**3GPP TSG-RAN WG4 Meeting #112 R4-24xxxxx**

**Maastricht, Netherlands, 19th Aug 2024 - 23rd Aug 2024**

**Source: China Telecom**

**Title: Offline minutes for NR\_demod\_Ph5 WI**

**Agenda Item: 8.16.4**

**Document for: discussion**

1. **UE performance requirements for 8Rx**

**Issue 2-1-1: Test scope**

* Proposals:
  + Proposal 1: RAN4 to introduce UE demodulation requirements for both TDD and FDD for 8Rx (Nokia, China Telecom, CMCC, Qualcomm)
  + Proposal 2: RAN4 to discuss whether to cover PDSCH absolute physical layer throughput requirements for 8Rx (China Telecom)
* CTC: PDSCH absolute physical layer throughput requirements are mandatory requirements for 2/4Rx.
  + Proposal 3: Clarify if CQI reporting requirements are needed for 8Rx UE antennas with inter-cell interference (Samsung)
* HW: Only AWGN is covered for 8Rx CQI requirements in current spec. It seems strange that RAN4 skip fading channel requirements and jump directly to requirements with interference.

Discussion:

* Proposal 1: RAN4 to introduce UE demodulation requirements for both TDD and FDD for 8Rx (Nokia, China Telecom, CMCC, Qualcomm)

Tentative consensus: RAN4 to introduce UE demodulation requirements for both TDD and FDD.

* Proposal 2: RAN4 to discuss whether to cover PDSCH absolute physical layer throughput requirements for 8Rx (China Telecom)

Apple, QC: RAN5 didn’t ask RAN4 to define such requirements.

Tentative consensus: Not to cover PDSCH absolute physical layer throughput requirements for 8Rx

* Proposal 3: Clarify if CQI reporting requirements are needed for 8Rx UE antennas with inter-cell interference

CMCC: Can we only use AWGN for ICI requirements?

Apple: In ICI CQI tests, both AWGN and fading channel are involved.

CTC, E///, Nokia, ZTE, HW, CMCC, QC: CQI reporting requirements under ICI should be cover for 8Rx.

Samsung, Apple, MTK: Based on the observation from HW, no need to cover such requirements.

MTK: For Rel-18, we down-select CQI requirements under fading follow LTE approach.

Candidate options on whether to cover CQI requirements for ICI scenario:

* + Option 1: CQI reporting requirements under ICI should be cover for 8Rx (CTC, E///, Nokia, ZTE, HW, CMCC, QC)
  + Option 2: No need to cover such requirements (Samsung, Apple, MTK)

**Issue 2-1-2: 8Rx UE MMSE-IRC receiver assumption**

* UE receiver capability definition in Rel-18:

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| *SU-MIMO 8Rx receiver*  *- Baseline SU-MIMO 8Rx receiver: 8Rx receivers for SU-MIMO transmissions with support of up to 8 layers with joint 8Rx MIMO detector in FR1*  *- Simplified SU-MIMO 8Rx receiver: 8Rx receivers for SU-MIMO transmissions with support of up to 4 layers with two joint 4Rx MIMO detectors in FR1.* |

* Proposals:
  + Option 1: Cover both Baseline SU-MIMO 8Rx receiver and Simplified SU-MIMO 8Rx receiver (China Telecom, MTK, Apple if requirements are release independent from Rel-18)
* MTK: The gap between 8Rx MMSE-IRC baseline receiver and 8Rx MMSE-IRC simplified receiver is over 1dB.
  + Option 2: Define requirements only for SU-MIMO baseline receiver (Qualcomm, Huawei)
* QC, HW: Requirements with 4Rx are already defined in 38.101.
* Discussion:

Nokia: We introduce 2 types because significant performance gap.

QC: Requirements with 4Rx are already defined in 38.101. simplified 8Rx does not support more than 4 layers.

Apple: IF we only cover Baseline SU-MIMO requirements, what happen if UE only support simplified? No MMSE-IRC requirements for those UEs?

* Recommended WF
  + Interested companies are encouraged to bring simulation results to show the gap between the two types of receivers.

**Issue 2-1-4: Test parameters for different devices with 8Rx**

* Proposals:
  + Proposal 1: Define different parameters for FWA, Vehicular and Industrial deployments respectively (Nokia)

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| * For FWA performance requirements   + TDLA 30-10 Low   + MCS 17 (table 2)   + 15 kHz SCS and 50 MHz CBW   + 30 kHz SCS and 100 MHz CBW   + Rank 4 * For vehicular performance requirements   + TDLB 100-400 Low   + MCS 2 (table 1)   + 15 kHz SCS and 5 MHz CBW   + 30 kHz SCS and 10 MHz CBW   + Rank 2 * For industrial performance requirements   + TDLC 300-100 Low   + MCS 13 (table 2)   + 15 kHz SCS and 5 MHz CBW   + 30 kHz SCS and 10 MHz CBW   + Rank 2 |

Discussion:

QC: We already cover TDLA and TDLC for different devices.

MTK: Prefer to keep the same configuration as in Rel-17 MMSE-IRC.

Tentative consensus: Not to define different set of requirements for different device types.

**Issue 2-3-1: Receiver type for MU-MIMO**

* Proposals:
  + Proposal 1: Consider MMSE-IRC and also check the possibility to support R-ML receiver in Rel-19 (China Telecom)
* Samsung: Clarify whether PDSCH demodulation requirements are needed or not for intra-cell inter-user interference with Enhanced receiver Type 2.

Tentative consensus: MMSE-IRC only

1. **BS demodulation performance requirements for MMSE-IRC**

**Issue 3-1-1: MMSE-IRC Receiver assumption**

* Proposals:
  + Option 1: Reuse the same receiver assumption for MMSE-IRC in TR36.884 (China Telecom, Intel, Huawei, Nokia, Samsung)

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| MMSE-IRC receiver The MMSE-IRC receiver weight matrix is usually defined as  The MMSE-IRC receiver weight matrix is usually defined as    where and denote the estimated channel matrix and covariance matrix, respectively.  To obtain the MMSE-IRC receiver weight matrix, the covariance matrix including the sources of inter-cell interference needs to be estimated. The covariance matrix is estimated at DM-RS REs by following equations:  , ,  where the DM-RS symbols are used to estimate the covariance matrix, and *Nsp* is the number of sampling DM-RS REs.  The estimation of interference covariance matrix is performed at per PRB and per TTI basis. |

* Recommended WF
  + Option 1

**Issue 3-1-2: Baseline receiver assumption (for performance gain study only)**

* Proposals:
  + Option 1: MMSE receiver as defined in TR36.884 (Samsung, [Huawei])

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| Baseline receiver: MMSE receiver The MMSE receiver weight matrix is expressed as follow:  ,  where and denote the estimated channel matrix and noise power, respectively. *P*1 is the transmission power of UE scheduled by the serving cell and is equal to . |

* Recommended WF
  + Option 1

**Issue 3-2-1: Signalling model**

* Proposals:
  + Option 1: Reuse the same signalling model in TR36.884 (Nokia)

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| 4.1 Signal model  For PUSCH, the receiver equations are provided as the reference receiver for evaluation purpose.  Assume that  is the  frequency domain representation of the *k*-th subcarrier in the -th DFT-OFDM symbol for the -th UE scheduled by its serving BS.  is obtained with DFT operation of the time-domain modulating symbol, denoted as , where , with DFT size of . The *NRx*-dimensional received signal vector  of the *k*-th subcarrier and the *l*-th DFT-OFDM symbol by the serving BS of the 1st UE is assumed to be expressed as a sum of the signal from the 1st UE, the interference signals  (*j*>1) from other UEs and the white noise , as    where ,  represent the *(NRx* x *NStream)* effective channel matrix between the -th UE and the serving BS of the 1st UE, containing the contribution from all receiver branches.  is the total number of UEs scheduled by their corresponding BSs in the network.  The recovered *NStream* x 1 signal vector  for the 1st UE at its serving BS is detected as follows:    where the (*NStream* x *NRx*) receiver weight matrix  is determined according to the type of PUSCH receiver, as discussed in the following sections. The detected time-domain modulating symbol, denoted as , can be obtained with a IDFT operation for .  There will be two types of PUSCH receiver, as MMSE receiver and MMSE-IRC receiver. The equalization is assumed to be performed in the frequency domain. |

* Recommended WF
  + Option 1 with agnostic to the waveform.

**Issue 3-2-3: Interference profile**

* Proposals on interference power level:
  + Option 1: Reuse the same interference power level as in LTE, i.e., DIP -1.11dB and -10.91dB for HomNet scenario and DIP -0.43dB and -13.78dB for HetNet scenario (China Telecom, CATT, CMCC, ZTE, Nokia, Huawei for performance study)
  + Option 2: System level simulation can be performed to check the SINR and interference distribution (Intel, Huawei if performance gain is not enough, Ericsson for TDD only)
* Qualcomm: RAN4 to discuss what are the different assumptions in the Rel-19 WI in terms of deployment scenarios
* E///: Proposed system level simulation assumptions can be found in Table 2.1-1 to 2.1-3 in R4-2412319
* Intel: Deployments, CHBW, Traffic model, precoding and UE Tx power are different from LTE study
* Samsung: Open to discuss. Technical Report may be needed.
  + Option 3: Check if artificial interference profile is feasible (Ericsson)
* E///: For example, INR could take 7dB or 3dB higher than LTE to reflect PC1 or PC2 HPUE in NR.
* Recommended WF
  + Reuse the LTE interference power level as a start point, and check performance gain of MMSE-IRC over baseline MMSE.
  + It is not precluded for companies to bring system level simulation on other profiles.
  + FFS how to account for HPUE in existing LTE profiles.