**3GPP TSG-RAN WG4 Meeting #101bis-e** **R4-2201011**
**Electronic Meeting, 17th - 25th Jan, 2022**

**Title:** Discussion and simulation results on 1024QAM PDSCH

**Source:** Huawei, HiSilicon

**Agenda item:** 6.6.5.2

**Document for:** Discussion

# 1 Background

As per WF [1], demodulation part of 1024QAM WI should be discussed from this meeting. In this contribution, we share our views about the 1024QAM PDSCH demodulation requirements.

# 2 Discussion

## 2.1 PDSCH demodulation requirements

The simulation assumption is derived as following Table 2.1-1 and the simulation results is shown in Figure 2.1-1 and Table 2.1-2.

**Table 2.1-1 Simulation assumption for 1024QAM PDSCH**

| Parameters | FDD | TDD |
|---|---|---|
| SCS/CBW | 15kHz and 10MHz | 30kHz and 40MHz |
| TDD UL/DL configuration | N/A | 7D1S2U, with S=6:4:4<br>FFS to schedule PDSCH in the special slots |
| MCS (See appendix) | Option 1: MCS23<br>Option 2: MCS24<br>Option 3: MCS25 | |
| Rank | 1 | |
| Antenna configuration | 2x2 and 2x4 with ULA Low | |
| Propagation channel | Option 1: TDLA30-10<br>Option 2: TDLD30-5 | |
| PDSCH configuration | Type A mapping, Start symbol 2, Duration 12 | |
| PDSCH DMRS configuration | Type 1, Single symbol, additional DMRS: pos1 | |
| Tx EVM assumed for simulation | Option 1: 2.0%<br>Option 2: 2.5%<br>Option 3: 2.8%<br>Note: The assumed Tx EVM should be same or less than the BS Tx EVM requirements. | |
| SSB configuration | Periodicity 20 ms, Allocated in first slot within 20ms | |
| TRS configuration | 20 ms periodicity, 2 slots, Offset 10 ms | |
| Number of HARQ processes | 4 for FDD 15kHz, 8 for TDD 30kHz | |
| Transform precoding | CP-OFDM | |
| Allocated RBs | Full BWP | |
| PRB bundling | 2 | |
| Precoding model | Random Precoding, per slot, WB granularity (codebook configuration Single panel Type 1) | |
| Receiver type | MMSE-IRC | |
| Test metric | 70% of maximum throughput | |

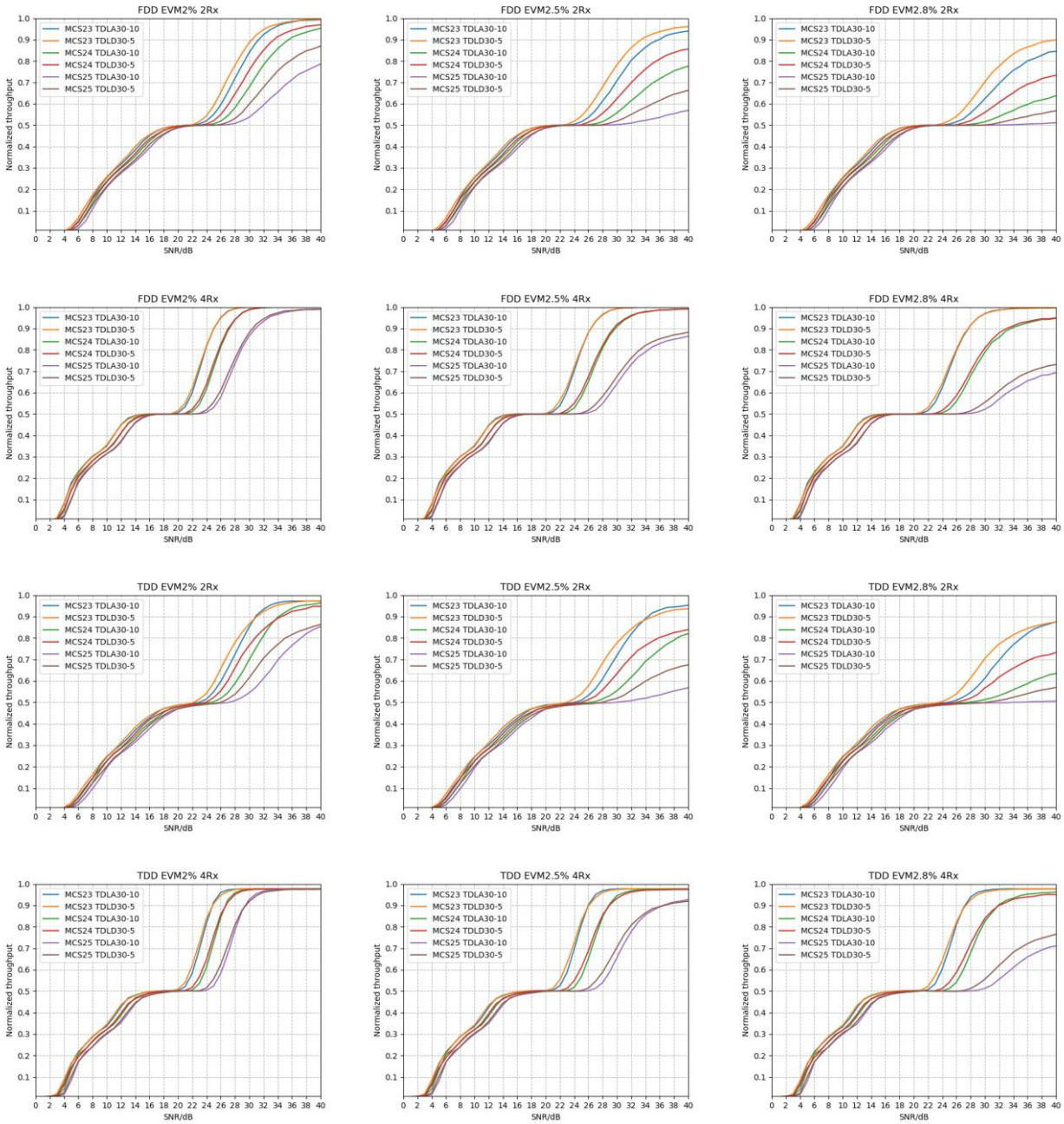


**Figure 2.1-1 Ideal simulation results for 1024QAM PDSCH**

**Table 2.1-1 Ideal simulation results for 1024QAM PDSCH**

| SNR@70%maximum throughput | | | TDLA30-10 | | | TDLD30-5 | | |
|---|---|---|---|---|---|---|---|---|
| | | | MCS23 | MCS24 | MCS25 | MCS23 | MCS24 | MCS25 |
| FDD | 2Rx | EVM2% | 27.70 | 30.40 | 35.50 | 26.69 | 29.01 | 32.57 |
| | | EVM2.5% | 29.84 | 35.15 | None | 28.39 | 32.06 | None |
| | | EVM2.8% | 32.17 | None | None | 29.96 | 36.78 | None |
| | 4Rx | EVM2% | 22.95 | 24.83 | 27.54 | 22.77 | 24.62 | 27.18 |
| | | EVM2.5% | 23.98 | 26.58 | 31.27 | 23.78 | 26.31 | 30.55 |
| | | EVM2.8% | 24.89 | 28.37 | None | 24.67 | 27.98 | 36.51 |
| TDD | 2Rx | EVM2% | 27.63 | 30.00 | 34.07 | 26.67 | 28.66 | 31.86 |
| | | EVM2.5% | 29.65 | 34.34 | None | 28.31 | 31.70 | None |
| | | EVM2.8% | 32.11 | None | None | 29.90 | 36.42 | None |
| | 4Rx | EVM2% | 23.02 | 24.75 | 27.23 | 22.75 | 24.48 | 26.84 |
| | | EVM2.5% | 24.03 | 26.46 | 30.66 | 23.73 | 26.12 | 29.92 |
| | | EVM2.8% | 24.98 | 28.26 | 38.65 | 24.62 | 27.70 | 34.89 |

**Tx EVM assumed for simulation**

As per latest CR [1], BS 1024QAM EVM requirements is specified as 2.5% for frequencies equal to or below 4.2 GHz and 2.8% for frequencies above 4.2 GHz. As per feedback from BS vendors in last meeting, BS RF agreement should be followed considering that high SNR values will be required which will require higher output power from the test system thus potentially worsen the signal quality from the gNodeB emulator for 1024QAM. Therefore, we propose to follow the BS RF agreement for performance requirements definition.

**Proposal 1: For 1024QAM performance requirements, follow the BS RF agreement that 2.5% EVM for frequencies equal to or below 4.2 GHz and 2.8% EVM for frequencies above 4.2 GHz.**

**MCS & Propagation channel**

From simulation results we can see that MCS24 or MCS25 cannot achieve 70% maximum throughput for some cases. Also, SNR less than 30dB for all cases with TDLD30-5 propagation condition. Therefore, we propose to select MCS23 and TDLD30-5 for 1024QAM PDSCH requirements.

**Proposal 2: Select MCS23 and TDLD30-5 for 1024QAM PDSCH requirements.**

**Impairment margin**

We have the following formula about the logarithmic SNR and linear EVM:

$$\mathrm{SNR}_{equivalent} = -10\log_{10}\left(\mathrm{EVM}^2 + 10^{-\mathrm{SNR}_{\mathrm{extra}}/10}\right)$$

Where, $\mathrm{SNR}_{equivalent}$ is the equivalent SNR at the UE side, and $\mathrm{SNR}_{\mathrm{extra}}$ is the extra SNR added by channel simulator. The curve about two different SNR can be shown in the following Figure 2.1-3.

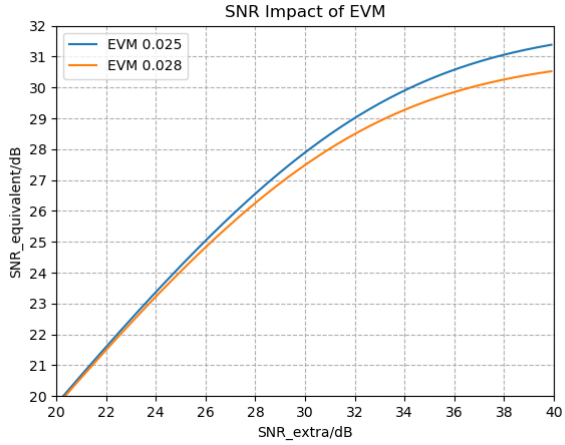


**Figure 2.1-3 The curve about equivalent SNR and extra SNR**

We can see that the equivalent SNR at the UE side is much less than the extra SNR when high extra SNR is added due to EVM impact. For the existing lower MCS point case with lower SNR, companies usually add about 1~3dB margin for impairment. To achieve the same effect under 1024QAM, the SNR to be added for impairment should be greatly increased. The following Figure 2.1-4 show the function about the SNR point for ideal simulation results and the SNR to be added for impairment to achieve different equivalent impairment values.

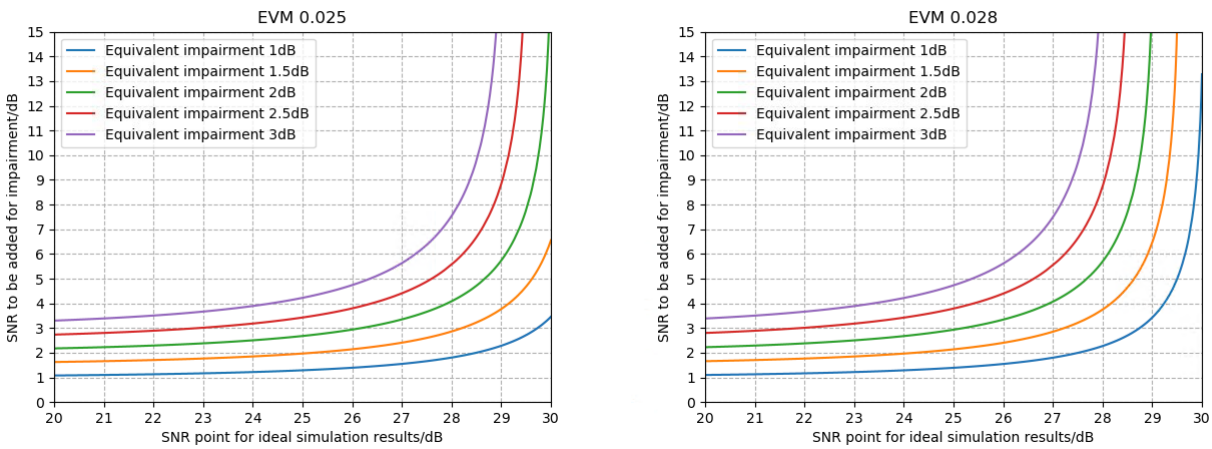


**Figure 2.1-4 The SNR point for ideal simulation results and the SNR to be added for impairment**

For example, by selecting 30dB as SNR point for ideal simulation results, corresponding to the 2Rx requirements in above Table 2.1-2, it is almost impossible to achieve equivalent impairment greater than 2dB. To ensure proper impairment margin, we propose to add extra margin based on the SNR point for ideal simulation results, besides the impairment margin added by companies.

**Proposal 3: Add extra margin based on the SNR point for ideal simulation results, besides the impairment margin added by companies.**

# 3 Proposals

In this contribution, we discuss on UE PDSCH demodulation requirements for 1024QAM. Our observations and proposals are:

**Proposal 1: For 1024QAM performance requirements, follow the BS RF agreement that 2.5% EVM for frequencies equal to or below 4.2 GHz and 2.8% EVM for frequencies above 4.2 GHz.**

**Proposal 2: Select MCS23 and TDLD30-5 for 1024QAM PDSCH requirements.**

**Proposal 3: Add extra margin based on the SNR point for ideal simulation results, besides the impairment margin added by companies.**

# 4 Reference


[1] R4-2102699, WF on DL1024QAM demodulation and CQI reporting requirements, RAN4#101-e, Ericsson

[2] R4-2120770, CR for TS 38.104: 1024QAM, RAN4#101-e, Huawei, HiSilicon