**3GPP TSG-RAN WG4 Meeting #109 R4-2321036**

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

**Agenda item:** 5.18.4

**Source:** Apple

**Title:** Offline meeting minutes for [109] [323] NR\_demod\_enh3\_Part1

**Document for:** Information

# Introduction

This contribution summarizes the discussion on select 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

### 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* |

* 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, MTK)
* 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, MTK)
* 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 (If related requirements are introduced)
* 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.

We discuss this under UE capability and revisit if not addressed there.

### 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, Huawei)
* 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, Nokia)
* 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)
  + Option 2: Not to introduce such capability definition (China Telecom, Spreadtrum, Huawei, Samsung if the max number of DMRS ports is no more than 4)
* 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 DMRS ports 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.

Discussion points:

1. Basic capability - UE capability for advanced receiver for MU-MIMO [Already agreed, need to discuss components]

* 2Rx UE capable of R-ML process 2 layers across target and co-scheduled UEs
* 4Rx UE capable of R-ML process [2,3,] 4 layers across target and co-scheduled UEs
* Is this needed or is it signaled implicitly by UE capability of *maxNumberMIMO-LayersPDSCH*.

**Discussion Monday AM offline**

**Basic capability**

Qualcomm: The basic capability should be tied to BD MO capability?

Mod: This capability is without BD MO.

Huawei: Agree. This Capability is for DCI index 1-5

Mod: The UE capability signalling should be irrespective of DCI

Qualcomm: Is this union or the sub feature group

Nokia: What about 8RX UE capable of R-ML? Does it not signal anything?

QC: To Nokia this is covered below when 8RX UE signals MU-MIMO capability under 4RX and 2RX mode.

Tentative agreement:   
The basic UE capability with R-ML receiver for MU-MIMO (for all UE types):

* UE is capable of MU-MIMO with R-ML for 2 layers across target and co-scheduled UEs under 2RX conditions
* UE is capable of MU-MIMO with R-ML up to 2,3, or 4 layers across target and co-scheduled UEs under 4RX conditions

The above bullets are not intended to be components.

**UE Types**

Should we discuss different UE types – capable of BD MO, not capable of BD-MO

QC: There is additional processing for BD-MO. But it need not do BD-MO if it receives index 1-5. IT can have different capability for MIMO layers if it does BD-MO, than when it does

Tentative agreement:

The UE Types to be covered in terms of #layers it can process with R-ML:

1. Capability when modulation order is signaled (index 1-5)
   1. Up to *maxNumberMIMO-LayersPDSCH* layers in 2 RX and 4RX condition
2. Capability when modulation order is not signalled (index 6)
   1. UE cannot support R-ML
   2. UE can support 2 layers across target and co-scheduled UEs with 2RX and 4RX
   3. UE can support 2 layers across target and co-scheduled UEs with 2RX; UE can support 4 layers across target and co-scheduled UEs with 4RX
3. Capability when modulation order is not signalled (index 7)
   1. UE cannot support R-ML
4. For R-ML with blind modulation order detection
   * Option 1: Blind modulation order detection is based on UE capability signaling (MTK, Apple, Nokia, Samsung, ZTE, Spreadtrum)
     1. Option 1A: Define different capability in the scenarios indicated by DCI index 6 and 7 respectively (Spreadtrum)
     2. 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, Huawei)
5. For Maximum number of layers and Maximum number of DMRS ports
   * Option 1: Introduce UE capability signalling for maximum DMRS ports to be detected. (MTK, Apple, Nokia, ZTE)
   * Option 2: Not to introduce such capability definition (China Telecom, Spreadtrum, Huawei, Samsung if the max number of DMRS ports is no more than 4)
6. For Maximum modulation orders of interfering DMRS ports
   * 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 DMRS ports is no more than 4)
7. For supported DMRS configurations
   * Option 1: Introduce UE capability signaling for supported DMRS configuration for R-ML (Apple)

**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?

### 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, MTK)
    - 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.* |

* *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, which is helpful when PRG aligned information is invalid.
  + 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, [MTK])
* 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*  |  |  | | --- | --- | | ***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, [MTK])
    - 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.

# Topic #2: Test parameters and simulation results

**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 2-6: 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 (Nokia)
  + Option 2: Use MCS Table1 (China Telecom, MTK, Apple, ZTE, [Nokia])
  + Option 3: Use maximum 256QAM MCS table (Samsung, ZTE, [Nokia])
* 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 2-10: 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.

Discuss online:  
**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, Nokia)
* Option 1A: Same test configurations as Tests#1-1 (China Telecom, MTK, Apple, Qualcomm, Nokia)
* 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