

*Tentative agreement:* Agree option 1.* Issue 2-4-2: Test of different CA capabilities
	+ Option 1: Test intra-band contiguous CA, intra-band non-contiguous CA and inter-band CA with the largest number of bands. (HW, Intel, QC)
		- HW: We can select the inter-band CA with the largest aggregated CBW among the selected inter-band CA with the largest number of bands.
		- Intel: it is redundant to test UE for multiple Inter-band CA scenarios with different number of bands.
		- QC, Intel: Max aggregated CBW among all possible combinations will anyway be tested in SDR tests.
	+ 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.
		- DCM: apply the same rules across CA capabilities to prevent the potential degradation of the quality of testing.
	+ Option 3 (recommended WF in the 1st round, CTC, Intel)
		- 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.

*Recommendations for 2nd round:* Further discuss and work on the compromised solution.* Issue 2-5: Selection of CA configuration(s) and CBW combination
	+ Option 1 (China Telecom)
	+ Option 2 (Intel, QC for FR2)
	+ Option 3 (HW)
	+ Option 4 (Recommended baseline in the 1st round, China Telecom, QC for FR1)

Note: detailed descriptions on the options are in section 2.2.5.*Recommendations for 2nd round:* Further discuss the following aspects:* + Whether to consider *maxNumberMIMO-LayersPDSCH, supportedModulationOrderDL* and *scalingFactor*, since only 16QAM and rank 2 are used?
	+ If yes for the above bullet, align the understanding of these capability based on 38.306, such as, applied per CC, per band or in the final data rate calculation?
	+ Which option is better to accommodate the FR2 testability?
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*Suggestion on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Way forward on PDSCH CA normal demodulation requirements | Intel Corporation |
|  |  |  |

### 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”* |
| R4-2010182, CMCC, FR1 2Rx | *To be revised* |
| R4-2011011, Huawei, HiSilicon, FR1 4Rx | *To be revised* |
| R4-2011413, Qualcomm, FR2 | *To be revised* |
| R4-2009731, Intel, FRC | *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 SetupObservation #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 ParametersObservation #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 PMIProposal #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: TDLA30-5HzAntenna Correlation: XP-MediumPMI format Indicator: SubbandSubband Amplitude: TRUENpsk: 8 |
| R4-2009732 | Intel Corporation | Simulation results |
| R4-2010104 | CMCC | Simulation results (not available yet) |
| R4-2010142 | Samsung | Performance requirements for Type I codebookProposal 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 TDLA30-5Proposal 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 testProposal 2: Use QPSK for Npsk configurationProposal 3: Use ‘false’ for SubbandAmplitude configurationProposal 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 thisObservation 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 reportingObservation 2: In MU-MIMO scenario with rich channel environment (CDL) employing ZF precoding with Type II CSI feedback provides the gNB with sufficient information to schedule multiples UEs close to each other with high MCS and rank. Observation 3: Type I CSI feedback does not provide sufficient information for the ZF algorithm to correctly calculate the most suitable precoders to achieve FRC maximum throughput.Observation 4: Zero-forcing algorithm is needed to properly cancel out interference in between the two scheduled UEs.Proposal 1: Use Rank1 MCS7 for MU-MIMO PMI testingProposal 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 testingObservation 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 = trueProposal 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** $$y=\left[\sqrt{\frac{1}{1+\sum\_{i=2}^{L}p\_{i}^{2}}}H\_{m}D\_{θ\_{k,1},θ\_{k,2}}^{(m)}+\sum\_{i= 2}^{L}\sqrt{\frac{p\_{i}^{2}}{1+\sum\_{i=2}^{L}p\_{i}^{2}}}H\_{i}D\_{θ\_{k,1},θ\_{k,2}}^{(i)}\right]Wx+n$$And the steering matrix is further expressed as following:where- $H\_{m}$, $H\_{i}$ are independent channels for the first beam and the consecutive i beams with the N­rx Ntchannel matrix per subcarrier.- $p\_{i}$ is the relative power difference from the first beam.- , $D\_{θ\_{k,1},θ\_{k,2}}^{(i)}$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** |
| 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. Updates: For Qualcomm’s comments, we agree that we could limit the number of beams for randomization by using follow PMI configurations. But for amplitude and phase coefficient, is this a common understanding to randomize all possible combinations?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. |
| China Telecom | **Sub-topic 3-1: Type I PMI test**Issue 3-1-1: Gamma (gain) valuesIn our paper, we proposed to define different gamma (gain) values for 2Rx and 4Rx. Because 4Rx achieves larger performance gain than 2Rx based on all companies’ simulation results before this meeting. However, this phenomenon is not shown in the latest 16Tx results from Huawei and Ericsson, and the latest 32Tx results from Intel. So, we can compromise to define the same gamma (gain) value for 2Rx and 4Rx.From all companies’ results, the lowest gamma values are 2.6 for 16 Tx and 5.29 for 32 Tx. As a result, based on all companies’ results, our compromised proposals are 2.5 for 16Tx and 5.0 for 32Tx, for both 2Rx and 4Rx.**Sub-topic 3-2: Type II PMI test setup** Issue 3-2-1: Test setup for type IISupport the recommended WF and option 1, We understand the motivation of proposing option 2. Our main concerns are on the testability and timeline.On the testability, we need confirmation from TE vendors on the following aspects: 1) Model one co-scheduled UE to perform correct PMI calculation, 2) Implement ZF precoding for the two UEs, 3) Double the number of channel faders.On the timeline, MU setup is a new work for RAN4, we have no confidence to complete the work within Rel-16 timeline, even if every company is willing to do this.So we still prefer to use SU-MIMO setup, i.e., option 1.In addition, we fully agree with Samsung’s point that there is no restriction of Type II codebook usage scenario no matter SU-MIMO or MU-MIMO set-up agreed in RAN4. It is our understanding that the type II codebook performance benefits in MU scenario has been confirmed in RAN1.**Sub-topic 3-3: SU-MIMO Type II PMI test parameters**Issue 3-3-1: Type II codebook constructionAgree with the recommended WF.Issue 3-3-6: MCS and rank for type II codebookAgree with the recommended WF.Issue 3-3-7: Beam steering model for Type II CodebookAgree with the recommended WF. |
| Qualcomm | **Sub-topic 3-1: Type I PMI test**Issue 3-1-1: Gamma (gain) valuesOur preference is 2.0 for 2Rx, 3.0 for 4Rx in case of 16Tx; 4.5 for 2Rx, 8.0 for 4Rx in case of 32Tx.**Sub-topic 3-2: Type II PMI test setup**Issue 3-2-1: Test setup for type IIAs shown in our paper, based on RAN4 assumptions, UE reported PMI will not change with setup. MU-MIMO setup will only be testing how gNB is designing its precoder. But, this test is for UE requirements and not gNB requirements. So, we prefer not to complicate the setup and use SU-MIMO setup.**Sub-topic 3-3: SU-MIMO Type II PMI test parameters**Issue 3-3-1: Type II codebook constructionOk with recommended WF.Issue 3-3-2: Npsk (phaseAlphabetSize) for type II codebook constructionOk with option 2.Issue 3-3-3: subbandAmplitude for type II codebook constructionOk with option 2.Issue 3-3-4: PMI-FormatIndicator for type II codebookOk with option 2.Issue 3-3-5: MIMO correlation for type II codebookPrefer option 1 similar to existing PMI reporting tests.Issue 3-3-6: **MCS and rank for type II codebook**Ok with recommended WF.Issue 3-3-7: Beam steering model for Type II CodebookOk with recommended WF.Issue 3-3-8: Implementation of random type II PMIWe should limit the set of possible beams to the possible beams under the configuration of following PMI. For example, randomly choose beams from all possible beams for 16 ports, Npsk = 8, subbandAmplitude = True.**Sub-topic 3-4: MU-MIMO Type II PMI test parameters**Prefer not to use this setup.  |
| Apple | **Sub-topic 3-1: Type I PMI test**Issue 3-1-1: Gamma (gain) valuesBased on the results from all companies, Gamma of 2.6 is minimum for 16TX and we propose to define gamma=2.6 for 16TX.**Sub-topic 3-2: Type II PMI test setup**Issue 3-2-1: Test setup for type IIWe recommend SU-MIMO setup for PMI reporting with Type II codebook. Repeating comments from eMIMO demod thread:We recommend to define requirements with SU-MIMO test setup. Results shown in Ericsson’s paper with MU-MIMO in CDL channel and the comparison is performance with MU-MIMO set up when Type II and Type I are used. This doesn’t justify that MU-MIMO setup is better to test Type II. Also, the evaluation results from Ericsson with MU-MIMO setup are for lower MCS and Rank 1 which results in much lower TP than the SU-MIMO set up we have been using, so that doesn’t show that MU-MIMO setup can achieve better performance with Type II codebook.**Sub-topic 3-3: SU-MIMO Type II PMI test parameters**Issue 3-3-1: Type II codebook constructionWe support the recommended WF.Issue 3-3-2: Npsk (phaseAlphabetSize) for type II codebook constructionWe support the recommended WF.Issue 3-3-3: subbandAmplitude for type II codebook constructionWe support the recommended WF.Issue 3-3-4: PMI-FormatIndicator for type II codebookOption 2. We support the recommended WF.Issue 3-3-5: MIMO correlation for type II codebookWe support the recommended WF.Issue 3-3-6: MIMO correlation for type II codebookWe support the recommended WF.Issue 3-3-7: Beam steering model for Type II CodebookIssue 3-3-8: Implementation of random type II PMIWe need some time to check.**Sub-topic 3-4: MU-MIMO Type II PMI test parameters**No comments as we support SU-MIMO setup. |
| **Ericsson** | **Sub-topic 3-1: Type I PMI test**Issue 3-1-1: Gamma (gain) valuesWe are ok with Option 1.**Sub-topic 3-2: Type II PMI test setup**Issue 3-2-1: Test setup for type IIWe’re proposing an MU-MIMO based test setup based on the intended deployment scenario for Type II codebooks. SU-MIMO has seen marginal to no gains when comparing Type I codebook with Type II codebook. Furthermore, we agree that from a UE perspective there is no difference in how the PMI will be reported irrespective of an SU-MIMO, or MU-MIMO test setup. With these two points in mind this leaves room for a poor UE implementation where a Type I CSI report could be reported with Type II format and still pass RAN4 testing, whereas in a MU-MIMO test case we’ve shown in our simulations that proper Type II CSI reporting is needed to achieve maximum theoretical throughput. The SU-MIMO test furthermore does not fulfil the purpose of ensuring that the channel state information reported to the BS enables selection of orthogonal MU-MIMO beam parings. Without a proper test, the network will not know whether UE implementations vary and will not be able to ensure that MU-MIMO orthogonality is achievable, and the MU-MIMO feature, which is an important building block of NR would risk to become a paper feature with little ability to provide gain.Justifiably we think RAN4 should implement test setups which would share similarities for the intended use case. In this case Type II PMI codebook are inherently designed for an MU-MIMO operation in a live network. Thus, it does not make sense to simply reuse the test method from SP Type I requirements since the two codebooks are designed for different operation.**Sub-topic 3-4: MU-MIMO Type II PMI test parameters**Issue 3-4-1: Test metric for MU-MIMO Type II PMIFor the purpose of defining performance requirements we support Option 2 comparing Type II with Type I. Type II codebook was developed to extend the MU-MIMO support of NR. Employing a Random PMI does not make sense since this will never be a precoding scheme employed at the gNB side. Thus, for benchmarking purposes the logical reference performance would be Type I codebook with a similar configuration.Issue 3-4-3: Npsk (phaseAlphabetSize) for MU-MIMO Type II PMIWe see in our simulations that 8PSK provides a better performance over 4PSK, therefore we propose phaseAlphabetSize 8Issue 3-4-4: L for MU-MIMO Type II PMIIn our simulations we see performance gains with configuring 4 DFT beams, therefore we propose L=4.Issue 3-4-5: SubbandAmplitude for MU-MIMO Type II PMIWe see performance gains with SubbandAmplitude set to ‘TRUE’.Issue 3-4-6: Subband size for MU-MIMO Type II PMIThere’s a small gain when configuring subband size 4, and 8 for FDD, and TDD respectively. Therefore, we propose to use 4, and 8.Issue 3-4-7: Channel model for MU-MIMO Type II PMIWe prefer a channel model with a large delay spread to get frequency selectivity across the subband size. In RAN4 we have defined TDLC with 300ns delay spread which is the largest delay spread currently defined.Issue 3-4-8: Impairment model for MU-MIMO Type II PMIWe are not sure whether an impairment model is needed for this scenario. The interference coming from a co-scheduled UE may be sufficient from a testing purpose perspective.Issue 3-4-9: Rank and MCS for MU-MIMO Type II PMIIn our simulations we see that MCS7 Rank1 can achieve maximum throughput which is the MCS we select.Issue 3-4-10: ZF-precoding model for MU-MIMO Type II PMIFor ZF-precoding model we think it is necessary for TE-vendors to comment on what’s feasible from their perspective. We have a couple of different options in our paper, but our preference would be to use the PMI values sent from both the DUT and the co-scheduled as input to the ZF-algorithm since this would mimic the scenario used in a live network. However, we are open to other options based on the input on what’s feasible and based on other companies’ views.  |
| Rohde & Schwarz | **Issue 3-2-1: Test setup for type II**Agree with the proposed WF to align with eMIMO discussions. In case separated discussion is necessary, we support SU-MIMO.**Issue 3-3-1: Type II codebook construction**We also support Option 1: 16Tx.**Issue 3-3-7: Beam steering model for Type II Codebook**Agree with recommended WF.**Sub-topic 3-4: MU-MIMO Type II PMI test parameters**We support to utilize SU-MIMO testing, so no detailed comments.  |
| Intel | **Issue 3-1-1: Gamma (gain) values**Support Option 2 for 16 and 32 Tx. New proposal from CTC (i.e. 2.5 for 16 Tx and 5.0 for 32 Tx) is also fine for us. |
| Orange | **Issue 3-2-1: Test setup for type II**We support Option 2 in order to ensure the right performance for MU-MIMO with codebook type II, i.e., to ensure that the UE feedback is the closest to the eigenvectors of the MIMO channel.  |
| Anritsu | **Issue 3-2-1: Test setup for type II**In our understanding the purpose of the test is to check that the UE provides the correct Type II feedback, and that this only shows up as performance improvement of the UE under test when the Test system emulates the eNB precoding in a scenario with another co-scheduled UE.Further we understand that the eNB precoding with another co-scheduled UE is not itself standardised (please confirm) so a precoding algorithm would need to be defined to meet the test purpose, and implemented in the test system. The test system would receive feedback only from the UE under test, not from the co-scheduled UE. The proposed test metric could be T-put using Type II PMI compared to T-put using Type I PMI. Definition of a test like this appears to need:a) A defined and agreed precoding algorithm in the test systemb) An agreed requirement metricc) Simulations from UE vendors providing requirement values for the chosen metricInitial indications are that the test could be implemented by the test system, subject to sufficiently clear definitions, but would need detailed confirmation.We note that at present there doesn’t appear to be consensus among UE vendors that the test would be usefully testing the UE. |
| Samsung | **Sub-topic 3-1: Type I PMI test**Issue 3-1-1: Gamma (gain) valuesWe suggest to discuss in the 2nd round based on the simulation results input from interested companies.**Sub-topic 3-2: Type II PMI test setup**Issue 3-2-1: Test setup for type IIWe are fine with recommend WF**Sub-topic 3-3: SU-MIMO Type II PMI test parameters**Issue 3-3-1: Type II codebook constructionWe are fine with option 1Issue 3-3-2: Npsk (phaseAlphabetSize) for type II codebook constructionWe prefer option 2 and recommend WFWith narrow PMI sub-band size and larger value of Npsk, we can maximize number of candidate codebooks and number of sub-band for PMI reporting. From UE processing respective, this requires maximum UE calculation complexity and acts like a pressure testIssue 3-3-3: subbandAmplitude for type II codebook constructionWe prefer option 2 and recommend WFIssue 3-3-4: PMI-FormatIndicator for type II codebookWe prefer option 2 and recommend WFIssue 3-3-5: MIMO correlation for type II codebookWe are fine with recommend WFIssue 3-3-6: MCS and rank for type II codebookWe are fine with recommend WFIssue 3-3-7: Beam steering model for Type II CodebookWe are fine with recommended WF and option 3. Although only two beams is configured in beam steering model for Rel-16 type II test cases, from future proof manner, we think it is more proper to use a generic beam steering approach, which can be applied for PMI test cases with different codebook types i.e. single beam direction (Type I codebook), dual beam directions (Rel-15 Type II codebook) and multi-beam directions (Rel-16 Type II codebook). We think there is no impact on current test for type II codebook.Issue 3-3-8: Implementation of random type II PMIWe need time to check and discussion in 2nd round**Sub-topic 3-4: MU-MIMO Type II PMI test parameters**Issue 3-4-1: Test metric for MU-MIMO Type II PMIWe are also fine with TP ratio between following PMI and random PMI.Issue 3-4-2: Codebook construction for MU-MIMO Type II PMIIn our contribution, we propose apply the same codebook construction in both MU-MIMO and SU-MIMO setupOption 2: 16 Tx ports (N1,N2) =(4,2), (O1,O2) =(4,4)Issue 3-4-3: Npsk (phaseAlphabetSize) for MU-MIMO Type II PMIIn our contribution, we propose apply the Npsk in both MU-MIMO and SU-MIMO setupOption 1: 8Issue 3-4-4: L for MU-MIMO Type II PMIWe prefer use the same number of beam as 2 in both MU-MIMO and SU-MIMO setupOption 2: 2Issue 3-4-5: SubbandAmplitude for MU-MIMO Type II PMIIn our contribution, we propose apply the same value for subbbandAmpltude in both MU-MIMO and SU-MIMO setupWe are fine option1Issue 3-4-6: Subband size for MU-MIMO Type II PMIIn our contribution, we propose apply the same value for subband size in both MU-MIMO and SU-MIMO setupOption 1: 4 for FDD and 8 for TDDIssue 3-4-7: Channel model for MU-MIMO Type II PMIWe prefer TDLA30-5, which can be regarding as baseline, reuse from assumption for type IIssue 3-4-8: Impairment model for MU-MIMO Type II PMIWe think more clarification is needed. With MU-MIMO setup, if there is no beam steering model for DUT and co-located UE, how can guarantee the different beam directions for each UE?Issue 3-4-9: Rank and MCS for MU-MIMO Type II PMIWe are fine with option1 with Rank1, while the MCS, we suggest with high MCS, which is similar assumption with type I codebook requirement. The current MCS is too low, it cannot guarantee the benefit of MU-MIMO compared with SU-MIMO test up.Issue 3-4-10: ZF-precoding model for MU-MIMO Type II PMIWe are fine with option1, but other options is not precluded |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2011014, Huawei, CR on Applicability  | Qualcomm: Looks ok |
| Company B |
|  |
| R4-2011367, Ericsson, CR on tests, FRCs, correlation matrices | Qualcomm: Looks ok |
| Ericsson: if we can agree to a gain requirement for SP Type I we can revise TBD to [] value instead.  |
|  |

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**  |
| **Topic #3: UE PMI reporting** | **Sub-topic 3-1: Type I PMI test*** Issue 3-1-1: Gamma (gain) values
	+ Summary of companies’ proposals:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | CTC, HW, Ericsson | Samsung, Intel | Intel, CTC | QC | Apple |
| 16T2R | 2.5 | 2.0 | 2.5 | 2.0 | 2.6 |
| 16T4R | 3.5 | 2.0 | 2.5 | 3.0 | 2.6 |
| 32T2R | 5.0 | 4.5 | 5.0 | 4.5 |  |
| 32T4R | 8.0 | 4.5 | 5.0 | 8.0 |  |

*Recommendations for 2nd round:*Five different proposals were given in the 1st round, due to the different simulation results for both random and follow PMIs. So further checking on the simulation results is needed.**Sub-topic 3-2: Type II PMI test setup*** Issue 3-2-1: Test setup for type II
	+ Option 1: Only use SU-MIMO test setup, i.e., one tested UE (CTC, Huawei, Apple, Qualcomm, R&S)
	+ Option 2: MU-MIMO based test setup, i.e., one tested UE + one co-scheduled UE (generated by TE) (Ericsson, Orange)
	+ 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)

Feedback from TE venders:* + R&S: Reuse the agreement from Rel-16 eMIMO demod, since from testability aspect these discussions should be the same.
	+ Anritsu: Definition of a test like this appears to need: a) A defined and agreed precoding algorithm in the test system b) An agreed requirement metric c) Simulations from UE vendors providing requirement values for the chosen metric. Initial indications are that the test could be implemented by the test system, subject to sufficiently clear definitions, but would need detailed confirmation.

 *Tentative agreements:* * + Reuse the agreement from Rel-16 eMIMO demod (HW, CTC, R&S, Samsung)

**Sub-topic 3-3: SU-MIMO Type II PMI test parameters*** Issue 3-3-1: Type II codebook construction

*Tentative agreements:* * + 16Tx ports (N1, N2) = (4,2), (O1, O2) = (4,4) (CTC, Apple, Samsung, Huawei, Qualcomm, R&S)
* Issue 3-3-2: Npsk (phaseAlphabetSize) for type II codebook construction

*Tentative agreements:* * + Agree to use Npsk of 8 (Apple, Samsung, Qualcomm, Huawei)
		- HW: 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: subbandAmplitude for type II codebook construction
	+ 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.

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round and see if option 2 is acceptable.
* Issue 3-3-4: PMI-FormatIndicator for type II codebook
	+ Option 1: Wideband (Huawei)
		- HW: In our simulation results that the gain brought by subband is limited as a maximum 0.6dB. Wideband should be supported if UE supports Type II codebook while subband can be optional. Thus, using wideband for testing can cover more UEs.
	+ Option 2: Subband (Apple, Samsung, Qualcomm)

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round and see if option 2 is acceptable.
* Issue 3-3-5: MIMO correlation for type II codebook
	+ Option 1: XP High (Qualcomm)
		- QC: Prefer option 1 similar to existing PMI reporting tests.
	+ 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: As SNR differences between configurations are more obvious when using XP medium, we slightly prefer option 2.

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round and see if option 2 is acceptable.
* Issue 3-3-6: MCS and rank for type II codebook

*Tentative agreements:** + Confirm the baseline agreed in the last meeting, i.e., use MCS 20 and rank 2 (Samsung, Huawei, CTC, QC, Apple)
* Issue 3-3-7: Beam steering model for Type II Codebook

*Tentative agreements:** + 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
	+ 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)
		- Beam randomization:
			* Option 1: Randomly select a beam combination from a set which include all possible beam combinations (Huawei)
			* Option 2: Limit the set of possible beams to the possible beams under the configuration of following PMI (Qualcomm, HW)
		- Amplitude and phase coefficient randomization:
			* Option 1: 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. (Huawei)

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round.
* Issue 3-3-9: Subband size for SU-MIMO Type II PMI
	+ Option 1: 4 for FDD and 8 for TDD (Samsung)
	+ Option 2: 8 for FDD and 16 for TDD

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round.

**Sub-topic 3-4: MU-MIMO Type II PMI test parameters*** Issue 3-4-1: Test metric for MU-MIMO Type II PMI
	+ Option 1: TP ratio between following PMI and random PMI (Samsung)
	+ Option 2: TP ratio between following Type II codebook and following SP Type I codebook (Ericsson)
		- Ericsson: Type II codebook was developed to extend the MU-MIMO support of NR. Employing a Random PMI does not make sense since this will never be a precoding scheme employed at the gNB side.
* Issue 3-4-2: Codebook construction for MU-MIMO Type II PMI
	+ Option 1: 32Tx ports (N1, N2) = (4,4), (O1, O2) = (4,4) (Ericsson)
	+ Option 2: 16Tx ports (N1, N2) = (4,2), (O1, O2) = (4,4) (Samsung)
* Issue 3-4-3: Npsk (phaseAlphabetSize) for MU-MIMO Type II PMI
	+ Option 1: 8 (Ericsson, Samsung)
		- Ericsson: 8PSK provides a better performance over 4PSK
* Issue 3-4-4: L for MU-MIMO Type II PMI
	+ Option 1: 4 (Ericsson)
		- Ericsson: we see performance gains with configuring 4 DFT beams
	+ Option 2: 2 (Samsung)
* Issue 3-4-5: SubbandAmplitude for MU-MIMO Type II PMI
	+ Option 1: true (Ericsson, Samsung)
		- Ericsson: See performance gains with SubbandAmplitude set to ‘TRUE’.
* Issue 3-4-6: Subband size for MU-MIMO Type II PMI
	+ Option 1: 4 for FDD and 8 for TDD (Ericsson, Samsung)
		- Ericsson: There’s a small gain when configuring subband size 4, and 8 for FDD, and TDD respectively.
* Issue 3-4-7: Channel model for MU-MIMO Type II PMI
	+ Option 1: TDLC300-5 (Ericsson)
		- Ericsson: We prefer a channel model with a large delay spread to get frequency selectivity across the subband size
	+ Option 2: TDLA30-5 (Samsung)
* Issue 3-4-8: Impairment model for MU-MIMO Type II PMI
	+ Option 1: Not introducing impairment model (Ericsson)
		- Ericsson: We are not sure whether an impairment model is needed for this scenario. The interference coming from a co-scheduled UE may be sufficient from a testing purpose perspective.
	+ FFS (Samsung)
		- Samsung: With MU-MIMO setup, if there is no beam steering model for DUT and co-located UE, how can guarantee the different beam directions for each UE
* Issue 3-4-9: Rank and MCS for MU-MIMO Type II PMI
	+ Rank:
		- Option 1: Rank 1 (Ericsson, Samsung)
			* Ericsson: we see that MCS7 Rank1 can achieve maximum throughput
	+ MCS:
		- MCS7 (Ericsson)
		- Higher MCS (Samsung)
			* Samsung: The current MCS is too low, it cannot guarantee the benefit of MU-MIMO compared with SU-MIMO test up.
* Issue 3-4-10: ZF-precoding model for MU-MIMO Type II PMI
	+ Option 1: (Xa, Xb) = (PMIa, PMIb) as the zero-forcing method (Ericsson, Samsung)
	+ Other options are not precluded (Samsung)
 |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Way forward on PMI reporting requirements for Tx ports larger than 8 and up to 32 | Ericsson, Samsung |
| #2 | Simulation assumptions for NR PMI reporting requirements for more than 8 Tx ports | Ericsson |

### 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”* |
| R4-2011014, Huawei, CR on Applicability  | *Agreeable* |
| R4-2011367, Ericsson, CR on tests, FRCs, correlation matrices | *Agreeable*Note: recommend to agree the CR in this meeting, and add the type I gain requirements in the next meeting. |

## 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 SCSProposal 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 1Number 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 requirementsProposal 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 1Number 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** |
| Huawei, HiSilicon | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA**Issue 4-1-1: Channel bandwidth combination for defining performance requirementsOK with recommended WFIssue 4-1-2: Channel bandwidth combination for testingOK with recommended WFIssue 4-1-3: PDSCH RB allocationOK with recommended WFIssue 4-1-4: MCSWe support option 1We 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 4RxIssue 4-1-5: Other test applicability aspectsProposal 1 is OK for us.**Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC**Issue 4-2-1: Tested carrierOK with option 1.Issue 4-2-2: Channel bandwidth combination for defining performance requirementsOK with recommended WFIssue 4-2-3: Channel bandwidth combination for testingCompared 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: SCSStill prefer 30kHz SCS only for TDD. Issue 4-2-5: TDD patternWe support 7D1S2U for 30kHz and no need for 15kHz SCSIssue 4-2-6: Test applicability and special inter-band EN-DCBoth Option 1 and Option 2 are ok for us.Issue 4-2-7: Other test parametersOK with proposal 1 and proposal 2 if no further technical issues will be figured out.  |
| China Telecom | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA**Issue 4-1-1: Channel bandwidth combination for defining performance requirementsSupport the recommended WF.Issue 4-1-2: Channel bandwidth combination for testingSupport the recommended WF.Issue 4-1-3: PDSCH RB allocationSupport the recommended WF.Issue 4-1-4: MCS* + Modulation order: support 64QAM for 2Rx and 4Rx
	+ MCS: support option 1 (MCS 27 for 2Rx, MCS 28 for 4Rx) based on our simulation results

Issue 4-1-5: Other test applicability aspectsSupport the proposal 1.**Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC**Issue 4-2-1: Tested carrierSupport option 1.Issue 4-2-2: Channel bandwidth combination for defining performance requirementsSupport option 1.Issue 4-2-3: Channel bandwidth combination for testingAn further updated option 3 based on Huawei’s proposal provided in the 1st round, and also take into account CMCC’s proposal to consider the aggregated carriers for LTE.* + - Step 1: First select the CBW combinations with the **same BWs between LTE carrier (single carrier or aggregated contiguous carriers**) and NR 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 **(aggregated)** BW of LTE carrier**(s)**.
			* Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between **NR carrier and LTE carrier(s)**
		- Step 2: Among the CBW combinations selected from Step 1, select the CA combination with the largest aggregated CBW

Issue 4-2-7: Other test parametersOK with proposal 1 and proposal 2 if no further technical issues will be figured out. |
| Qualcomm | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA**Issue 4-1-1: Channel bandwidth combination for defining performance requirementsOk with recommended WFIssue 4-1-2: Channel bandwidth combination for testingOk with recommended WFIssue 4-1-3: PDSCH RB allocationOk with recommended WFIssue 4-1-4: MCSOk with recommended WF. We need to agree on impairment margin. In our simulations, we added 0.8dB on top of our impairment results to derive the requirements like it was done in normal NR demod test cases while other companies assumed total impairment margin of 2dB. That also impacts the proposed MCS.Issue 4-1-5: Other test applicability aspectsNeed more time to check.**Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC**Issue 4-2-1: Tested carrierOk with recommended WFIssue 4-2-2: Channel bandwidth combination for defining performance requirementsOk with recommended WFIssue 4-2-3: Channel bandwidth combination for testingOk with option 1 with one correction in Step 3: “CA” should be replaced by “EN-DC”.Issue 4-2-4: SCSPrefer Option 1.Issue 4-2-5: TDD patternNo preference.Issue 4-2-6: Test applicability and special inter-band EN-DCNo strong preference.Issue 4-2-7: Other test parametersOk with recommended WF. |
| SoftBank | **Issue 4-2-6: Test applicability and special inter-band EN-DC**Support Option 1. It is starightfoward that the test applicability include all the band combinations the minimum requirements for intra-band EN-DC are applied. "*interBandContiguousMRDC*" is used for the inter-band combination where the frequency range of the E-UTRA band is subset of the frequency range of the NR band, such as DC\_42\_n77/n78. 38.101-3 describes that the requirements for intra-band EN-DC are applied to those combinations.  |
| CMCC | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA**Issue 4-1-1: Channel bandwidth combination for defining performance requirementsSupport the recommended WFIssue 4-1-2: Channel bandwidth combination for testingSupport the recommended WFIssue 4-1-3: PDSCH RB allocationSupport the recommended WF**Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC**Issue 4-2-1: Tested carrierOK with recommended WFIssue 4-2-2: Channel bandwidth combination for defining performance requirementsOK with recommended WFIssue 4-2-3: Channel bandwidth combination for testingSupport Option 2. Agree to moderator’s observation that we cannot directly choose the carrier with smaller CBW for testing. From Table 5.3B.1.2-1 and Table 5.3B.1.3-1 in TS 38.101-3, It can be observed there are cases that NR carrier CBW is always larger than LTE carrier, such as DC\_(n)41AA and DC\_41A\_n41A. In this case, it is necessary to clarify how to allocate the test RBs on NR carriers. As stated in Option2:* 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.

Besides, we think the case that the BW of aggregated LTE carriers is same with NR carrier BW is a special case of the same BWs between LTE carrier and NR carrier, and it should be clarified in the statement.Issue 4-2-4: SCSEither Option 1 and Test#2b is OK to us.Issue 4-2-5: TDD patternSupport Option 1. For intra-band contiguous EN-DC, the NR UL/DL configuration should be aligned with LTE in order to avoid the interference. The LTE TDD configuration DSUDD is widely used in LTE deployment.Issue 4-2-6: Test applicability and special inter-band EN-DCIf it is common understanding RAN4 agreed that some inter-band EN-DC combinations like B42-n77 are treated as "intra-band EN-DC", then both Option1 and Option2 is OK for us, i |
| Ericsson | Issue 4-2-4: SCSSupport Option 1. According to TS38.101-3, RAN4 assumes B3+n3A, B7+n7, B66+n66, B41+n41, and B42+n77/n78 for intra-band EN-DC. In these combinations, the TDD bands are n41 and n77/n78. Since these bands are so called mid-band (>2.5GHz) and SCS=30kHz is used in our understanding. Therefore we don’t think RAN4 need to define the case with SCS=15kHz for NR TDD. Issue 4-2-6: Test applicability and special inter-band EN-DCSupport option 1. In our understanding the reason RAN4 did not introduce ‘n42’ is because this frequency band is a part of band n77/n78. Therefore, we think B42-n77/n78 should be considered as intra-band EN-DC.  |
| Intel | **Issue 4-1-1: Channel bandwidth combination for defining performance requirements**Support recommended WF**Issue 4-1-2: Channel bandwidth combination for testing**Support recommended WF**Issue 4-1-3: PDSCH RB allocation**Support recommended WF**Issue 4-1-4: MCS**We are fine to agree that 64QAM will be used for requirements. As for MCS selection, we can list possible options in this meeting and decide in the next meeting based on collection of simulation results from different companies.**Issue 4-1-5: Other test applicability aspects**Need more time to double check LTE CA power imbalance assumptions.**Issue 4-2-1: Tested carrier**Ok with recommended WF**Issue 4-2-2: Channel bandwidth combination for defining performance requirements**Ok with recommended WF**Issue 4-2-3: Channel bandwidth combination for testing**For intra-band contiguous EN-DC, we are fine to reuse methodology from intra-band contiguous CA. As for intra-band non-contiguous EN-DC, we think that more discussion is needed, because selection of scenarios with the sane CBW can be not the worst case form image point of view (please find below the example) **Issue 4-2-4: SCS**Support Option 2. Supported SCS is up to UE capability. If we go with Option 1 then we can have the chance that TDD scenarios will not be tested for power imbalance requirements.**Issue 4-2-5: TDD pattern**In previous meeting, 7D1S2U TDD pattern was agreed for 30 kHz SCS. It means that start of LTE transmission will be delayed by 2 subframes to ensure alignment with LTE UL/Dl pattern. Therefore, we propose to use Option 2 to avoid situation that for 30 kHz case we have this shift, but for 15 kHz case we don’t have this shift.**Issue 4-2-6: Test applicability and special inter-band EN-DC**We understand that that for some inter-band EN-DC configuration, intra-band RF requirements are applied. Same time, WID clear indicates that from demodulation requirements point of view we consider only intra-band EN-DC scenarios for power imbalance tests. Therefore, we suggest to use general 3GPP procedure and first include such scenarios in the scope of WI.**Issue 4-2-7: Other test parameters**Ok with recommended WF. |
| docomo | Sub-topic 4-1: Requirements for FR1 intra-band contiguous CAIssue 4-1-1: Channel bandwidth combination for defining performance requirementsWe are OK with the recommended WF.Issue 4-1-2: Channel bandwidth combination for testingWe are OK with the recommended WF.Issue 4-1-3: PDSCH RB allocationWe are OK with the recommended WF.Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DCIssue 4-2-1: Tested carrierWe are OK with the recommended WF.Issue 4-2-2: Channel bandwidth combination for defining performance requirementsWe prefer Option 1.Issue 4-2-3: Channel bandwidth combination for testingOur proposal is based on China Telecom 's updated Option 3 but with some suggestions highlighted in RED.* + - Step 1: First select the CBW combinations with the same BWs between LTE carrier (single carrier or aggregated contiguous carriers) and NR carrier. If there is no such CBW combination, go to Step 1a, Step 1b and Step 1c.
			* Step 1a: Select the CBW combinations that the BW of NR carrier is smaller than the (aggregated) BW of LTE carrier(s). If there is no such CBW combination, go to Step 1c.
			* Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between NR carrier and LTE carrier(s)
			* Step 1c: select the EN-DC combinations with smallest CBW difference between the NR carrier and LTE carrier(s).
		- Step 2: Among the CBW combinations selected from Step 1, select the EN-DC combination with the largest aggregated CBW

Issue 4-2-4: SCSTotal number of testing will not be increased even if we choose Option 2. Therefore, our preference is Option 2b. Issue 4-2-6: Test applicability and special inter-band EN-DCOur preference is still Option 1. From our understanding, some of the inter-band EN-DC are treated as intra-band EN-DC based on the RAN4 specification. Therefore, intra-band EN-DC requirements should be applied to the aforementioned special inter-bands EN-DC.Issue 4-2-7: Other test parametersWe are OK with both proposal 1 and proposal 2 unless further technical issues will be identified. **As a note with our suggestion. Similar to the other Rel.16 UE demod topics, we prefer to treat power imbalance requirement as the release independent from Rel.15, that we like to hear the other companies’ view.** |

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2011040, EN-DC power imbalance requirements, DCM | Qualcomm: Table 9.5B.1.2.1.1-1 is missing. |
| Ericsson: Since this is DC scenario, we are wondering if Pcell/Scell is correct terminology. Use MCG CC/SCG CC? There’s also spelling error, should be “power imbalance” under section header 9.5B.1.2. |
|  |

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**  |
| **Topic #4: UE power imbalance requirement** | **Sub-topic 4-1: Requirements for FR1 intra-band contiguous CA*** Issue 4-1-1: Channel bandwidth combination for defining performance requirements

*Tentative agreement:*Define generic methodology for selection of CBW combination among all CBW combinations in supported CA configurations, and define bandwidth agnostic requirements. (HW, CTC, QC, CMCC, Intel, DCM)* Issue 4-1-2: Channel bandwidth combination for testing

*Tentative agreement:* 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, QC, DCM)* Issue 4-1-3: PDSCH RB allocation

*Tentative agreement:*Full RB allocation (CMCC, HW, QC, CTC, Intel, DCM)* Issue 4-1-4: MCS

*Tentative agreement:* Modulation order: 64QAM for 2Rx and 4Rx*Recommendations for 2nd round:*For MCS, further check the simulation results, taking into account the impairment margin and extra margin of 0.8dB.* + Option 1: MCS 27 for 2Rx, MCS 28 for 4Rx (CTC, Intel, HW)
	+ Option 3: MCS 25 for 2Rx (QC)
* Issue 4-1-5: Other test applicability aspects

*Candidate options:** + Option 1: Reuse the following applicability rule from LTE CA power imbalance test (CTC, HW)
		- 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.

*Recommendations for 2nd round:*Further check the above option 1. **Sub-topic 4-2: Requirements for intra-band contiguous and non-contiguous EN-DC*** Issue 4-2-1: Tested carrier

*Tentative agreement:* Allocate the test RBs on NR carrier (CMCC, HW, CTC, QC, Intel, DCM, aligned with the WID in RP-200472)* Issue 4-2-2: Channel bandwidth combination for defining performance requirements

*Tentative agreement:* Reuse the agreement from FR1 intra-band contiguous CA (CTC, HW, DCM, QC, CMCC, Intel)* Issue 4-2-3: Channel bandwidth combination for testing
	+ Option 1 (CTC, QC)
		- 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~~ EN-DC 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.
	+ Updated Option 3 (HW)
		- 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
	+ Option 5 (New option based on option 2 and option 3, DCM, CTC)
		- Step 1: First select the CBW combinations with the same BWs between LTE carrier (single carrier or aggregated contiguous carriers) and NR carrier. If there is no such CBW combination, go to Step 1a, Step 1b and Step 1c.
			* Step 1a: Select the CBW combinations that the BW of NR carrier is smaller than the (aggregated) BW of LTE carrier(s). If there is no such CBW combination, go to Step 1c.
			* Step 1b: Among the CBW combinations selected from Step 1a, select the CBW combinations with the smallest CBW difference between NR carrier and LTE carrier(s)
			* Step 1c: select the EN-DC combinations with smallest CBW difference between the NR carrier and LTE carrier(s).
		- Step 2: Among the CBW combinations selected from Step 1, select the EN-DC combination with the largest aggregated CBW
	+ **Additional issue for intra-band non-contiguous EN-DC:** selection of scenarios with the sane CBW can be not the worst case form image point of view (Intel)

 *Recommendations for 2nd round:*For intra-band contiguous EN-DC, further check the above options, and discuss the following aspects:* + Is it ok to consider the aggregated contiguous carriers for LTE if UE supports it?
	+ Whether to test partial PRB or full PRB for NR carrier, in case the CBW is different in LTE carrier(s) and NR carrier?

For intra-band non-contiguous EN-DC, further discuss the additional issue raised by Intel.* Issue 4-2-4: SCS
	+ Option 1: 30kHz (HW, QC, CMCC, E///)
	+ Option 2: 15kHz and 30kHz (CMCC, Intel, DCM)
		- Test #2b: LTE TDD + NR TDD 30 kHz, in case UE supports it, otherwise LTE TDD + NR TDD 15 kHz (CMCC, Intel, DCM)

*Recommendations for 2nd round:*Further discuss and down-select one of the two options. If option 2 is adopted, use Test #2b.* Issue 4-2-5: TDD pattern for 15kHz SCS
	+ Option 1: DSU+DD (CMCC)
		- CMCC: For intra-band contiguous EN-DC, the NR UL/DL configuration should be aligned with LTE in order to avoid the interference. The LTE TDD configuration DSUDD is widely used in LTE deployment.
	+ Option 2: DDDSU (Intel)
		- Intel: In previous meeting, 7D1S2U TDD pattern was agreed for 30 kHz SCS. It means that start of LTE transmission will be delayed by 2 subframes to ensure alignment with LTE UL/Dl pattern. Therefore, we propose to use Option 2 to avoid situation that for 30 kHz case we have this shift, but for 15 kHz case we don’t have this shift.
	+ Option 3: Not needed (HW, QC)

*Recommendations for 2nd round:*Further discuss by taking into account the outcome of Issue 4-2-4.* Issue 4-2-6: Test applicability and special inter-band EN-DC
	+ Select Option 1 (HW, DCM, SoftBank, CMCC, E///)
		- 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, HW)
		- Intel: inter-band (NG)EN-DC/NE-DC combination is out of scope of this work item.

*Recommendations for 2nd round:*Further check the possibility of agreeing option 1.* Issue 4-2-7: Other test parameters
	+ Proposal 1: For the other test parameters and applicability rules, if not explicitly discussed, reuse the same agreements from CA power imbalance test.
	+ Proposal 2: the following test parameters should be applied for EN-DC (aligned with the agreed parameters for NR CA)

|  |  |
| --- | --- |
| Parameters | Value |
| Reference testing point | 85% of maximum throughput  |
| PDSCH DMRS configurations | DMRS type: Type 1Number 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 |

*Tentative agreement:* Agree the above proposal 1 and proposal 2 as baseline if no technical issues will be figured out. |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Way forward on UE power imbalance requirements for FR1 CA and EN-DC | NTT DOCOMO |

### 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”* |
| R4-2011040, EN-DC power imbalance requirements, DCM | *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** |
| Huawei, HiSilicon | **Sub-topic 5-1: Duplex mode and SCS combinations** Issue 5-1: Duplex mode and SCS combinationsWe support Option 2. **Sub-topic 5-2: Channel bandwidth and test applicability rule**Issue 5-2: Channel bandwidth and test applicability ruleOK with recommended WF**Sub-topic 5-3: TDD UL-DL pattern** Issue 5-3: TDD UL-DL pattern for 120 kHz SCSWe 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 testWe support Option 1 to keep the previous agreement.Issue 5-4-2: Signal power density for 2Rx and 4Rx bandsOK with recommended WF.**Sub-topic 5-5: Test metric** Issue 5-5-1: SNR configuration for 2DL CA CQI testWe support Option 1Issue 5-5-2: SNR configuration for 3DL CA CQI testWe support Option 1.Issue 5-5-3: Delta CQI threshold OK with recommended WF. |
| China Telecom | **Sub-topic 5-1: Duplex mode and SCS combinations** Issue 5-1: Duplex mode and SCS combinationsSupport option 1. As expressed in the last meeting and in our paper to this meeting, our concern on option 2 is that FDD 15 kHz +TDD 30kHz CA is not covered. If one UE only supports FDD-TDD CA (i.e., not support FDD + FDD CA and TDD + TDD CA in FR1), there will be no requirements for the UE.Defining the performance requirement based on option 1, and only testing 2 of the 3 cases are already a compromise between the two options. Hope this compromise can be reconsidered by companies.**Sub-topic 5-2: Channel bandwidth and test applicability rule**Issue 5-2: Channel bandwidth and test applicability ruleAgree with the recommended WF.**Sub-topic 5-3: TDD UL-DL pattern** Issue 5-3: TDD UL-DL pattern for 120 kHz SCSAgree with the recommended WF.**Sub-topic 5-4: Antenna configuration** Issue 5-4-1: Antenna configuration for 2Rx and 4Rx testAgree with the recommended WF.Issue 5-4-2: Signal power density for 2Rx and 4Rx bandsAgree with the recommended WF.**Sub-topic 5-5: Test metric** Issue 5-5-1: SNR configuration for 2DL CA CQI testWe understand the motivation of option 2 to set higher SNR levels while keeping the same SNR difference between CCs.But given the test purpose of CA CQI is to verify independent CQI calculation in different CCs, option 1 could also serve this purpose.Therefore, both options could be fine to us. For the progress, option 1 is preferred since it has been simulated and confirmed by majority companies.Issue 5-5-2: SNR configuration for 3DL CA CQI testSame comment as for issue 5-5-1.Issue 5-5-3: Delta CQI threshold Agree with the recommended WF. |
| Qualcomm | **Sub-topic 5-1: Duplex mode and SCS combinations** Issue 5-1: Duplex mode and SCS combinationsPrefer Option 2.**Sub-topic 5-2: Channel bandwidth and test applicability rule**Issue 5-2: Channel bandwidth and test applicability ruleNeed more time to check**Sub-topic 5-3: TDD UL-DL pattern** Issue 5-3: TDD UL-DL pattern for 120 kHz SCSOk with recommended WF.**Sub-topic 5-4: Antenna configuration** Issue 5-4-1: Antenna configuration for 2Rx and 4Rx testOk with recommended WF.Issue 5-4-2: Signal power density for 2Rx and 4Rx bandsOk with recommended WF.**Sub-topic 5-5: Test metric** Issue 5-5-1: SNR configuration for 2DL CA CQI testPrefer Option 1. If we change the SNR, we will have to rerun the simulations to confirm this. Also, for FR2, higher SNR may mean that very few aggregated CBWs may get tested.Issue 5-5-2: SNR configuration for 3DL CA CQI testSame comment as for Issue 5-5-1.Issue 5-5-3: Delta CQI threshold Ok with recommended WF. |
| CMCC | **Sub-topic 5-1: Duplex mode and SCS combinations** Issue 5-1: Duplex mode and SCS combinationsFor the performance requirements, Option 1 is preferred.For the applicability rule, we think the Test#1 Test#2 and Test#3 in Option 1 are all typical CA scenarios, all of them should be covered in test applicability rule.**Sub-topic 5-2: Channel bandwidth and test applicability rule**Issue 5-2: Channel bandwidth and test applicability ruleOK with the recommended WF**Sub-topic 5-4: Antenna configuration** Issue 5-4-2: Signal power density for 2Rx and 4Rx bandsOK with the recommended WF |
| Ericsson | **Sub-topic 5-1: Duplex mode and SCS combinations** Issue 5-1: Duplex mode and SCS combinationsWe still prefer option 2. As a compromise, we are also ok to specify CA CQI test with FDD SCS=15kHz+TDD SCS=30kHz. But we don’t want to define TDD with SCS=15kHz. **Sub-topic 5-2: Channel bandwidth and test applicability rule**Issue 5-2: Channel bandwidth and test applicability ruleSupport the recommended WF.**Sub-topic 5-3: TDD UL-DL pattern** Issue 5-3: TDD UL-DL pattern for 120 kHz SCSSupport Option 2. DDSU is also typical FR2 TDD pattern used in the commercial networks. **Sub-topic 5-4: Antenna configuration** Issue 5-4-1: Antenna configuration for 2Rx and 4Rx testOur proposal (Option 2) is to apply the same configuration as single carrier case. We want to listen other companies’ view. Issue 5-4-2: Signal power density for 2Rx and 4Rx bandsSupport the recommended WF.**Sub-topic 5-5: Test metric** Issue 5-5-1: SNR configuration for 2DL CA CQI testSince NR single carrier CQI definition test uses 256QAM CQI table, we prefer to set higher SNR level compared with LTE whose test is defined with 64QAM CQI table. Issue 5-5-2: SNR configuration for 3DL CA CQI testSame comments as 5-5-1. Issue 5-5-3: Delta CQI threshold Support the recommended WF. |
| Intel | **Issue 5-1: Duplex mode and SCS combinations**Prefer Option 2. Same time, we understand the concern from China Telecom. As compromise, we can consider the following approach: * Test #1: FDD 15 kHz + FDD 15 kHz
* Test #2: TDD 30 kHz + TDD 30 kHz
* Test #3: FDD 15 kHz + TDD 30 kHz, in case UE does not support both, FDD-FDD CA and TDD-TDD CA.
 |
| docomo | Sub-topic 5-1: Duplex mode and SCS combinations Issue 5-1: Duplex mode and SCS combinationsWe prefer Option 1.Sub-topic 5-2: Channel bandwidth and test applicability ruleIssue 5-2: Channel bandwidth and test applicability ruleWe are OK with the recommended WFSub-topic 5-3: TDD UL-DL pattern Issue 5-3: TDD UL-DL pattern for 120 kHz SCSBoth Option 1 and Option 2 are OK for us. |

## 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**  |
| **Topic #5: CA CQI** | **Sub-topic 5-1: Duplex mode and SCS combinations** * Issue 5-1: Duplex mode and SCS combinations
	+ For the performance requirements:
		- Option 1: Reuse the duplex mode and SCS combination of PDSCH normal CA requirements (CTC, CMCC, DCM)
		- Option 2: (Ericsson, Huawei, Qualcomm, Intel)
			* FR1: FDD + FDD with 15 kHz SCS and TDD + TDD with 30 kHz SCS
			* FR2: TDD + TDD with 120 kHz SCS
		- Option 3: (Ericsson, Intel)
			* FR1: FDD + FDD with 15 kHz SCS, TDD + TDD with 30 kHz SCS, FDD 15 kHz +TDD 30kHz
			* FR2: TDD + TDD with 120 kHz SCS
	+ Test applicability rule if the above option 1 or option 3 is agreed for FR1:
		- Option A: test 3 cases (CMCC)
			* CMCC: We think the Test#1 Test#2 and Test#3 in Option 1 are all typical CA scenarios, all of them should be covered in test applicability rule
		- Option B: test 2 cases (CTC)
			* CTC: Defining the performance requirement based on option 1, and only testing 2 of the 3 cases are already a compromise between the two options. Hope this compromise can be reconsidered by companies
		- Option C: test 2 or 1 cases (Intel):
			* Test #1: FDD 15 kHz + FDD 15 kHz
			* Test #2: TDD 30 kHz + TDD 30 kHz
			* Test #3: FDD 15 kHz + TDD 30 kHz, in case UE does not support both, FDD-FDD CA and TDD-TDD CA.

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round to seek for a compromise.

**Sub-topic 5-2: Channel bandwidth and test applicability rule*** Issue 5-2: Channel bandwidth and test applicability rule
	+ Is it feasible to define CA CQI performance requirements in a bandwidth agnostic way:
		- Option 1: Yes (CTC, Huawei, CMCC, Ericsson, DCM)
		- Need more time to check (QC)
	+ For the test applicability rule:
		- Option 1 (CTC, Huawei, CMCC, Ericsson, DCM)
			* 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
	+ - Need more time to check (QC)

*Recommendations for 2nd round:** + Encourage QC to check if option 1 for band agnostic requirements and test applicability is acceptable.

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

*Tentative agreements:* 2D1S1U with S=11:3:0 (CTC, Ericsson, Qualcomm, Huawei, DCM)* + HW: We support 3D1S1U considering that it is more typical pattern for FR2 deployment. But we can compromise 2D1S1U by following majority’s view.
	+ DCM: Both options are OK for us.

**Sub-topic 5-4: Antenna configuration** * Issue 5-4-1: Antenna configuration for 2Rx and 4Rx test
	+ Option 1: 1T2R and 1T4R for FR1, and 1T2R for FR2 (Agreement in RAN4 #95e,Huawei, CTC, QC)
	+ Option 2: 2T2R and 2T4R for FR1, and 2T2R for FR2 (Ericsson)
		- Ericsson: Our proposal is to apply the same configuration as single carrier case.

*Recommendations for 2nd round:** + Given AGWN condition is assumed for CA CQI test, can we keep the previous agreement to use option 1?
* Issue 5-4-2: Signal power density for 2Rx and 4Rx bands

*Tentative agreements:* * + 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 (E///, Huawei, CTC, QC, CMCC)

**Sub-topic 5-5: Test metric** * Issue 5-5-1: SNR configuration for 2DL CA CQI test
	+ For FR1
		- Option 1: SNRPcell = 10dB and SNRScell = 4dB (CTC, Huawei, Qualcomm)
			* CTC: Given the test purpose of CA CQI is to verify independent CQI calculation in different CCs, option 1 could also serve this purpose. Therefore, both options could be fine to us. For the progress, option 1 is preferred since it has been simulated and confirmed by majority companies.
			* QC: If we change the SNR, we will have to rerun the simulations to confirm this. Also, for FR2, higher SNR may mean that very few aggregated CBWs may get tested.
		- Option 2: SNRPcell = 16dB and SNRScell = 10dB (Ericsson)
			* Ericsson: Since NR single carrier CQI definition test uses 256QAM CQI table, we prefer to set higher SNR level compared with LTE whose test is defined with 64QAM CQI table.
	+ For FR2
		- Option 1: SNRPcell = 10dB and SNRScell = 4dB (CTC, Huawei, Qualcomm)
		- Option 2: SNRPcell = 14dB and SNRScell = 8dB (Ericsson)

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round and see if we can agree option 1 based on majority’s view.
* Issue 5-5-2: SNR configuration for 3DL CA CQI test
	+ 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)

*Recommendations for 2nd round:** + Encourage more discussion in the 2nd round and see if we can agree option 1 based on majority’s view.
* Issue 5-5-3: Delta CQI threshold

*Tentative agreements: thr* = 2 for 2 or more DL CA in FR1 and FR2 (CTC, Ericsson, Huawei, Qualcomm) |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Way forward on CA CQI reporting requirements | China Telecom |

### 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”* |