**3GPP TSG-RAN WG4 Meeting # 109 R4-2316920**

**Chicago, USA, November 13 ‒ November 17, 2023**

**Title:** WF on NR\_MIMO\_evo\_DL\_UL\_demod

**Agenda Item:** 8.29.5

**Source: Samsung**

**Document for:** Approval

# Topic #1 General Scope

## Sub-topic 1-1 Scope of UE demodulation performance and CSI requirements

**Issue 1-1-1: clarify criteria of feasibility for ‘typeII-Doppler-r18’ codebook**

**Agreement:**

* Define PMI reporting requirements with ‘typeII-Doppler-r18’ using option 2 if both option 1 and option 2 could be fulfilled. Otherwise, if only option 1 is fulfilled, further discuss if feasible to define PMI reporting requirement using option 1 only.
	+ - * Option 1: UE throughput with ‘typeII-Doppler-r18’ codebook could outperform Rel-16 Type II codebook with the same CSI-RS configurations and medium/high UE speed.
			* Option 2: UE throughput with ‘typeII-Doppler-r18’ codebook could outperform random precoding based on Single Panel Type I codebook with the same CSI-RS configurations and medium/high UE speed.

**Issue 1-1-2: clarify test metric for PMI reporting requirements with ‘typeII-Doppler-r18’ codebook**

**Agreement:**

* Test metric defined as $γ\_{1}=\frac{t\_{typeII-doppler}}{t\_{rnd}}$ as a starting point, where $t\_{typeII-doppler}$ is X % (e.g. X=90) of the maximum throughput obtained at $SNR\_{typeII-doppler}$ using the *typeII-Doppler-r18* precoder configured according to the UE reports, and $t\_{rnd}$ is the throughput measured at $SNR\_{typeII-doppler}$ with random precoding based on Type I Single Panel codebook.

**Issue 1-1-3: clarify if CSI requirements are needed for TDCP**

**Agreement:**

* Do not introduce CSI requirements for TDCP measurement.

**Issue 1-1-4: clarify if PMI reporting requirements are needed for ‘typeII-CJT-r18’ codebook**

**Tentative Agreement:**

* Focus on co-located scenario (zero time offset and zero frequency offset), introduce PMI reporting requirements with ‘typeII-CJT-r18’ (FR1 FDD only) if performance gain could be observed, with Test metric defined as $γ\_{3}=\frac{t\_{typeII-CJT}}{t\_{rnd}}$, where $t\_{typeII-CJT}$ is Z % (e.g., Z=90) of the maximum throughput obtained at $SNR\_{typeII-CJT}$ using the precoders configured according to the UE reports, and $t\_{rnd}$ is the throughput measured at $SNR\_{typeII-CJT}$ with random precoding based on type I Single Panel codebook.

**Issue 1-1-5: clarify if applicability rules are needed for demodulation requirements of Rel-18 DMRS ports**

**Agreement:**

* Introduce applicability rules for UE to skip legacy case(s) if UE has passed the case(s) with same configuration using the Rel-18 DMRS ports.

## Sub-topic 1-2 Scope of BS demodulation performance requirements

**Issue 1-2-1: clarify the details of applicability rule for Rel-18 DMRS ports**

**Agreement:**

* Unless otherwise stated, PUSCH requirements with enhanced DM-RS port configuration shall apply only for a BS declaring support of enhanced DM-RS port type (see D.xxx in table 4.6-1).

|  |  |  |
| --- | --- | --- |
| D.xxx | PUSCH enhanced DM-RS port | Declaration of support PUSCH enhanced DM-RS port configuration enhanced-dmrs-Type\_r18.  |

* [A BS that passes tests with enhanced DM-RS port can consider corresponding legacy PUSCH tests as passed. Definition of "corresponding" needs to be further specified.] FFS on specific wording.

**Issue 1-2-2: clarify if BS demodulation requirements are needed for FR2 STxMP**

**Agreement:**

* Do not define FR2 STxMP demodulation requirements in Rel-18, postpone the discussion on BS performance requirement introduction with UE FR2 STxMP to future release.

# Topic #2: Test set-up and simulation assumptions for UE demodulation performance and CSI

## Sub-topic 2-1 Initial simulation assumptions for TypeII Doppler

**Issue 2-1-1:** **Propagation channel**

**Way forward:**

* Start with TDLA30-30, TDLA30-50 and TDLA30-100 for TypeII Doppler feasibility study.

**Issue 2-1-2:** **Correlation configurations**

**Tentative agreement:**

* Use 16 Tx with XP Medium for TypeII Doppler feasibility study.

**Issue 2-1-3:** **N1, N2, O1, O2 and the number of CSI-RS ports**

**Tentative agreement:**

* Use 16Tx with (N1, N2) = (4, 2), (O1, O2) = (4, 4) for TypeII Doppler feasibility study.

**Issue 2-1-4:** **paramCombination-Doppler-r18**

**Tentative agreement:**

* Set paramCombination-Doppler-r18 as 7 (L=4, pυ=1/2, β=1/2).
* Other options are not precluded.

**Issue 2-1-5:** **RI restriction (typeII-Doppler-RI‑Restriction-r18)**

**Tentative agreement:**

* Set RI restriction as 0010 for TypeII Doppler feasibility study.

**Issue 2-1-6:** **N4 configuration**

**Tentative agreement:**

* Simulate both N4=1 and N4=4 for feasibility study. FDD is in first priority for feasibility study due to configuration complexity in TDD.

**Issue 2-1-7: CSI-RS configuration**

**Tentative agreement:**

* Aperiodic CSI-RS with 2 slots separation, [with 8ms CSI request triggering periodicity].

**Issue 2-1-8:** **K (number of NZP CSI-RS resources)**

**Tentative agreement:**

* Set K=4 as a starting point.

**Issue 2-1-9:** **m (separation between two consecutive CSI-RS resources) and d (DD unit duration (in slots)**

**Tentative agreement:**

* Set m and d as 2 as a starting point for N4=4.

**Issue 2-1-10:** **delta (slot associated with CSI report)**

**Tentative agreement:**

* Set delta as 1.

**Issue 2-1-11:** **MCS**

**Tentative agreement:**

* MCS13 (16QAM, 0.48) as a starting point.
* Other options are not precluded.

**Issue 2-1-12:** **other parameters**

**Tentative agreement:**

* follow below table

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Channel bandwidth and subcarrier spacing | For FDD, 10MHz/15kHzFor TDD, 40MHz/30kHz |
| TDD DL-UL configuration | FR1.30-1 as specified in 38.101-4 Annex A. |
| Number of UE receiver antennas | 2 and 4 |
| R (numberOfPMI-SubbandsPerCQI-Subband-Doppler-r18) | 1 |
| Other Test parameters not mentioned above | For FDD 2Rx, Table 6.3.2.1.6-1 in 38.101-4For TDD 2Rx, Table 6.3.2.2.6-1 in 38.101-4For FDD 4Rx, Table 6.3.3.1.6-1 in 38.101-4For TDD 4Rx, Table 6.3.3.2.6-1 in 38.101-4 |

* Other options are not precluded.

## Sub-topic 2-2 Initial simulation assumptions for TypeII for CJT

**Issue 2-2-1: Propagation channel and correlation configuration**

**Way forward:**

* Option 1: Use TDLA30-10 with XP high as the propagation channel and correlation configuration for Rel-18 TypeII for CJT test. (MTK, Nokia, Samsung)
* Option 2: TDLA30-5 with XP medium. (Ericsson)
* Other options are not precluded

**Issue 2-2-2: K (numberOfCSI-RS-Resources), NTRP (Number of TRPs) and restrictedCMR-Selection**

**Way forward:**

* Option 1: Set K=2 CSI-RS resources, NTRP=2 TRPs and configure parameter *restrictedCMR-Selection* to restrict the number of selected CSI-RS resources is N=NTRP for Rel-18 TypeII for CJT PMI test. (MTK, Nokia, Samsung, Huawei)
* Other options are not precluded

**Issue 2-2-3: N1, N2, O1, O2 and the number of CSI-RS ports**

**Way forward:**

* Option 1:Set PCSI-RS=8 CSI-RS ports per TRP with (N1, N2) = (4, 1), (O1, O2) = (4, 1) as a starting point for Rel-18 TypeII for CJT PMI test. (MTK, Nokia, Samsung, Huawei, Ericsson)
* Other options are not precluded

**Issue 2-2-4: paramCombination-CJT-L-r18**

**Way forward:**

* Option 1: Set *paramCombination-CJT-L-r18* as 7 ({4, 4})
* Option 2: Set paramCombination-CJT-L-r18 as 4 ({2, 2})
* Other options are not precluded

**Issue 2-2-5: paramCombination-CJT-r18**

**Way forward:**

* Option 1: Set *paramCombination-CJT-r18* as 4 ($p\_{ν}=\frac{1}{4}and\frac{1}{8}$,$ β=\frac{1}{2}$) or 7 ($p\_{ν}=\frac{1}{2}and\frac{1}{2}$,$ β=\frac{1}{2}$) for *paramCombination-CJT-L-r18* = 7
* Option 2: Set *paramCombination-CJT-r18* as 1 ($p\_{ν}=\frac{1}{8}$,$ β=\frac{1}{4}$) for *paramCombination-CJT-L-r18* = 4
* Other options are not precluded

**Issue 2-2-6: RI restriction (typeII-CJT-RI‑Restriction-r18)**

**Way forward:**

* Option 1: Set RI restriction as 0001 for Rel-18 TypeII for CJT PMI test. (MTK, Nokia, Samsung, Ericsson)
* Other options are not precluded

**Issue 2-2-7: codebookMode**

**Way forward:**

* Option 1: Set *codebookMode* as Mode2 for Rel-18 TypeII for CJT test. (Nokia, Samsung, Huawei, Ericsson)
* Option 2: Set *codebookMode* as Mode2 as a starting point, keep Mode1 as FFS until finish feasibility study with conclusions.(MTK)

**Issue 2-2-8:** **other parameters**

**Way forward:**

* Option 1: follow below table (MTK, Nokia, Samsung, Ericsson)

|  |  |
| --- | --- |
| **Parameter** | **Value** |
| Channel bandwidth and subcarrier spacing | For FDD, 10MHz/15kHz |
| TDD DL-UL configuration | FR1.30-1 as specified in 38.101-4 Annex A. |
| Number of UE receiver antennas | 2 and 4 |
| R (numberOfPMI-SubbandsPerCQI-Subband-Doppler-r18) | 1 |

## Sub-topic 2-3 Test set-up and simulation assumptions for Rel-18 DMRS

**Issue 2-3-1: DMRS configuration type and length**

**Way forward:**

* Option 1: Rel-18 DMRS configuration Type 1 with length 1 (MTK, Apple, Nokia, Samsung, Ericsson, Huawei, Qualcomm)
* Other options are not precluded

**Issue 2-3-2: DMRS ports**

**Way forward:**

* Option 1: DMRS ports introduced by Rel-18 (MTK, Apple, Nokia, Samsung, Ericsson, Huawei)
	+ - * {1008} if Rank 1 test is selected
			* {1008, 1009} if Rank 2 test is selected
			* {1008-1010} if Rank 3 test is selected
			* {1008-1011} if Rank 4 test is selected
* Option 2: DMRS ports introduced by Rel-18 (Qualcomm)
	+ - * {1008} if Rank 1 test is selected
			* {1008, 1009} if Rank 2 test is selected
			* {1008-1010} if Rank 3 test is selected
			* {1000, 1001, 1008, 1009} if Rank 4 test is selected
* Other options are not precluded

**Issue 2-3-3: Duplex mode for tests need to be defined for Rel-18 DMRS**

**Way forward:**

* Option 1: both FDD and TDD (Apple, Samsung, Ericsson)
* Option 2: Only FDD (MTK, Nokia)
* Option 3: Only TDD (Qualcomm)

**Issue 2-3-4: Number of Rx for tests need to be defined for Rel-18 DMRS**

**Way forward:**

* Option 1: both 2Rx and 4Rx (Apple, Samsung, Ericsson)
* Option 2: Only 4Rx (MTK, Nokia, Qualcomm)
* Option 3: Only 2Rx (Huawei)

**Issue 2-3-5: Cases need to be defined for FR1 Rel-18 DMRS**

**Way forward:**

* Option 1: define one test for each Rank 1, 2, 3 and 4 with 4Rx (MTK, Nokia)
	+ - * Option 1A: Use Test 1-3 for Rank 1, Test 2-1 for Rank 2, Test 3-1 for Rank 3, Test 4-1 for Rank 4 in Chapter 5.2.3.1.1 (MTK)
			* Option 1B: Use Test 1-1 for Rank 1, Test 2-1 for Rank 2, Test 3-1 for Rank 3, Test 4-1 for Rank 4 in Chapter 5.2.3.1.1 (Nokia)
* Option 2: define one test for Rank 2 with 2Rx, one test for each Rank 2, Rank 4 with 4Rx (Apple)
	+ - * For 2Rx: Test 2-1 in Chapter 5.2.2.1.1, 5.2.2.2.1
			* For 4Rx: Test 2-1, 4-1 in Chapter 5.2.3.1.1, 5.2.3.2.1
* Option 3: define one test for Rank 2 with 2Rx, one test for Rank 4 with 4Rx (Samsung)
	+ - * For 2Rx: Test 2-1 in Chapter 5.2.2.1.1, 5.2.2.2.1
			* For 4Rx: Test 4-1 in Chapter 5.2.3.1.1, 5.2.3.2.1
* Option 4: define one test for each Rank 1, Rank 2 with 2Rx, one test for each Rank 3, Rank 4 with 4Rx (Ericsson)
	+ - * For Rank 1 with 2Rx, Test 1-2 in Chapter 5.2.2.1.1, 5.2.2.2.1
			* For Rank 2 with 2Rx, Test 2-1 in Chapter 5.2.2.1.1, 5.2.2.2.1
			* For Rank 3 with 4Rx, Test 3-1 in Chapter 5.2.3.1.1, 5.2.3.2.1
			* For Rank 4 with 4Rx, Test 4-1 in Chapter 5.2.3.1.1, 5.2.3.2.1
* Option 5: define one test for FDD Rank 1 with 2Rx, one test for TDD Rank 2 with 2Rx (Huawei)
	+ - * For Rank 1 with 2Rx, Test 1-1 in Chapter 5.2.2.1.1
			* For Rank 2 with 2Rx, Test 2-1 in Chapter 5.2.2.2.1
* Option 6: define one test for TDD rank 4 with 4Rx (Qualcomm)
	+ - * For rank 4 with 4 Rx, Test 4-1 in clause 5.2.3.2.1
* Other options are not precluded

**Issue 2-3-6: Cases need to be defined for FR2-1 Rel-18 DMRS**

**Way forward:**

* Option 1: define one test for each Rank 1, 2 with 2Rx (Ericsson)
	+ - * Option 1A: Use Test 1-1 for Rank 1, Test 2-1 for Rank 2 in Chapter 7.2.2.2.1 (Ericsson)
* Other options are not precluded

**Issue 2-3-7: Minimum requirements for tests need to be defined for Rel-18 DMRS**

**Way forward:**

* Option 1: reuse legacy value (Samsung, Ericsson, Huawei)
	+ - * No performance difference between Rel-15 and Rel-18 DMRS configurations as far as 1 or 2 DMRS ports share one resource element. (Ericsson)
			* There is negligible performance difference between the cases with different DMRS ports. (Huawei)
* Option 2: new value according simulation results (Nokia, [MTK])
* Other options are not precluded

# Topic #3: Test set-up and simulation assumptions for BS demodulation performance

## Sub-topic 3-1 Test set-up and simulation assumptions for Rel-18 DMRS

**Issue 3-1-1: DMRS ports**

**Tentative Agreement**:

* Rank 1 for 1Tx: {8}
* Rank 2 for 2Tx: {8,9}

**Issue 3-1-2: agreed parameters**

**Tentative Agreement**:

|  |  |
| --- | --- |
| Parameter | Value |
| Transform precoding | Disabled |
| Waveform | CP-OFDM |
| Channel Model | TDLC300-100 |
| Antenna configuration | 1Tx2Rx2Tx2Rx |
| SCS | 15 kHz SCS30 kHz SCS |
| Default TDD UL-DL pattern (Note 1) | 15 kHz SCS:3D1S1U, S=10D:2G:2U30 kHz SCS:7D1S2U, S=6D:4G:4U |
| HARQ | Maximum number of HARQ transmissions | 4 |
|  | RV sequence | 0, 2, 3, 1 |
| DM-RS | DM-RS configuration type | 1 |
| DM-RS duration | single-symbol DM-RS |
| Additional DM-RS position | pos1 |
| Number of DM-RS CDM group(s) without data | 2 |
| Ratio of PUSCH EPRE to DM-RS EPRE | -3 dB |
| DM-RS port | {8}, {8, 9} |
| DM-RS sequence generation | NID0=0, nSCID =0 |
| DM-RS type  | *enhanced-dmrs-Type\_r18* |
| Time domain | PUSCH mapping type | Both A and B |
| resource | Start symbol | 0  |
| assignment | Allocation length | 14  |
| Frequency domain resource | RB assignment | Full applicable test bandwidth |
| assignment | Frequency hopping | Disabled |
| TPMI index for 2Tx two-layer spatial multiplexing transmission  | 0 |
| Code block group based PUSCH transmission | Disabled |
| NOTE 1: The same requirements are applicable to FDD and TDD with different UL-DL pattern. |

**Issue 3-1-3: CBW**

**Way forward:**

* Option 1: (Nokia, Ericsson, Samsung)
	+ - * 15KHz SCS, 5MHz;
			* 30KHz SCS, 10MHz;
* Option 2: maximum CBW (Huawei)

**Issue 3-1-4: PUSCH demodulation cases need to be defined for Rel-18 DMRS**

**Tentative Agreement**:

Cases for selected combination of CBW, SCS and PUSCH mapping type

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Number of TX antennas | Number of RX antennas | Cyclic prefix | Propagation conditions and correlation matrix | Fraction of maximum throughput | MCS | Additional DM-RS position |
| 1 | 2 | Normal | TDLC300-100 Low | 70 % | [16 or 21 (64QAM)] | pos1 |
| 2 | 2 | Normal | TDLC300-100 Low | 70 % | [16 or 21 (64QAM)] | pos1 |