**3GPP TSG-RAN WG4 Meeting #109 R4-231xxxx**

**Chicago, US, November 13 – 17, 2023**

**Agenda item:** 5.18.4

**Source:** Moderator (China Telecom)

**Title:** Topic summary for [109] [323] NR\_demod\_enh3\_Part1

**Document for:** Information

# Introduction

This contribution summarizes the open issues, candidate options as well as the recommended WF for the advanced receiver for MU-MIMO part of the Rel-18 NR demodulation requirement evolution WI under agenda 8.18.

# Topic #1: Receiver assumption and NWA signaling

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318558 | MediaTek Inc. | Proposal #1: We support Option 1 to define UE layer processing capability by UE declaration.Proposal #2: We are open to introduce DMRS port related RRC signalling to limit UE’s blind detection search space of DMRS ports (related to Issue 1-4-1 UE capability).Proposal #3: We support Option 2 not to have 1-bit RRC signalling for frequency domain alignment.Proposal #4: We are open to discuss additional default assumptions if feasible.Proposal #5: We are open to discuss after further clarifications.Proposal #6: We support Option 1B to introduce 3 level UE capabilities for MIMO advanced receiver as listed.Proposal #7: We support Option 2A.Observation #1: Explicit definition of DMRS port search space reduction is needed if UE capability is agreed.Proposal #8: We support UE capability for maximum number of DMRS ports for blind detection.Proposal #9: We propose UE DMRS search space always start from the first DMRS port index.Proposal #10: As alternative proposal information of UE DMRS search space, like the starting DMRS port index, could be signalled by network with MAC-CE or RRC.Proposal #11: We propose considering maximum number of modulation orders of interfering DMRS ports supported related UE capability together with modulation order blind detection capability.Proposal #12: We support Option 2 to guarantee feasible UE complexity. |
| R4-2318575 | Apple | Proposal #1: Modify 2 bit RRC signaling to indicate max configured MCS table to maximum modulation order of paired UEsProposal #2: Introduce UE capability signaling instead of NWA for upper bound on number of co-scheduled UE portsProposal #3: Introduce UE capability signaling instead of NWA for supported DMRS configuration for R-ML for MU-MIMO Observation #1: Knowledge of resource allocation type of co-UE helps determine the granularity to detect presence and FDRA of co-UE especially if Type 0 with same RBG is used. Proposal #4: Introduce signaling to indicate if RBG size of the target and co-scheduled UE are the same when resource allocation Type 0 is used for target UE. |
| R4-2318576 | Apple | Proposal #1: Introduce UE capability for MU-MIMO advanced receiver with the following components;UE capable of advanced receiver for MU-MIMO for 2 layers with 2RXUE capable of advanced receiver for MU-MIMO for 2,3,4 layers with 4RXProposal #2: The maximum number of layers for R-ML (target +co-UE(s)) is upper bounded by UE capability of maxNumberMIMO-LayersPDSCH. Observation #1: The UE capability of maxNumberMIMO-LayersPDSCH is indicated per-FSPC.Proposal #3: Introduce per CC per band per band combination (Per-FSPC) UE capability for Rel-18 MU-MIMO advanced receiver.Observation #2: The capability for modulation order blind detection would be needed if requirements with MO blind detection are introduced in RAN4. Proposal #4: If requirements with modulation order blind detection are introduced, then introduce UE optional capability with signaling if UE. Observation #3: The UE complexity for blind detection depends on the number of ports it needs to detect and the DMRS configuration. Observation #4: Network would use the information on supported DMRS configuration to provide the NWA for advanced receiver, and/or configure the supported DMRS while pairing UEs. Proposal #5: Introduce UE capability signaling for supported DMRS configuration for advanced receiver for MU-MIMOProposal #6: Introduce UE capability for maximum DMRS ports to be detected. |
| R4-2318785 | Nokia, Nokia Shanghai Bell | Additional assumptions to the R-ML receiverObservation 1: Optimal network scheduling will require that UE provides capability signalling about number of layers it can process with R-ML receiver.Proposal 1: RAN4 to introduce UE capability to signal support of the following 3 target UE types:- Type 1: 2Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver- Type 2: 4Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver- Type 3: 4Rx UEs which can process up to 4 layers across target and co-scheduled UEs with R-ML receiverProposal 2: Do not introduce additional restrictions on supported DMRS configurations. Further discuss how to define UE capability for supported DMRS configurations.The DMRS port information for the co-scheduled UEObservation 2: We see no reason for the NW to restrict the number of ports for the co-scheduled UEs.Proposal 3: Do not consider additional RRC signalling for DMRS port (option 1).Frequency domain resource allocation type for the co-UE and the target UEObservation 3: For detecting FDRA with multiple co-UEs are scheduled, the target UEs must detect co-UE FDRA with PRG granularity. With PRG level detection it is not require for the UE to assume a specific FDRA type.Proposal 4: UE to not assume FDRA type being the same between target and co-UE (option 2).Additional evaluation on modulation order blind detectionObservation 4: In case of type 0 FDRA allocation of multiple co-UEs, the blind MO detection requires PRG granularity.Observation 5: UEs not capable of blind MO detection with PRG granularity, must detect the number of co-UEs and their individual FDRA.Observation 6: Type 0 FDRA allocation complicates blind detection of number of co-UEs and PRB mapping of each co-UE.Proposal 5: RAN4 to consider default assumption of only type 1 FDRA allocation of co-UEs, in case of target UEs which are capable of blind MO detection are signaled DCI value 6.Observation 7: Optimal ML based modulation order classification with PRG granularity of 1 co-UE layer, requires at least 16 to 20 dB SNR to achieve 1% classification error.Observation 8: ML based MO classification is feasible with ZP-CSI-RS because the few numbers of REs and the lack of target UEs own layers, reduce complexity significantly.Observation 9: Optimal ML based modulation order classification with FDRA granularity of 1 co-UE layer, requires at least 10 to 12 dB SNR to achieve 1% classification error when based on ZP-CSI-RS REs. In addition, MO classification with PRG granularity does not reach 1% classification error in many scenarios.Observation 10: MO blind detection with PRG granularity of ≤ 2 PRBs cannot be assumed for making performance requirements for UEs with MO detection.Proposal 6: Further evaluate if UE blind MO detection capability can be extended to include:- UEs capable of blind detection with granularity of N PRBs, where value of N is signalled by the UE to the network - UEs capable of blind MO detection within each type 1 FDRA allocation.- UEs capable of single blind MO detection per layer- UEs capable of only one blind MO detection across all layers in a slotNew MAC-CE command to assist DMRS port blind detection.Proposal 7: Do not introduce a new MAC-CE command for DMRS port blind detection assistance.Capability signalling for advanced receiver for MU-MIMOObservation 11: The NW can be more optimal with UE capability signalling, hence it is our preference to introduce capability signalling instead of UE declaration w/o signalling. We are however open to further discuss capability signalling vs. UE declaration w/o signalling for blind MO detection.Proposal 8: Introduce UE capability signalling to inform about UE supporting R-ML with modulation order blind detection.Proposal 9: Introduce UE capability signalling to inform about maximum number of DMRS ports supported by the UE for blind detection.Proposal 10: Introduce UE capability signalling to inform about maximum modulation orders of interfering DMRS ports supported by the UE.Capability granularity and details for the R-ML capability signalling.Observation 12: If a UE is capable of R-ML we assume that it will have the capability for all bands and band combinations supported by the UE.Proposal 11: Align with the Rel-17 MMSE-IRC for MU-MIMO, i.e., per UE, no FDD/TDD difference, FR1 only (Option 1) |
| R4-2318934 | Qualcomm Incorporated | Proposal 1: For R-ML receiver capability granularity from supporting bands perspective, align with the Rel-17 MMSE-IRC for MU-MIMO, i.e., per UE, no FDD/TDD difference, FR1 only, with the common understanding that UE may have limited processing resources to support R-ML on all the carriers in the carrier aggregation cases with larger bandwidths on component carriers.Proposal 2: Support of blind modulation detection is based on UE declaration, do not introduce capability signaling.Proposal 3: We propose to structure the R-ML receiver capability discussion in the following:* RAN4 first establishes the capability full scope of R-ML receiver, i.e., the union of all the features that the different types of R-ML receivers within R18 MU-MIMO scope can support.
* Next, RAN4 decides whether to introduce finer granularities to signal or to declare different feature supports under the agreed R-ML scope.
* We also want to propose the following common understanding to simplify the discussion
	+ Assume supported total numbers of layers for co-scheduled UE detection, blind modulation order detection and R-ML demodulation are consistent (if the individual feature support is signaled/declared)
	+ Regardless of capability discussion outcome, the test scope is within DMRS symbol length = 1 and type 1 DMRS.

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|  | R-ML feature scope | Finer granularity with UE capability signaling | Finer granularity based on UE declaration |
| Blind modulation order detection | Both with and without  | No | * With detection capability
* Without detection capability
 |
| Support of R18 DMRS | Not covered | No | No |
| Maximum number of total layers  | Up to 4\*Assume supported total numbers of layers for co-scheduled UE detection, blind modulation order detection and ML demodulation are consistent (if the capability is supported) | No | No |
| R15 DMRS length and type | All covered when total number of layers is within 4 | Open to discuss if needed | No |
| Maximum number of interfering layers | No limit as long as maximum number of total layers <= 4 | No | No |

Proposal 4: The R-ML requirement is applicable only when all the conditions in the previous observation are satisfied and signaled to the DUT UE. |
| R4-2319234 | Ericsson | *Proposal 1: Propose followings for declaration:*For R-ML receiver without modulation order detection for MU-MIMOType 1: R-ML with enhanced inter-stream interference suppression for MU-MIMO transmissions with rank 2 with 2 RxType 2: R-ML with enhanced inter-stream interference suppression for MU-MIMO transmissions with rank 2,3,4 with 4 RxFor R-ML receiver with modulation order detection for MU-MIMOType 1: 2Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiverType 2: 4Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiverType 3: 4Rx UEs which can process up to 4 layers across target and co-scheduled UEs with R-ML receiver*Proposal 2: Propose not to add any restriction on the maximum layer for R-ML implementation.**Proposal 3: Propose not to consider additional RRC signaling for DMRS port.**Proposal 4: Propose not to have the assumption on the frequency domain resource allocation type for the co-scheduled UE.**Proposal 5: Propose not to consider additional RAN4 default assumptions to assist modulation order blind detection.**Proposal 6: Propose not to consider introducing new MAC-CE/RRC related assistance on DMRS port blind detection.**Proposal 7: Propose not to introduce the capability of maximum number of layers as long as RAN4 assume the maximum number of interfering DMRS ports supported by Rel-18 MU-MIMO receiver is derived by subtracting the scheduled MIMO layers for the target UE from maxNumberMIMO-LayersPDSCH.**Proposal 8: Introduce a per UE capability for Rel-18 MU-MIMO receivers as follows: Maximum modulation orders of interfering DMRS ports supported by Rel-18 MU-MIMO receiver.* |
| R4-2319334 | Samsung | Proposal 1: Define MU-MIMO enhanced receiver type in definition section similar as SU-MIMO enhanced receiver type, such as, Enhanced Receiver Type 2: MU-MIMO interference mitigation advanced receiver- R-ML (reduced complexity ML) receiver with enhanced inter-stream interference suppression for MU-MIMO transmissions with rank 2 with 2 RX antennas- R-ML (reduced complexity ML) receiver with enhanced inter-stream interference suppression for MU-MIMO transmissions with rank 2, 3, and 4 with 4 RX antennasProposal 2: Not to have additional restrictions on supported DMRS configurations.Proposal 3: No need to consider additional RRC signaling for DMRS port.Proposal 4: For the Frequency domain resource allocation type for the co-UE and the target UE, do not to introduce default assumption that assume the same frequency domain resource allocation type.Proposal 5: Do not consider default assumption of only type 1 FDRA allocation of co-UEs.Proposal 6: Introduce new UE capability about R-ML receiver with and without modulation order blind detection, network could use more flexible scheduling strategies correspondingly.Proposal 7: If the maximum number of layers or DMRS ports for R-ML blind detection is no more than 4 as discussed in reference receiver assumptions part, no need to define capability signalling for Maximum number of layers of co-UE or total number of layers for joint detection, Maximum number of DMRS ports for blind detection and Maximum modulation orders of interfering DMRS ports supported.Proposal 8: For the capability granularity and details for the R-ML capability signalling, support aligning with the Rel-17 MMSE-IRC for MU-MIMO, i.e., per UE, no FDD/TDD difference, FR1 only. |
| R4-2319392 | China Telecom | Proposal 1: Fine to define different types of UEs that defines the minimum total layer number across target and co-scheduled UEs with R-ML processing based on UE declaration, and specify phase II demodulation requirements for each type of UE to be defined.Proposal 2: Not to have additional restrictions to the use cases for R-ML receiver at least for the feature design.Proposal 3: Not to introduce additional RRC based assistant signalling for UE to obtain the DMRS port information for the co-scheduled UE.Proposal 4: Not to have the assumption on the frequency domain resource allocation type for the co-scheduled UE.Proposal 5: Not to have additional assumptions on modulation order blind detection. As for the evaluation aspects, it can be discussed under the detailed test parameter part.Proposal 6: Not to introduce additional MAC-CE based network assistant signaling for DMRS port blind detection.Proposal 7: Not to introduce capability definition for Maximum number of layers of co-UE or total number of layers for joint detection, Maximum number of DMRS ports for blind detection or Maximum modulation orders of interfering DMRS ports for R-ML receiver.Proposal 8: For the granularity and details for the new R-ML capability, align with the Rel-17 MMSE-IRC for MU-MIMO, i.e., per UE, no FDD/TDD difference, FR1 only. |
| R4-2319539 | ZTE Corporation | Observation 1. For UEs which support modulation order detection or not, could separately discussed.Observation 2. If RAN4 wants to use maxNumberMIMO-LayersPDSCH to derive the maximum number of layers of co-schedule UE. The issue mentioned above needs to be clarified. Proposal 1. Define the applicability of the corresponding test cases for two types of UEs respectively,which support without modulation order detection based on UE declaration, such as Type 1: 2Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver Type 2: 4Rx UEs which can process up to 4 layers across target and co-scheduled UEs with R-ML receiverProposal 2. Define the applicability of the corresponding test cases for three types of UEs respectively,which support with modulation order detection based on UE declaration, such as Type 1: 2Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver Type 2: 4Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver Type 3: 4Rx UEs which can process up to 4 layers across target and co-scheduled UEs with R-ML receiverProposal 3. No need to introduce the assistant RRC signalling for co -scheduled UEs DMRS port.Proposal 4. No need to consider frequency domain resource allocation type for co-UE and target UE.Proposal 5. Introduce new UE capability about R-ML receiver with and without modulation order blind detection.Proposal 6. No need to introduce UE capability definition for maximum number of layers or maximum number of DMRS ports.Proposal 7. No need to introduce UE capability definition for maximum modulation orders of interfering DMRS ports supported.Proposal 8. Considering align with the Rel-17 MMSE-IRC, per UE capability granularity. |
| R4-2320172 | Spreadtrum Communications | Proposal 1: we support option 2, i.e to indicate the maximum number of layers that UE could handle via UE capability signaling.Proposal 2: it’s proposed to have no more than 4 layers across UE layers and interference layers with respect to test requirements setup.Proposal 3: With R18 DMRS ports extended up to 16 or 24, we still hold proposal 2. Moreover when the target UE doesn’t support R18 DMRS, it won’t be tested under interference layers associated with DMRS ports which is not included R15 basic DRMS ports.Proposal 4: we agree there is no additional DMRS configuration restriction on DMRS type and length for R-ML. We agree on DMRS type 1 and maxlen= 1 with respect to test requirements setup .Observation 1: 256QAM would be the solo choice in reality according to what is reflected by “The MCS table with the highest modulation order among all MCS tables configured to the co-scheduled UE(s)”in LS [6] Proposal 5: It’s proposed to send another LS to RAN2 to make further update to the relevant content in LS [6],on option update is recommended below • ~~The MCS table with the highest modulation order among all MCS tables configured to the co-scheduled UE(s), which has the same DM-RS sequence as the target UE, The MCS table is one of the following:~~~~o 1024QAM MCS table(s) (Table 5.1.3.1-4 from TS38.214)~~~~o 256QAM MCS table(s) (Table 5.1.3.1-2 from TS38.214)~~~~o 64QAM MCS tables (Table 5.1.3.1-1 or 5.1.3.1-3 from TS38.214)~~• the highest modulation order used in all the MU-MIMO scheduling instances for co-scheduled UE(s), which has the same DM-RS sequence as the target UE, the modulation order is one of the following:o 1024QAM o 256QAM o 64QAMObservation 2: it’s observed that DMRS port detection error leads to performance loss, e.g test number 5 shows 2.1dB loss due to FDRA and DMRS port blind detection error according to our simulation result captured in [4]Observation 3: Joint signal power detection across multiple PRBs/PRGs can increase DMRS port detection accuracy, on the basis that all the PRBs/PRGs are allocated to a single UE with respect to one DMRS port.Proposal 6: It’s proposed to apply MAC-CE command to indicate target UE to apply joint DMRS power detection across multiple PRBs/PRGs with respect to one DMRS port on the basis that all the PRBs/PRGs are allocated to a single UE with respect to one DMRS port.Proposal 7: UE is allowed to have optional capability of “R-ML with modulation order blind detection”, It’s proposed to allow a type of UE to perform blind detection only to address the scenario indicated by DCI index 6, whereas the UE is not expected to perform blind detection for the “else” scenarios indicated by DCI index 7.Proposal 8: We support UE capability signaling of R-ML modulation order blind detection to indicate UE is capable of MO BD to address the scenario indicated by DCI code point 6. Whereas whether the UE is capable to perform blind detection for the “else” scenarios indicated by DCI index 7 could be based on UE capability signaling or UE declaration.Proposal 9: It’s proposed to have a new UE capability signalling to indicate maximum number of layers of co-UE or total layers for joint detection. We could also compromise to link Maximum number of layers across co-UEs for joint detection with the existing UE capability of maxNumberMIMO-LayersPDSCH per FSBC, i.e the maximum number of layers of co-UE can be derived by subtracting the scheduled MIMO layers for the target UE from maxNumberMIMO-LayersPDSCH.Proposal 10: It’s proposed target UE to support detection on the maximum amount of DMRS ports with respect to DMRS type. We don’t think an additional UE capability of “Maximum number of DMRS ports for blind detection” is necessary.Observation 4: it would result in demodulation performance degradation if an interference DMRS port with MO beyond the UE capability is selected following DMRS port BD.Proposal 11: It’s proposed to have UE capability signaling to inform network of the maximum modulation orders of interfering DMRS port supported. Furthermore, the UE capability means UE doesn’t support higher MO detection than indicated for co-scheduled UE regardless the modulation order is going to be obtained by assistant signaling or by blind detection.Proposal 12: It’s proposed to assume network scheduler’s behavior not to apply the modulation orders beyond target UE’s capability to any co-scheduled UEs.Proposal 13: we support option 2 Introduce per CC per band per band combination (Per-FSPC) UE capability |
| R4-2320187 | Huawei, HiSilicon | Proposal 1: For R-ML receiver without modulation order detection for MU-MIMO (With the help of DCI index 1~5) 2Rx UEs can process up to 2 layers across target and co-scheduled UEs with R-ML receiver 4Rx UEs can process up to 4 layers across target and co-scheduled UEs with R-ML receiverObservation 1: It’s very difficult to apply the logic of Rel-15 R-ML receiver assumption definition to Rel-18 R-ML receiver assumption on MU-MIMO scenario with modulation order detection due to the additional complexity of modulation order detection highly depending on number of serving layers and interference layers.Proposal 2: For R-ML receiver with modulation order detection for MU-MIMO, consider the following receive assumption. Basic receiver assumption: UEs can process up to 2 layers across target and co-scheduled UEs Advanced receiver assumption: UEs can process more than 4 layers across target and co-scheduled UEs with DCI assistant signaling index 6.  Note1: If a UE support R-ML receiver with modulation order detection, basic receiver assumption is mandatory to be supported. Advanced receiver assumption is optional with UE declaration.  Note2: Above receiver assumptions are valid only if the related requirements are defined. E.g. (Rank 1+1 with modulation order detection for basic receiver assumption and Rank 2+2 with modulation order detection for advanced receiver assumption)Proposal 3: Don’t define restriction and capability on DMRS configuration for R-ML receiver for MU- MIMO scenario.Observation 2: The port information for co-scheduled UEs can be dynamically changed due to the high mobility of UEs, which can make RRC signalling indication unfeasible.Proposal 4: RAN4 should further discuss how to address the concern that port information of co-scheduled UE can be dynamically changed due to the high UE mobility or environment changes.Observation 3 : With prior information that resource type 0 is configured for co-scheduled UE, even target UE doesn’t know the exact RBG size of co-scheduled UEs, one thing that can be sure is that co-scheduled UEs are allocated with minimum 2 RBs granularity in frequency allocation, which would be beneficial by making UE perform per 2RBs detection rather than per RB detection when PRG aligned information is invalid.Proposal 5: Introduce dedicated RRC signalling to indicate whether the resource allocation type of co-scheduled UE is same as target UE.Proposal 6: Don’t do any additional evaluation on modulation order blind detection proposed in Issue 1-3-3.Proposal 7: Don’t introduce new MAC-CE command to assist DMRS port blind detection.Proposal 8: Don’t introduce any finer capability with respect to R-ML.Observation 4 : R-ML receiver for MU-MIMO is also more complicated than CRS-IM, which has been defined as per CC granularity capability, so R-ML receiver for MU-MIMO should also be defined as per CC granularity capability. Proposal 9: Introduce R-ML capability signalling with Per-FSPC granularity. |

## Open issues summary

### Sub-topic 1-1 Reference receiver assumptions

**Issue 1-1-1: Additional assumptions to the R-ML receiver**

* *Status in the last meeting WF in R4-2316915*

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| *Candidate options on maximum number of layers need to be handled with R-ML receiver:** + *Option 1: Different types of UEs that defines the minimum total layer number across target and co-scheduled UEs with R-ML processing based on UE declaration*
		- *Option 1A:*
* *Type 1: R-ML with enhanced inter-stream interference suppression for MU-MIMO transmissions with rank 2 with 2 Rx*
* *Type 2: R-ML with enhanced inter-stream interference suppression for MU-MIMO transmissions with rank 2,3,4 with 4 Rx*
	+ - *Option 1B:*
* *For R-ML receiver without modulation order detection for MU-MIMO*
* *Type 1: 2Rx UEs can process up to 2 layers across target and co-scheduled UEs with R-ML receiver*
* *Type 2: 4Rx UEs can process up to 4 layers across target and co-scheduled UEs with R-ML receiver*
* *For R-ML receiver with modulation order detection for MU-MIMO*
* *Type 1: 2Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver*
* *Type 2: 4Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver*
* *Type 3: 4Rx UEs which can process up to 4 layers across target and co-scheduled UEs with R-ML receiver*
	+ *Option 2: Introduce UE capability signalling for the following types*
		- *Type 1: 2Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver*
		- *Type 2: 4Rx UEs which can process up to 2 layers across target and co-scheduled UEs with R-ML receiver*
		- *Type 3: 4Rx UEs which can process up to 4 layers across target and co-scheduled UEs with R-ML receiver*
	+ *Option 3: Maximum 4 layer including target and co-scheduled UEs are required. When the assumptions are not fulfilled, UE is allowed to fall back to MMSE-IRC requirements*

*Candidate options on supported DMRS configurations:** + *Option 1: Not to have additional restrictions on supported DMRS configurations*
	+ *Option 2: Restrict R-ML for MU-MIMO to certain DMRS configuration and length or introduce UE capability on the supported DMRS configuration and lengths*
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* Proposals on different types of UE with R-ML receiver for MU-MIMO:
	+ For UE without modulation order blind detection:
		- Option 1: (Apple, Samsung, Ericsson, ZTE, Huawei)
* Type 1: 2Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
* Type 2: 4Rx UE capable of R-ML process up to 4 layers across target and co-scheduled UEs
	+ - Option 2: (Nokia, Spreadtrum)
* Type 1: 2Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
* Type 2: 4Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
* Type 3: 4Rx UE capable of R-ML process up to 4 layers across target and co-scheduled UEs
	+ For UE supporting modulation order blind detection:
		- Option 1: (Apple, Samsung)
* Type 1: 2Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
* Type 2: 4Rx UE capable of R-ML process up to 4 layers across target and co-scheduled UEs
	+ - Option 2: (Ericsson, ZTE, Nokia, Spreadtrum)
* Type 1: 2Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
* Type 2: 4Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
* Type 3: 4Rx UE capable of R-ML process up to 4 layers across target and co-scheduled UEs
	+ - Option 3: (Huawei)
* Type 1: UE process up to 2 layers across target and co-scheduled UEs with R-ML receiver
* Type 2: UE process more than 4 layers across target and co-scheduled UEs
* Proposals on supported DMRS configurations:
	+ Option 1: Not to have additional restrictions on supported DMRS configurations. (China Telecom, Apple, Nokia, Qualcomm, Samsung, Spreadtrum, Huawei)
		- Option 1A: Introduce UE capability signaling for supported DMRS configuration for R-ML (Apple)
* Recommended WF
	+ For definition of different UE types with R-ML:
		- For UEs w/o modulation order blind detection:
* The following types could be considered based on consensus:
* 2Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
* 4Rx UE capable of R-ML process up to 4 layers across target and co-scheduled UEs
* Discuss whether to include:
* 4Rx UE capable of R-ML process up to 2 layers across target and co-scheduled UEs
	+ - For UEs supporting modulation order blind detection:
* Discuss whether to have different UE type definition with UEs w/o modulation order blind detection.
	+ - Discuss whether to network should be informed the specific UE type, which is separate discussion whether to consider capability signalling for UE support modulation order blind detection.
	+ Not to have additional restrictions on supported DMRS configurations.
		- Further discuss whether to consider UE capability on the supported DMRS configuration in Issue 1-3-1.

### Sub-topic 1-2 Discussion on the potential required information

**Issue 1-2-1: The DMRS port information for the co-scheduled UE**

* *Status in the last meeting WF in R4-2316915*

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| *Candidate options on additional RRC based assistant signalling:** + *Option 1: No need to consider additional RRC signaling for DMRS port*
	+ *Option 2: Introduce RRC signaling for upper bound on number of co-scheduled UE ports*
	+ *Option 3: Introduce RRC signalling to indicate whether there is UE with Rel-18 DMRS configuration in the whole cell existing*
 |

* Proposals on additional RRC based assistant signalling:
	+ Option 1: No need to consider additional RRC signaling for DMRS port (China Telecom, Apple, Nokia, Ericsson, Samsung, ZTE)
		- Option 1A: Introduce UE capability signalling for maximum DMRS ports instead of RRC based NWA (Apple)
		- HW: Port information of co-scheduled UE can be dynamically changed due to the high UE mobility or environment changes.
* Recommended WF
	+ Not to consider additional RRC signaling for DMRS port
		- Further discuss whether to consider UE capability on maximum DMRS ports in Issue 1-3-1.

**Issue 1-2-2: Frequency domain resource allocation type for the co-UE and the target UE**

* *Previous agreement on the related RAN4 default assumption in the approved LS to RAN2 in R4-2316980:*

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| * + *The target UE can assume the precoding and resource allocation of the co-scheduled UE are the same in the PRG-level grid configured to the target UE when PRG=2 or 4.*
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* *Status in the last meeting WF in R4-2316915*

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| *Candidate options** + *Option 1: Introduce default assumption for resource allocation type for co-UE same as targe UE. Introduce dedicated RRC signaling to indicate if the default assumption is true or false*
	+ *Option 2: Not to have the assumption on the frequency domain resource allocation type for the co-scheduled UE*
 |

* Proposals:
	+ Option 1: Introduce signaling to indicate if RBG size of the target and co-scheduled UE are the same when resource allocation Type 0 is used for target UE. (Apple)
		- Apple: If the target and co-UE have the same RBG size, then the UE can detect FDRA and DMRS ports with the granularity of RBG size.
	+ Option 2: Introduce dedicated RRC signalling to indicate whether the resource allocation type of co-scheduled UE is same as target UE (Huawei)
		- HW: With the prior information that resource type 0 is configured for co-scheduled UE, target UE can confirm that co-scheduled UEs are allocated with minimum 2 RBs granularity in frequency allocation.
	+ Option 3: Not to have assumption on the frequency domain resource allocation type for the co-scheduled UE (China Telecom, MTK, Nokia, Ericsson, Samsung, ZTE)
		- CTC, Nokia: UEs should be able to blind detect FDRA and DMRS ports of co-UEs with PRG granularity.
* Recommended WF
	+ Need discussion.

**Issue 1-2-3: Additional evaluation on modulation order blind detection**

* *Status in the last meeting WF in R4-2316915*

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| *Candidate options on additional RAN4 default assumptions to assist modulation order blind detection:** + *Proposal 1: RAN4 to consider default assumption of only type 1 FDRA allocation of co-UEs, and Further evaluate if UE blind MO detection capability can be extended to include*
		- *UE capable of blind MO detection with granularity of PRG =2/4*
		- *UEs capable of blind MO detection within each type 1 FDRA allocation.*
		- *UEs capable of single blind MO detection per layer.*
		- *UEs capable of only one blind MO detection across all layers in a slot.*
 |

* Proposals:
	+ Proposal 1: (Nokia) RAN4 to consider default assumption of only type 1 FDRA allocation of co-UEs, and Further evaluate if UE blind MO detection capability can be extended to include
		- UE capable of blind MO detection with granularity of PRG =2/4
		- UEs capable of blind MO detection within each type 1 FDRA allocation.
		- UEs capable of single blind MO detection per layer.
		- UEs capable of only one blind MO detection across all layers in a slot.
	+ Proposal 2: Not to have additional assumptions on modulation order blind detection (China Telecom, Ericsson, Samsung, Huawei)
* Recommended WF
	+ Since the modulation order blind detection structure is stable and RAN1 and RAN2 has accordingly started the assistant signalling design, it is recommended not to have additional assumptions on modulation order blind detection.
	+ Detailed phase II test parameters for modulation order blind detection can be discussed within Topic #2.

**Issue 1-2-4: New MAC-CE command to assist DMRS port blind detection**

* *Status in the last meeting WF in R4-2316915*

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| * + *Option 1: Introduce the following new MAC-CE command to assist DMRS port blind detection*

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| ***New MAC-CE Command*** |  ***Content*** |
| *Joint signal power detection across multiple PRBs/PRGs with respect to one DMRS port* | ***1 bit:*** *Target UE apply joint signal power detection across multiple PRBs/PRGs with respect to one DMRS port;****3 bits****: Valid period for UE to apply joint signal power detection across multiple PRBs/PRGs with respect to one DMRS port. 2~16 ms* |

 |

* Proposals:
	+ Option 1: Apply MAC-CE command to indicate target UE to apply joint DMRS power detection across multiple PRBs/PRGs with respect to one DMRS port on the basis that all the PRBs/PRGs are allocated to a single UE with respect to one DMRS port. (Spreadtrum)
	+ Option 2: Not to introduce additional MAC-CE based network assistant signaling for DMRS port blind detection. (China Telecom, Nokia, Ericsson, Huawei)
		- CTC, Nokia, HW: UEs should be able to blind detect FDRA and DMRS ports of co-UEs with PRG granularity.
* Recommended WF
	+ Need discussion.

**Issue 1-2-5: The modulation order information of the co-scheduled UE (RRC based assistant signaling)**

* *Previous agreements on the RRC-based assistant signalling design in R4-2309892:*

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| *The modulation order information of the co-scheduled UE (Only required for R-ML)**Additional RRC-based network assistant signaling:** + *Introduce RRC signaling to discriminate MCS table with 256QAM or 1024 QAM enable or not for co-scheduled UEs (optional)*
 |

* *Status in the approved LS to RAN2 in R4-2316980*

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| * + *The MCS table with the highest modulation order among all MCS tables configured to the co-scheduled UE(s), which has the same DM-RS sequence as the target UE. The MCS table is one of the following:*
	+ *1024QAM MCS table(s) (Table 5.1.3.1-4 from TS38.214)*
	+ *256QAM MCS table(s) (Table 5.1.3.1-2 from TS38.214)*
	+ *64QAM MCS tables (Table 5.1.3.1-1 or 5.1.3.1-3 from TS38.214)*
 |

* Proposals on updated LS to RAN2:
	+ Proposal 1: Modify 2 bit RRC signaling to indicate max configured MCS table to maximum modulation order of paired UEs (Apple, Spreadtrum)

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| The highest modulation order used in all the MU-MIMO scheduling instances for co-scheduled UE(s), which has the same DM-RS sequence as the target UE, the modulation order is one of the following* + 1024QAM
	+ 256QAM
	+ 64QAM
 |

* Recommended WF
	+ Since RAN2 will start their work on the RRC assistant signalling design based on R4-2316915, it is recommended to keep the previous RRC signalling design unless consensus could be reached on proposal 1.

### Sub-topic 1-4 UE capability aspects

**Issue 1-3-1: Capability signalling for advanced receiver for MU-MIMO**

* *Status in the last meeting WF in R4-2316915*

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| *UE advanced receiver to cancel inter-user interference for MU-MIMO is an optional feature with UE capability signalling**Candidate options on capability definition for R-ML with modulation order blind detection:** + *Option 1: Blind modulation order detection is based on UE capability signaling*
		- *Option 1A: Define different capability in the scenarios indicated by DCI index 6 and 7 respectively*
		- *Option 1B: Introduce 3 level UE capabilities: 1) Low-end UE: Support DCI 0-5; 2) Medium-end UE supporting DCI 0-6; 3) High-end UE supporting DCI 0-7*
	+ *Option 2: Blind modulation order detection is based on UE declaration*

*Candidate options on capability definition for Maximum number of layers:** + *Option 1: Introduce UE capability for Maximum number of layers of co-UE or total number of layers for joint detection*
	+ *Option 2: Not to introduce such capability definition*
		- *Option 2A: The maximum number of layers of co-UE can be derived by subtracting the scheduled MIMO layers for the target UE from maxNumberMIMO-LayersPDSCH*

*Candidate options on capability definition for Maximum number of DMRS ports:** + *Option 1: Introduce UE capability signalling for maximum DMRS ports to be detected*
	+ *Option 2: Not to introduce such capability definition*

*Candidate options on capability definition for Maximum modulation orders of interfering DMRS ports supported:** + *Option 1: UE capability signaling to inform network of the maximum modulation orders of interfering DMRS port supported*
	+ *Option 2: Not to introduce such capability definition*
 |

* Proposals on capability definition for R-ML with modulation order blind detection:
	+ Option 1: Blind modulation order detection is based on UE capability signaling (MTK, Apple, Nokia, Samsung, ZTE, Spreadtrum)
		- Option 1A: Define different capability in the scenarios indicated by DCI index 6 and 7 respectively (Spreadtrum)
		- Option 1B: Introduce 3 level UE capabilities: 1) Low-end UE: Support DCI 0-5; 2) Medium-end UE supporting DCI 0-6; 3) High-end UE supporting DCI 0-7 (MTK)
	+ Option 2: Blind modulation order detection is based on UE declaration (Qualcomm)
* Proposals on capability definition for Maximum number of layers:
	+ Option 1: Introduce UE capability for Maximum number of layers of co-UE or total number of layers for joint detection (Spreadtrum)
	+ Option 2: Not to introduce such capability definition (China Telecom, MTK, Apple, Ericsson, ZTE, Huawei, Samsung if the max number of layers is no more than 4)
		- Option 2A: The maximum number of layers for R-ML (target +co-UE(s)) is upper bounded by UE capability of *maxNumberMIMO-LayersPDSCH*. (MTK, Apple, Ericsson, Spreadtrum)
* Proposals on capability definition for Maximum number of DMRS ports:
	+ Option 1: Introduce UE capability signalling for maximum DMRS ports to be detected. (MTK, Apple, Nokia, ZTE, Samsung if the max number of layer is no more than 4)
	+ Option 2: Not to introduce such capability definition (China Telecom, Spreadtrum, Huawei)
* Proposals on capability definition for Maximum modulation orders of interfering DMRS ports supported:
	+ Option 1: UE capability signaling to inform network of the maximum modulation orders of interfering DMRS port supported (MTK, Nokia, Ericsson, Spreadtrum)
	+ Option 2: Not to introduce such capability definition (China Telecom, ZTE, Huawei, Samsung if the max number of layer is no more than 4)
* Proposals on capability definition for supported DMRS configurations:
	+ Option 1: Introduce UE capability signaling for supported DMRS configuration for R-ML (Apple)
* Recommended WF
	+ For R-ML with modulation order blind detection:
		- Need discussion.
	+ For Maximum number of layers and Maximum number of DMRS ports:
		- Need further check the necessity after UE types definition is made in Issue 1-1-1.
	+ For Maximum modulation orders of interfering DMRS ports:
		- Need discussion.
	+ For supported DMRS configurations:
		- Need discussion.

**Issue 1-3-2:** **Capability granularity for the R-ML capability signalling**

* *Status in the last meeting WF in R4-2316915*

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| * + *Option 1: Align with the Rel-17 MMSE-IRC for MU-MIMO, i.e., per UE, no FDD/TDD difference, FR1 only*
	+ *Option 2: Introduce per CC per band per band combination (Per-FSPC) UE capability*
 |

* Proposals:
	+ Option 1: Align with the Rel-17 MMSE-IRC for MU-MIMO, i.e., per UE. (China Telecom, Nokia, Qualcomm, Samsung, ZTE)
		- QC: With the assumption that UE may have limited processing resources to support R-ML on all the carriers in CA with large CHBW
	+ Option 2: Introduce per CC per band per band combination (Per-FSPC) UE capability (MTK, Apple, Spreadtrum, Huawei)
		- Apple: The UE capability of *maxNumberMIMO-LayersPDSCH* is indicated per-FSPC.
* Recommended WF
	+ Check if QC’s proposal could be a middle way for all companies:
		- R-ML receiver for MU-MIMO is a Per UE capability with the assumption that UE may have limited processing resources to support R-ML on all the carriers in CA with large CHBW.

**Issue 1-3-3:** **Other details for the R-ML capability signalling**

* Proposals:
	+ Option 1: (China Telecom, Apple, Nokia, Qualcomm, Samsung)
		- Applicable to the capability signalling exchange between UEs (V2X WI only)”: N/A
		- No FDD/TDD difference
		- FR1 only
* Recommended WF
	+ Option 1?

# Topic #2: Test parameters and simulation results

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318558 | MediaTek Inc. | Proposal #13: We support Option 1.Observation #2: We did not include 2Rx-4Tx (1+1) in Phase I study phase.Proposal #14: We support Option 2.Proposal #15: We propose defining tests with 1 co-scheduled UE for the cases without modulation order blind detection.Proposal #16: We propose defining tests with 1 co-scheduled UE for the cases with modulation order blind detection.Proposal #17: We support Option 1 to define tests with full frequency allocation for both target and co-scheduled UE.Proposal #18: We support defining requirements with using RAN4 default assumptions only.Proposal #19: We propose to use new RRC signalling to inform target UE of co-scheduled UE MCS table.Proposal #20: We support Option 2 to define requirements with using 64QAM MCS table.Proposal #21: We support Option 3A to use non-orthogonal PMI selection for Rank 1 tests, and orthogonal PMI selection for Rank 2 tests.Proposal #22: We support Option 1 to use 1 co-scheduled UE only.Proposal #23: We support Option 2 not to introduce tests with E-MMSE-IRC.Proposal #24: We support Option 1 to use 1 co-scheduled UE only as in proposed Test 1-1.Proposal #25: We support Option 1B to use 1 co-scheduled UE only as in proposed Test 2-1.Proposal #26: We support Option 1 to use 1 co-scheduled UE only as in proposed Test 2-1.Proposal #27: We support Option 2 to achieve better gains over baseline receiver.Proposal #28: We support Option 3 to achieve better gains over baseline receiver.Proposal #29: We propose to use MCS13, low antenna correlation and TDLC300-100 channelProposal #30: We propose not to introduce rank 1+1 tests with 2T4R.Proposal #31: We propose to use MCS13, low antenna correlation and TDLA30-10 channelProposal #32: We propose using other parameters in the phase I simulation assumptions as a starting point.Proposal #33: We propose the following UE feature list for NR\_demod\_enh3 |
| R4-2318559 | MediaTek Inc. | Simulation results of Advanced receiver to cancel inter-user interference for MU-MIMO |
| R4-2318577 | Apple | Receiver assumption for Advanced Receiver for MU-MIMOObservation #1: It is unclear where any restriction on R-ML receiver will be captured and UE capability seems to be a good option. Proposal #1: Introduce UE capability for the following:(1) UE capable of R-ML for MU-MIMO for 2 layers with 2RX(2) UE capable of R-ML for MU-MIMO for 2,3,4 layers with 4RXObservation #2: UE complexity for blind detection depends on the DMRS configuration. Proposal #2: Introduce UE capability for supported DMRS configuration and length for advanced receiver for MU-MIMO. Observation #3: Once we have agreement to define requirements with R-ML receiver in phase 2, we don’t see the necessity to discuss scenarios or requirements where R-ML is not applicable. Proposal #3: Do not introduce test cases for scenarios where R-ML receiver is not applicable.Test parameters for Phase IIObservation #4: Once we have agreement to define requirements with R-ML receiver in phase 2, we don’t see the necessity to discuss scenarios or requirements where R-ML is not applicable. Proposal #4: Do not introduce test cases for scenarios where R-ML receiver is not applicable.Proposal #5: Reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMO in Rel-18 with advanced receiver.Proposal #6: Define requirements with 1 co-scheduled UE for cases without modulation order detection.Proposal #7: Test cases with blind modulation order need further study.Proposal #8: Do not define requirements with partial CHBW FDRA co-scheduled UE.Observation #5: Unless 256QAM is used for test case, we should not need to configure 256QAM table for the test case. Proposal #9: Use 64QAM MCS table for defining requirements.Observation #6: The RRC signalling for max modulation order is irrespective of DCI signalling. Proposal #10: The RRC signalling for MCS table should be present irrespective of test case with or without blind modulation order detection. Proposal #11: Define requirements with orthogonal precoder for co-scheduled UE for all cases.Proposal #12: Configuration for defining requirements without MO blind detection:Rank 1+1, TDLC300-100 medium, MCS13 + QPSKRank 2+2, TDLA30-10 Low, MCS17 + QPSKProposal #13: Do no introduce requirements with E-IRC for index-6 scenario.Proposal #14: For tests configured with DCI index 1~5 the same tests are applicable for UE supporting or not supporting MO BD. Observation #7: The RRC signalling for max modulation order is irrespective of DCI signalling. Proposal #15: The RRC signalling for MCS table should be present irrespective of test case with or without blind modulation order detection. Proposal #16: Limit further study and requirements if any to DCI index 6 for R-ML with modulation order blind detection. Proposal #17: Co-scheduled UE with QPSK for all cases. Proposal #18: On other test parameters: For rank 1+1 tests with 2T2R and 2T4R: Target MCS: 13 (Table 1) MIMO configuration: 2x2 ULA medium  Channel: TDLC300-100For rank 2+1 tests with 4T4R: Target MCS: 17 (Table 1) MIMO configuration: 4x4 ULA Low Channel: TDLA30-10 |
| R4-2318786 | Nokia, Nokia Shanghai Bell | Detailed test parametersProposal 1: RAN4 to design test cases assuming R-ML receiver and using the agreed default assumptions for co-scheduled UEs parameters. Furthermore, use the following configuration for Target UE parameters:• For rank 1+1 tests with 2T2R:o Target MCS: 13 (Table 1)o MIMO configuration: ULA medium o Channel: TDLC300-100• For rank 1+1 tests with 2T4R:– Configuration 1o Target MCS: 13 (Table 1)o MIMO configuration: ULA Lowo Channel: TDLA30-10– Configuration 2o MIMO configuration: ULA mediumo Channel: TDLC300-100• For rank 2+2 tests with 4T4R:o Target MCS: 17 (Table 1)o MIMO configuration: 4T4R ULA Lowo Channel: TDLA30-10Test scopeObservation 1: 2Tx4Rx antenna configuration has different 70% throughput SNR as compared to 2Tx2Rx, hence requirements for both configurations can be defined.Observation 2: In our understanding not all UEs with 4 Rx antennas can process 4 layers with R-ML due to complexity constraints.Proposal 2: RAN4 shall reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMO including tests for 2Tx4Rx antenna configuration (option 1).Co-scheduled UE numberObservation 3: For UEs with 4Rx antennas the performance with 2 co-UEs each having Rank 1 is different from 1 co-UE having Rank 2 (2dB worser).Proposal 3: For the case without modulation order blind detection consider 1 co-scheduled UE and in addition consider 2 co-UES for cases with 4 Rx.Proposal 4: For the case with modulation order blind detection consider modeling 2 co-scheduled UEs with different FDRA and with either same or different modulation order.Frequency domain resource allocationObservation 4: Partial CHBW resource allocation needs to be present in order to test the FDRA detection capability of UEs with advanced receivers.Observation 5: Scenarios with partial CHBW resource allocation of co-UE have different performance as compared to scenarios with full CHBW resource allocation.Proposal 5: RAN4 to cover both full and partial CHBW resource allocation of co-UEs (option 2).Precoder Selection for co-scheduled UEObservation 6: Usage of orthogonal precoders across paired UEs cannot always be guaranteed in real world deployments.Proposal 6: RAN4 to define tests with random PMI for rank 1+1 and orthogonal PMI for rank 2+2 for REL-18 MU-MIMO advanced receivers (option 3A).Test setting for UEs not supporting modulation order blind detectionProposal 7: RAN4 to define tests for UEs not supporting MO blind detection, with 1 co-UE and in addition also consider cases with 2 co-UEs having same modulation order (option 2). Following test can be considered with 2 co-UEs:Test with 4T4R Co-UE1, Co-UE2: Rank 1, Full CHBW allocation, QPSKProposal 8: RAN4 to define tests verifying UE E-IRC receiving process when it is signalled DCI index 6 in order to differentiate from Rel 17 MMSE-IRC receiving process.Test setting for UEs supporting modulation order blind detectionProposal 9: RAN4 to define tests for UEs with MO blind detection with both 1 co-UE (option 1C) and 2 co-UEs having different MO and FDRA (option). Following test can be considered with 2 co-UEs:For test with 2T2R, 2T4RCo-UE1, Co-UE2: Rank 1, Partial CHBW allocations (0 to 25 PRBs, 38 to 51 PRBs), QPSK,16QAMFor test with 4T4RCo-UE1, Co-UE2: Rank 1, Full CHBW allocations, QPSKProposal 10: RAN4 to define additional tests covering DCI index 7 for UEs with 4 Rx antennas by modeling 2 co-UEs with different modulation orders which are multiplexed on different DMRS ports. Following test can be considered with 2 co-UEs:For test with 4T4R Co-UE1, Co-UE2: Rank 1, Full CHBW allocation, QPSK, 16QAMModulation order for the co-scheduled UEObservation 7: Blind detection of co-scheduled UEs DMRS ports and FDRA is independent of co-scheduled UEs modulation order.Proposal 11: RAN4 to define requirements with both QPSK and 16QAM for rank 1+1, and QPSK for rank 2+2 tests (option 4) for tests cases without modulation order blind detection.Proposal 12: RAN4 to define tests for UEs with modulation order blind detection both by modeling1 co-scheduled UE with QPSK for both rank1+1 and rank2+2 tests(option 2)2 co-scheduled UEs with QPSK and 16QAM respectively (option 4) |
| R4-2318787 | Nokia, Nokia Shanghai Bell | On Advanced Receivers - Test parameters - Simulations |
| R4-2318934 | Qualcomm Incorporated | Proposal 4: The R-ML requirement is applicable only when all the conditions in the previous observation are satisfied and signaled to the DUT UE.Proposal 5: When defining the requirement, the precoding matrices across co-scheduled UEs should be orthogonal given that it is a simple enhancement from the network to achieve a better performance in MU-MIMO scenarios.Proposal 6: We propose to consider the following categories of tests and list the corresponding receiver architecture:

|  |  |  |
| --- | --- | --- |
| Type of DUT/DCI signaling | MOD detection supported | MOD detection not supported |
| DCI 1-5 | R-ML | R-ML |
| DCI 6 | R-ML* Applicability of this test depends on UE capability/declaration
 | E-LMMSE* May have the same configuration as the corresponding R-ML test, but the SNR requirement can be different
* Pending on the following FFS: whether test cases need to be introduced for cases which R-ML receiver not applicable
 |

We also propose to have the same test configurations for the two rows except different DCI signaling (using a slightly different DCI signaling applicability scope of each code point without violating the definition) to simplify the test configurations. Note that DCI 6 can be tested by the identical tests with two sets of requirements. Therefore, we have a common test set for all the entries above except DCI signaling and SNR requirements.Proposal 7: For the common test set proposed above, we propose the following configurations besides the common ones proposed above* Full allocation, 1 co-scheduled UE, and the co-scheduled UE modulation order is smaller than the target UE modulation order to achieve better R-ML receiver gain. Note that test 1 is needed only when there is R-ML receiver with support of total number of layer = 2. Otherwise, test 2 is sufficient.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Test | Rank/DMRS | Serving MCS | Intf MCS | Channel |
| 1\* | 1+1 | 13 (16QAM) | QPSK | TDL-C 300ns 100Hz |
| 2 | 2+2 | 17 (64QAM) | 16QAM | TDL-A 30ns 10Hz |

 |
| R4-2319235 | Ericsson | Proposal 1: Propose not to introduce test cases for scenarios where R-ML receiver is not applicable, that is, this WI focus only on the test cases where R-ML is applicable.Proposal 2: Propose to consider option 1 as the scope of defining requirements in phase II.Proposal 3: Propose to consider 1 co-scheduled UE for cases without modulation order blind detection.Proposal 4: Propose to cover both full and partial CHBW resource allocation, and full CHBW resource allocation for the target UE. Partial CHBW tests can be combined with tests with modulation order blind detection.Proposal 5: For the target UE, consider random PMI selection for rank 1+1, and consider orthogonal PMI selection for rank 2+2 for phase IIProposal 6: Propose to define tests #1-1 with 1 co-scheduled UE and full FDRA for UEs not supporting modulation order blind detection.Proposal 7: Propose option 1A with DCI index 6 configured, and no additional test for any other cases.Proposal 8: Propose to select QPSK for the co-scheduled UE for both rank 1+1 and rank 2+2 tests without modulation order blind detection.Proposal 9: Propose QPSK for co-scheduled UE1 with Partial CHBW allocation, and QPSK or 16QAM for co-scheduled UE2 with Partial CHBW allocation.Proposal 10: Reuse the phase I simulation assumptions as a start point. |
| R4-2319335 | Samsung | Proposal 1: Reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMO: Both FDD 15kHz SCS with 10MHz CHBW and TDD 30kHz SCS with 40MHz CHBW, and- 2Tx-2Rx with rank 1 transmission for both target and co-scheduled UE on each PRB.- 2Tx-4Rx with rank 1 transmission for both target and co-scheduled UE on each PRB.- 4Tx-4Rx with rank 2 transmission for both target and co-scheduled UE on each PRB.Proposal 2: For the cases without modulation order blind detection, define requirements for R-ML receiver with 1 co-scheduled UE; for the cases with modulation order blind detection, define requirements for R-ML receiver with 2 co-scheduled UEs with different modulation orders and different FDRA, such as scenario 3 in Figure 1.Proposal 3: Define MU-MIMO requirements for cases with both full and partial CHBW resource allocation for the co-scheduled UE, and full CHBW resource allocation for the target UE.Proposal 4: For phase II tests, all the RAN4 agreed network default assumptions should be valid.Proposal 5: From current real network point of view, define MU-MIMO requirements by using maximum 256QAM MCS table is more reasonable than 64QAM MCS table.Proposal 6: Consider to use random PMI selection for rank 1+1, and consider to use orthogonal PMI for rank 2+2 for the co-scheduled UE precoder.Proposal 7: For DCI index 1-5 configured, consider to define test cases with 1 co-scheduled UE and full FDRA, and consider to define test cases with 1 co-scheduled UE and partial FDRA, but do not consider to define test cases with 2 co-scheduled UEs having same modulation order. For DCI index 6 configured, do not introduce test cases for UEs without modulation order blind detection capability.Proposal 8: For UEs with R-ML supporting modulation order blind detection: for DCI index 1-5 configured, consider to define test cases with 1 co-scheduled UE and full FDRA; for DCI index 6 configured, consider to define test cases with 2 co-scheduled UEs having different modulation order and different FDRA; for DCI index 7 configured, we are open to introduce related tests for R-ML with modulation order blind detection, such as with 2 co-scheduled UEs with different modulation order and full FDRA separately.Proposal 9: For test cases with/without modulation order blind detection, define 16QAM or 64QAM as modulation order of co-scheduled UEs. Proposal 10: for the detailed test parameters, we propose below settings- For rank 1+1 tests with 2T2R:• Target MCS: 13 (Table 2)• MIMO configuration: ULA medium • Channel: TDLC300-100- For rank 1+1 tests with 2T4R:• Target MCS: 13 (Table 2)• MIMO configuration: ULA Low• Channel: TDLC300-100- For rank 2+2 tests with 4T4R:• Target MCS: 13 (Table 2)• MIMO configuration: 4T4R ULA Low• Channel: TDLA30-10Proposal 11: For other parameters, support option 1, reuse the phase I simulation assumptions as a start point. |
| R4-2319393 | China Telecom | Proposal 1: RAN4 should first reach consensus on the exact UE behavior when UE receives DCI index 6 but the UE does not support modulation order blind detection, before defining test cases for scenarios where R-ML receiver is not applicable.Proposal 2: Reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMO:- Both FDD 15kHz SCS with 10MHz CHBW and TDD 30kHz SCS with 40MHz CHBW- 2Tx-2Rx with rank 1 for both target and co-scheduled UE on each PRB.- 2Tx-4Rx with rank 1 for both target and co-scheduled UE on each PRB.- 4Tx-4Rx, FFS the rank number for target and co-scheduled UE on each PRB.Proposal 3: For the cases without modulation order blind detection, model 1 co-scheduled UE; For the cases with modulation order blind detection, model 2 co-scheduled UEsProposal 4: For the FDRA for the co-scheduled UE, cover both full and partial CHBW resource allocation, and full CHBW resource allocation is configured for the target UE.Proposal 5: Postpone the discussion on RRC configuration details after RAN2 has finished RRC based assistant signaling design.Proposal 6: For the RRC assistant information configuration on the MCS table – For the cases without modulation order blind detection (UE informed DCI index 1-5), no need for the network to inform such information to the UE– For the cases with modulation order blind detection (UE informed DCI index 6), the RRC configuration on MCS Table should be ‘256QAM MCS Table’Proposal 7: Use MCS Table1 as the test configuration to the target UE.Proposal 8: Consider random PMI selection for rank 1+1, and consider orthogonal PMI selection for rank 2+2.Proposal 9: For both UEs supporting and not supporting co-scheduled UE modulation order blind detection, it is proposed to model 1 co-scheduled UE with single modulation order, and the UE should be informed DCI 1~5 according to the allocated modulation order.Proposal 10: For UE supporting modulation order blind detection, in the test with target UE full CHBW allocation, it is proposed to additionally perform the test under following configurations to verify the accuracy of such modulation order blind detection per PRG. And the UE should be informed DCI 6.- Co-UE1: Partial CHBW allocation with QPSK- Co-UE2: Partial CHBW allocation with 16QAMProposal 11: RAN4 should firstly reach consensus on the exact UE behavior under the following scenarios- UE receives DCI index 6 but the UE does not support modulation order blind detection- UE receives DCI index 7 and the UE supports modulation order blind detectionProposal 12: For the test cases without modulation order blind detection, we support to consider QPSK for rank 1+1, and 16QAM for rank 2+2 tests. For the cases with modulation order blind detection, as proposed above, option5 is preferred.Proposal 13: Propose the following detailed test parameters for phase II test requirement definition:- For rank 1+1 test: Target MCS: 13 (Table 1) Co-scheduled UE configuration: • For test without modulation order blind detection: 1 Co-UE with QPSK • For test with modulation order blind detection: Co-UE1: Partial CHBW allocation with QPSK; Co-UE2: Partial CHBW allocation with 16QAM MIMO configuration: ULA medium for 2T2R and ULA Low for 2T4R Channel : TDLC300-100 for 2T2R and TDLA30-10 for 2T4R- For rank 2+2 test: Target MCS: 17 (Table 1) Co-scheduled UE configuration:• For test without modulation order blind detection: 1 Co-UE with 16QAM • For test with modulation order blind detection: Co-UE1: Partial CHBW allocation with QPSK; Co-UE2: Partial CHBW allocation with 16QAM MIMO configuration: 4T4R ULA Low Channel : TDLA30-10Proposal 13: For the other parameters, it is proposed to reuse the phase I simulation assumptions as a start point. |
| R4-2319540 | ZTE Corporation | Proposal 1. Do not introduce test cases for scenarios where R-ML receiver is not applicable.Proposal 2. Reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMOo Both FDD 15kHz SCS with 10MHz CHBW and TDD 30kHz SCS with 40MHz CHBWo 2Tx-2Rx with rank 1 for both target and co-scheduled UE on each PRB.o 2Tx-4Rx with rank 1 for both target and co-scheduled UE on each PRB.o 4Tx-4Rx with rank 2 transmission for both target and co-scheduled UE on each PRB.Proposal 3. Define requirements with R-ML receiver for the case without modulation order blind detection with 1 co-scheduled UE .Proposal 4. Define requirements with R-ML receiver for the case with modulation order blind detection for 2 co-scheduled UEs with different modulation orders and different FDRA.Proposal 5. For the frequency domain resource allocation, propose to cover both full and partial CHBW resource allocation, and full CHBW resource allocation for the target UE.Proposal 6. For MCS table, propose to consider 256QAM or 64QAM MCS table as maximum MCS table.Proposal 7. Considering random PMI selection for rank 1+1, and consider orthogonal PMI selection for rank 2+2.Proposal 8. Regarding test scope for UEs not supporting modulation blind detection, we propose to only define tset #1-1 with 1 co-schedule UE and full FDRA. And no need to introduce test cases when R-ML receiver is not applicable.Proposal 9. Regarding test scope for UEs supporting modulation blind detection, we propose to introduce test cases which covered 2-co-scheduled UEs with different modulation order and different FDRA.Proposal 10. For the test cases without modulation order blind detection, cover QPSK for rank 1+1, and 16QAM for rank 2+2 tests; For the test cases with modulation order blind detection, cover rank 1+1: Co-scheduled UE1 with Partial CHBW allocation and QPSK, co-scheduled UE2 with Partial CHBW allocation and 16QAM; rank 2+2: Co-scheduled UE1 with Partial CHBW allocation and 16QAM, co-scheduled UE2 with Partial CHBW allocation and 64QAM.Proposal 11. For rank 1+1 tests with 2T2R, cover MCS 13, ULA medium and TDLC300-100; For rank 1+1 tests with 2T4R, cover MCS 13, ULA Low and TDLC30-10; For rank 2+2 tests with 4T4R, cover MCS 17, ULA Low and TDLA30-10.Proposal 12. For other parameters, reuse the phase I simulation assumption as a start point. |
| R4-2320188 | Huawei, HiSilicon | Proposal 1: Don't introduce test cases for scenarios where R-ML receiver is not applicable.Observation 1: Diverse modulation detection algorithms makes it challengeable to unify the algorithm and align the simulation results within the limited time left for this WI. Observation 2: Defining case with Rank 1+1 can minimize the performance impact of diverse implementation of MO detection, which makes it easier to align the simulation results.Proposal 2: RAN4 to consider following test scope:* For test without MO detection
	+ Rank 1+1: 2T2R ULA Med, 2T4R ULA Med.
	+ Rank 2+2: 4T4R ULA Low
* For test with MO detection
	+ Rank 1+1: 2T2R ULA Med, 2T4R ULA Med.

Proposal 3: RAN4 to only consider 1 co-scheduled UE.Proposal 4: Only consider full CHBW allocation for both target UE and co-scheduled UEs.Proposal 5: All the RAN4 agreed network default assumptions should be valid for Phase II testsProposal 6: For case without modulation order detection, the RRC based MCS table information is not configured. For case with modulation order detection, 256QAM table is configured for co-scheduled UE, related RRC assistant signalling should be configured.Proposal 7: Consider random PMI selection for rank 1+1, and orthogonal PMI selection for rank 2+2Proposal 8: For UEs not supporting modulation order detection, only introduce test cases with DCI index 1~5 with 1 co-scheduled UE configured. Observation 3: From modulation order detection complexity reduction perspective, DCI index 6 is not needed for Rank 1+1, but can help UE know the existence of co-scheduled UE. Proposal 9: For cases with modulation order detection (Only Rank 1+1), configure DCI index 6 to indicate testing UE the existence of the co-scheduled UE. Proposal 10: RAN4 to consider following combination of MCS (target UE) and modulation order (Co-scheduled UE)* For case without modulation order detection:
	+ Rank 1+1: Target UE: MCS13, Co-scheduled UE: QPSK
	+ Rank 2+2: Target UE: MCS17, Co-scheduled UE: QPSK
* For case with modulation order detection:
	+ Rank 1+1: Target UE: MCS13, Co-scheduled UE: QPSK

Proposal 11: RAN4 to consider following detailed parameters:* Rank 1+1: TDLC300-100 ULA Med
* Rank 2+2: TDLA30-10 ULA Low
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## Open issues summary

**Issue 2-1: Test cases for scenarios where R-ML receiver is not applicable**

* *Status in the last meeting WF in R4-2316915*

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| * + *Option 1: Do not introduce test cases for scenarios where R-ML receiver is not applicable*
	+ *Other options are not precluded*
 |

* Proposals:
	+ Option 1: Do not introduce test cases for scenarios where R-ML receiver is not applicable. (MTK, Apple, Ericsson, ZTE, Huawei)
	+ Option 2: RAN4 should first reach consensus on the UE behaviour for the scenarios that R-ML is not applicable (China Telecom)
* Recommended WF
	+ Discuss under detailed scenarios in Issue 2-8 and Issue 2-9.

**Issue 2-2: Test scope**

* *Status in the last meeting WF in R4-2316915*

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| * + *Option 1: Reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMO*
		- *Both FDD 15kHz SCS with 10MHz CHBW and TDD 30kHz SCS with 40MHz CHBW*
		- *2Tx-2Rx with rank 1 for both target and co-scheduled UE on each PRB.*
		- *2Tx-4Rx with rank 1 for both target and co-scheduled UE on each PRB.*
		- *4Tx-4Rx with rank 2 transmission for both target and co-scheduled UE on each PRB*
	+ *Other options are not precluded.*
 |

* Proposals:
	+ Option 1: Reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMO (China Telecom, Apple, Nokia, Ericsson, Samsung, ZTE, Huawei for tests without MO BD)
* Both FDD 15kHz SCS with 10MHz CHBW and TDD 30kHz SCS with 40MHz CHBW
* 2Tx-2Rx with rank 1+1 for target and co-scheduled UE
* 2Tx-4Rx with rank 1+1 for target and co-scheduled UE
* 4Tx-4Rx, FFS the rank number for target and co-scheduled UE
	+ Option 2: Reuse the same test scope for Rel-17 MMSE-IRC for MU-MIMO except for tests for 2Tx-4Rx (MTK)
	+ Option 3: For tests with MO BD, only consider 2T2R and 2T4R with rank 1+1 (Huawei)
* Recommended WF
	+ Need discuss whether to exclude 2T4R.
	+ Need discuss whether to have different scopes for UE supporting modulation order blind detection (related to the agreed UE types in Issue 1-1-1).

**Issue 2-3: Co-scheduled UE number**

* *Status in the last meeting WF in R4-2316915*

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| * + *For the cases without modulation order blind detection:*
* *Option 1: 1 co-scheduled UE*
* *Option 2: In addition to 1 co-scheduled UE, define performance requirements based on multiple co-UEs using the same modulation order*
	+ *For the cases with modulation order blind detection:*
* *Option 1: Model 2 co-scheduled UEs with different modulation orders and different FDRA*
* *Option 2: In addition to 1 co-scheduled UE, define performance requirements based on multiple co-UEs using the same modulation order*
* *Option 3: 1 co-scheduled UE*
 |

* Proposals:
	+ For the cases without modulation order blind detection:
* Option 1: 1 co-scheduled UE (China Telecom, MTK, Apple, Ericsson, Samsung, ZTE, Huawei)
* Option 2: In addition to 1 co-scheduled UE, define performance requirements based on multiple co-UEs using the same modulation order (Nokia)
	+ For the cases with modulation order blind detection:
* Option 1: Model 2 co-scheduled UEs with different modulation orders and different FDRA (China Telecom, Nokia, Samsung, ZTE)
* Option 2: In addition to 1 co-scheduled UE, define performance requirements based on multiple co-UEs using the same modulation order (Nokia)
* Option 3: 1 co-scheduled UE (MTK, Huawei)
* Recommended WF
	+ Discuss under Issue 2-8 and Issue 2-9.

**Issue 2-4: Frequency domain resource allocation**

* *Status in the last meeting WF in R4-2316915*

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| * + *Option 1: Define requirements with full CHBW FDRA co-scheduled UE only*
	+ *Option 2: Cover both full and partial CHBW resource allocation, and full CHBW resource allocation for the target UE*
 |

* Proposals:
	+ Option 1: Define requirements with full CHBW FDRA co-scheduled UE only (MTK, Apple, Huawei)
	+ Option 2: Cover both full and partial CHBW resource allocation, and full CHBW resource allocation for the target UE (China Telecom, Nokia, Ericsson, Samsung, ZTE)
* CTC: The reliability of FDRA and DMRS port blind detection consists of 2 aspects
* For the PRGs with co-scheduled UE(s) exists, the target UE can detect the presence and DMRS port interference of the co-scheduled layer.
* The target UE will not perform advanced receiving process on the REs without co-scheduled UE exists.
* Recommended WF
	+ Discuss under Issue 2-8 and Issue 2-9.

**Issue 2-5: Test setting for the RAN4 agreed network default assumptions**

* *Status in the last meeting WF in R4-2316915*

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| * + *For phase II tests, all the RAN4 agreed network default assumptions should be valid*
	+ *FFS on the detailed RRC configuration details pending decisions on the signalling design*
 |

* Proposals:
	+ Option 1: Postpone the discussion on RRC configuration details after RAN2 has finished RRC based assistant signaling design (China Telecom)
* Recommended WF
	+ Postpone the discussion on RRC configuration details after RAN2 has finished RRC based assistant signaling design.

**Issue 2-6: MCS Table**

* *Status in the last meeting WF in R4-2316915*

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| *Candidate options on the RRC assistant information configuration on the MCS table:** + *Option 1:*
		- *For the cases without modulation order blind detection (UE informed DCI index 1-5), no need for the network to inform such information to the UE*
		- *For the cases with modulation order blind detection (UE informed DCI index 6), FFS the RRC signaling configuration details after decisions are made*
	+ *Other options are not precluded.*

*Candidate options on MCS Table1 for the test configuration:** + *Option 1: The maximum MCS table is 256QAM or 64QAM MCS table, i.e., 1024QAM is not covered*
	+ *Option 2: Use MCS Table1*
 |

* *RRC assistant signalling design in the approved LS to RAN2 in R4-2316980*

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| * + *The MCS table with the highest modulation order among all MCS tables configured to the co-scheduled UE(s), which has the same DM-RS sequence as the target UE. The MCS table is one of the following:*
	+ *1024QAM MCS table(s) (Table 5.1.3.1-4 from TS38.214)*
	+ *256QAM MCS table(s) (Table 5.1.3.1-2 from TS38.214)*
	+ *64QAM MCS tables (Table 5.1.3.1-1 or 5.1.3.1-3 from TS38.214)*
 |

* Proposals on the RRC assistant information configuration on the MCS table:
	+ For UEs not supporting modulation order blind detection:
		- Option 1: No need for the network to inform such information to the UE (China Telecom, Huawei)
		- Option 2: Should be presented regardless of whether the UE supports MO BD (Apple)
	+ For UEs supporting modulation order blind detection:
		- Option 1: RRC-based assistant signalling on MCS Table should be ‘256QAM MCS Table’ (China Telecom, ZTE, Huawei)
		- Option 2: Align with the MCS Table configuration in the test (Apple)
* Proposals on MCS Table for the test configuration:
	+ Option 1: The maximum MCS table is 256QAM or 64QAM MCS table, i.e., 1024QAM is not covered ()
	+ Option 2: Use MCS Table1 (China Telecom, MTK, Apple, ZTE)
	+ Option 3: Use maximum 256QAM MCS table (Samsung, ZTE)
* Recommended WF
	+ Need discussion.

**Issue 2-7: Precoder selection for co-scheduled UE**

* *Status in the last meeting WF in R4-2316915*

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| * + *Option 1: Only consider orthogonal PMI selection with the target UE*
	+ *Option 2: Use the randomized precoder for co-scheduled UE which is not equal to any column of the precoder matrix of target UE*
	+ *Option 3: consider both random PMI and orthogonal PMI*
		- *Option 3A: Consider random PMI selection for rank 1+1, and consider orthogonal PMI selection for rank 2+2*
 |

* Proposals:
	+ Option 1: Only consider orthogonal PMI selection with the target UE (Apple, Qualcomm)
	+ Option 2: Consider random PMI selection for rank 1+1, and consider orthogonal PMI selection for rank 2+2. (China Telecom, MTK, Nokia, Ericsson, Samsung, Huawei, Rel-17 IRC test design)
* Recommended WF
	+ Can we agree option 2?

**Issue 2-8: Test setting for UEs not supporting modulation order blind detection**

* *Status in the last meeting WF in R4-2316915*

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| *Candidate options on Test with DCI index 1-5 configured (Tests #1-1):** + *Option 1: Define Tests #1-1 with 1 co-scheduled UE and full FDRA*
	+ *Option 2: In addition to the Tests with 1 co-UE, consider cases with 2 co-UEs having same modulation order*

*Candidate options on Test with DCI index 6 configured (Tests #1-2):** + *Option 1: In addition to Tests #1-1, define Tests #1-2 to verify UE E-IRC receiving process under the same test parameters with Tests #1-1*
	+ *Option 2: Do not introduce test cases for scenarios where R-ML receiver is not applicable*
 |

* Proposals on Tests with DCI index 1-5 configured (Tests #1-1):
	+ Option 1: Define Tests #1-1 with 1 co-scheduled UE and full FDRA (China Telecom, MTK, Apple, [Qualcomm], Ericsson, ZTE, Huawei, Nokia, Samsung)
* Nokia: In addition to the Tests with 1 co-UE, consider cases with 2 co-UEs having same modulation order
* Samsung: In addition to the Tests with full FDRA, consider 1 co-scheduled UE with partial FDRA.
* Proposals on Tests with DCI index 6 configured (Tests #1-2):
	+ Option 1: In addition to Tests #1-1, define Tests #1-2 to verify UE E-IRC receiving process under the same test parameters with Tests #1-1 (Nokia, Qualcomm)
* QC: have the same test configurations as Tests #2-2
	+ Option 2: Do not introduce test cases for scenarios where R-ML receiver is not applicable. (MTK, Apple, Ericsson, Samsung, ZTE, Huawei)
	+ Option 3: RAN4 should firstly reach consensus on the UE behaviour under the following scenario (China Telecom)
* UE receives DCI index 6 and the UE supports modulation order blind detection
* Recommended WF
	+ Define Tests with DCI index 1-5 configured (Tests #1-1) with 1 co-scheduled UE and full FDRA.
* Need discussion whether to additionally cover: 1) 2 co-UEs with different modulation order; and/or 2) 1 co-UE with partial FDRA.
* Further discuss the other detailed parameters under other issues.
	+ Need discussion whether to define Tests with DCI index 6 configured (Tests #1-2).
* RAN4 needs to firstly reach consensus on the UE behaviour:
* Option 1: UE fallbacks to MMSE-IRC.
* Option 2: UE will use E-IRC.
* Others

**Issue 2-9: Test setting for UEs supporting modulation order blind detection**

* *Status in the last meeting WF in R4-2316915*

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| *Candidate options on Tests with DCI index 6 configured (Tests #2-2):** + *Option 1: Define Tests #2-2 to verify UE R-ML process with modulation order blind detection*
* *Option 1A: Model 2-co-scheduled UEs with different modulation order and different FDRA*
* *Option 1B: Follow test settings from test without modulation order blind detection except DCI signalling*
* *Option 1C: Model 1-co-scheduled UE with partial FDRA and single modulation order*
* *Option 1D: Only consider rank 1+1 with QPSK for the co-UE*

*Candidate options on Test with DCI index 1-5 configured (Test #2-1):** + *Option 1: In addition to Tests #2-2, Define Tests #2-1 to verify UE R-ML receiving process with modulation order information with 1 co-scheduled UE and full FDRA*
	+ *Other options are not precluded.*

*Candidate options on Test with DCI index 7 configured (Test #2-3):** + *Option 1: Introducing tests for R-ML with modulation order blind detection, with DCI index 7*
	+ *Other options are not precluded.*
 |

* Proposals on Tests with DCI index 6 configured (Tests #2-2):
	+ Option 1: Define Tests #2-2 to verify UE R-ML process with modulation order blind detection (China Telecom, MTK, Nokia, Ericsson, Samsung, ZTE, Huawei)
* Option 1A: Model 2-co-scheduled UEs with different modulation order and different FDRA (China Telecom, Nokia, Ericsson, Samsung, ZTE)
* Option 1B: Same test configurations as Tests#1-1 except DCI signalling (MTK, Qualcomm)
* Option 1C: Model 1-co-scheduled UE with partial FDRA and single modulation order (Nokia)
* Option 1D: Only consider rank 1+1 with QPSK (Huawei)
	+ Option 2: Test cases with blind modulation order need further study. Limit further study and requirements if any to DCI index 6 for R-ML with modulation order blind detection. (Apple)
* Proposals on Tests with DCI index 1-5 configured (Tests #2-1):
	+ Option 1: In addition to Tests #2-2, Define Tests #2-1 to verify UE R-ML receiving process with modulation order information (China Telecom, MTK, Apple, Qualcomm, Samsung)
* Option 1A: Same test configurations as Tests#1-1 (China Telecom, MTK, Apple, Qualcomm)
* Option 1B: Consider 1 co-scheduled UE and full FDRA (Samsung)
	+ Option 2: No additional tests with DCI index 1-5 configured (Ericsson)
* Proposals on Test with DCI index 7 configured (Test #2-3):
	+ Option 1: Introducing tests for R-ML with modulation order blind detection, with DCI index 7 (MTK, Nokia)
* Option 1A: Same test setting as test without modulation order blind detection (MTK)
* Option 1B: modeling 2 co-UEs with different modulation orders which are multiplexed on different DMRS ports (Nokia)
	+ Option 2: RAN4 should firstly reach consensus on the UE behaviour under the following scenario (China Telecom)
* UE receives DCI index 7 and the UE supports modulation order blind detection
* Recommended WF
	+ Define tests with DCI index 6 configured (Tests #2-2) to verify UE R-ML process with modulation order blind detection.
* Need discussion on the co-UE number and FDRA.
	+ Can we agree to define tests with DCI index 5 configured (Tests #2-1) with 1 co-scheduled UE and full FDRA?
	+ Need discussion whether to define Tests with DCI index 7 configured (Tests #2-3).
* RAN4 needs to firstly reach consensus on the UE behaviour:
* Option 1: UE fallbacks to MMSE-IRC.
* Option 2: UE tries to perform R-ML for part of the co-scheduled layers.
* Others

**Issue 2-10: Modulation order for the co-scheduled UE**

* *Status in the last meeting WF in R4-2316915*

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| * + *For the test cases without modulation order blind detection (for Tests#1-1 and Tests#2-1 if defined):*
* *Option 1: QPSK for rank 1+1, and 16QAM for rank 2+2 tests*
* *Option 2: QPSK for both rank 1+1 and rank 2+2 tests*
* *Option 3: 16QAM for both rank 1+1 and rank 2+2 tests*
* *Option 4: Cover both QPSK and 16QAM for rank 1+1, and QPSK for rank 2+2 tests*
	+ *For the cases with modulation order blind detection (for Tests#1-2 and Tests#2-2 if defined):*
* *Option 1: Follow test settings from test without modulation order blind detection*
* *Option 2: Model 1 co-scheduled UEs with QPSK, for both rank 1+1 and rank 2+2 tests*
* *Option 3: QPSK only*
* *Option 4: Model 2 co-scheduled UEs with QPSK and 16QAM respectively, for both rank 1+1 and rank 2+2 tests*
* *Option 5:*
* *For rank 1+1: Co-scheduled UE1 with Partial CHBW allocation and QPSK, co-scheduled UE2 with Partial CHBW allocation and 16QAM*
	+ *For rank 2+2: Co-scheduled UE1 with Partial CHBW allocation and 16QAM, co-scheduled UE2 with Partial CHBW allocation and 64QAM*
 |

* Proposals:
	+ For the test cases without modulation order blind detection (for Tests#1-1 and Tests#2-1 if defined):
* For rank 1+1 tests:
* Option 1: QPSK (China Telecom, Qualcomm, ZTE, MTK, Apple, Ericsson, Huawei)
* Option 2: Cover both QPSK and 16QAM (Nokia)
* Option 3: 16QAM or 64QAM (Samsung)
* For rank 2+2 tests:
* Option 1: 16QAM (China Telecom, Qualcomm, ZTE, Samsung)
* Option 2: QPSK (MTK, Apple, Ericsson, Huawei, Nokia)
* Option 3: 64QAM (Samsung)
	+ For the cases with modulation order blind detection (for Tests#2-2 if defined):
* Option 1: Follow test settings from test without modulation order blind detection (Qualcomm)
* Option 2: Model 1 co-scheduled UEs with QPSK, for both rank 1+1 and rank 2+2 tests (Nokia)
* Option 3: QPSK only (MTK, Huawei)
* Option 4: Model 2 co-scheduled UEs with QPSK and 16QAM respectively, for both rank 1+1 and rank 2+2 tests (China Telecom, Nokia, Ericsson)
* Option 5: (ZTE)
* For rank 1+1: Co-scheduled UE1 with Partial CHBW allocation and QPSK, co-scheduled UE2 with Partial CHBW allocation and 16QAM
* For rank 2+2: Co-scheduled UE1 with Partial CHBW allocation and 16QAM, co-scheduled UE2 with Partial CHBW allocation and 64QAM
* Option 6: 16QAM or 64QAM (Samsung)
* Recommended WF
	+ For the test cases without modulation order blind detection (for Tests#1-1 and Tests#2-1 if defined):
* Can we use QPSK for rank 1+1 tests based on majorities’ view?
* Need discussion for rank 2+2 tests:
	+ For the cases with modulation order blind detection (for Tests#2-2 if defined).
* Further discuss after the co-UE number and FDRA is decided.

**Issue 2-11: Detailed test parameters**

* Proposals on rank 1+1 tests with 2T2R:
	+ Option 1 (China Telecom, Apple, Nokia, [Qualcomm], Samsung, ZTE, Huawei)
* Target MCS: 13 (Table 1)
* MIMO configuration: ULA medium
* Channel: TDLC300-100
	+ Option 2 (MTK)
* Target MCS: 13 (Table 1)
* MIMO configuration: ULA low
* Channel: TDLC300-100
* Proposals on rank 1+1 tests with 2T4R (if defined):
	+ Option 1 (China Telecom, Nokia, ZTE)
* Target MCS: 13 (Table 1)
* MIMO configuration: ULA Low
* Channel: TDLA30-10
	+ Option 2 (Apple, Nokia, [Qualcomm], Samsung, Huawei)
* Target MCS: 13 (Table 1)
* MIMO configuration: ULA medium
* Channel: TDLC300-100
* Proposals on rank 2+2 tests with 4T4R:
	+ Option 1 (China Telecom, Apple, Nokia, [Qualcomm], Samsung, ZTE, Huawei)
* Target MCS: 17 (Table 1)
* MIMO configuration: ULA Low
* Channel: TDLA30-10
	+ Option 2 (MTK)
* Target MCS: 13 (Table 1)
* MIMO configuration: XP medium
* Channel: TDLA30-10
* Recommended WF
	+ For rank 1+1 tests with 2T2R:
* Option 1?
	+ For rank 1+1 tests with 2T4R:
* Need discussion
	+ For rank 2+2 tests with 4T4R:
* Option 1?

**Issue 2-12: Other parameters**

* Proposals:
	+ Option 1: Reuse the phase I simulation assumptions as a start point. (China Telecom, MTK, Ericsson, Samsung, ZTE)
* Recommended WF
	+ Option1.

# Topic #3: CR on TR 38.878

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318784 | Nokia | CR for TR38.878 on Summary of link level evaluation |
| R4-2319394 | China Telecom | Big CR on TR38.878 |

## Open issues summary

**Issue 3-1: CRs on TR 38.878**

* *Change was endorsed in R4-2315905*
* Recommended WF
	+ R4-2315905 can be agreeable.
	+ R4-2319394 can be withdrawn since there is no additional change to TR38.878.

# Topic #4: Absolute physical layer throughput requirements with link adaptation – CR on TS 38.307 and TS 38.101-4

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2318578 | Apple | Introducing release independence for Absolute physical layer throughput requirements |
| R4-2318796 | Nokia, Nokia Shanghai Bell | CR for 38.101-4 on Demodulation and CSI requiremets for ATP |

## Open issues summary

**Issue 4-1: CR on TS 38.307**

* *Previous agreements in the WF (R4-2309782)*

|  |
| --- |
| *Release independence* *Release independent from Rel-17 based on UE declaration and mandatory for Rel-18* |

* *Endorsed changes in R4-2315480 in RAN4#108bis*
* Recommended WF
	+ R4-2318578 can be agreeable.

**Issue 4-2: CR on TS 38.101-4**

* Recommended WF
	+ Check if R4-2318796 can be agreeable.