3GPP TSG RAN WG1 #109-e R1-220xxxx

e-Meeting, May 9th – 20th, 2022

Source: Moderator (OPPO)

Title: Summary of EVM for UL Precoding indication for multi-panel transmission

Agenda Item: 9.1.4.1

Document for: Discussion and Decision

# Introduction

The Rel-18 WID for MIMO Evolution for Downlink and Uplink includes the following ojectives:

1. Study, and if needed, specify the following items to facilitate simultaneous multi-panel UL transmission for higher UL throughput/reliability, focusing on FR2 and multi-TRP, assuming up to 2 TRPs and up to 2 panels, targeting CPE/FWA/vehicle/industrial devices (if applicable)
	* UL precoding indication for PUSCH, where no new codebook is introduced for multi-panel simultaneous transmission
		+ The total number of layers is up to four across all panels and total number of codewords is up to two across all panels, considering single DCI and multi-DCI based multi-TRP operation.
2. EVM and simulation results for STxMP

Evaluation methodology and assumptions for STxMP of Rel-18 and SLS/LLS evaluation results are provided in contributions. SLS/LLS simulation results for STxMP were provided in contributions and are summarized in table below:

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| --- | --- |
| **Company** | **Simulation results provided by Compnaies** |
| **SLS results** | * Huawei, HiSilicon [1]: SLS showed that benefit of STxMP on throughput is marginal.
* ZTE [2]: SLS showed that STxMP with either 1 CW or 2 CW can provide considerable throughput gain.
* LG [12]: SLS showed that multi-panel diversity transmission can provide significant cell edge throughput gain (98%) over the best panel selection.
* Ericsson [21]: SLS showed that (1) in indoor scenario, STxMP provide clear throughout gain for high percentile while gain for cell-edge UE is smaller, STxMP supports rank 3 and 4 more often and provides benefit at low load (2) In dense urban scenario, STxMP provides benefit to UEs in good condition.
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| **LLS results** | * DCM [16]: LLS showed that STxMP FDM repetition scheme can provide same BLER performance as mTRP TDM repetition and single-panel transmission can support rank 3 or 4 only with <= ~1% chance, and it is beneficial to support 2 CW.
* Nokia [18]: LLS showed that the STxMP can provide potential throughput gain and STxMP provides higher gain at higher operating SINR region.
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Proposals for evaluation methodology and assumptions for STxMP were provided in contributions:

* Huawei, HiSilicon [1], Qualcomm [22] and Ericsson [21] proposed to use the EVM of multi-panel UE in R1-2007151 as starting point to define the SLS EVM for STxMP.
* Huawei, HiSilicon [1] proposed that EVM of STxMP should capture the total power of 2 panels is restricted by total Tx power of UE power class and Nokia [18] proposed to refer to UE power class. Qualcomm proposed to use per panel Tx power in EVM.
* EVM assumptions for SLS were provided by Huawei, HiSilicon [1], ZTE [2], LG [12], DCM [16], Ericsson [21] and Qualcomm [22].
* EVM for LLS were provided in Samsung [11], OPPO [12], DCM [16] and Intel [20].
* Samsung [11] and OPPO [10] proposed that the EVM of LLS for STxMP of Rel-18 can be based on EVM of LLS for Rel-17 mTRP UL transmission enhancement.

Based on the proposals in the contributions, the following proposal A is proposed for baseline SLS assumption by using the Rel-17 BM SLS assumption in R1-2007151 as starting point and baseline LLS assumption for STxMP of Rel18 by using the EVM of Rel-17 mTRP TDM repetition transmission as starting point.

**Proposal A: For the EVM of STxMP of Rel-18:**

* **Reuse the SLS assumption of BM/Multi-panel UE in R1-2007151 with necessary update, as shown in Table A1**
* **Reuse the LLS assumption of Rel-17 mTRP UL repetition transmission with necessary update, as shown in Table A2**
* **Note: company can evaluate FR1 and explain the details of EVM assumptions for that.**

**Table A1: SLS assumption for STxMP of Rel-18**

|  |  |
| --- | --- |
| **Parameters** | **Values** |
| Frequency Range | FR2 @ 30 GHz, SCS: 120 kHz, BW: 80 MHz,  |
| Scenarios | * Dense urban (macro-layer only, TR 38.913) @FR2, 200m ISD, 2-tier model with wrap-around (7 sites, 3 sectors/cells per cell), 100% outdoor
* Indoor (TR 38.901/802)
 |
| UE speed | Option 1: 3 km/hr for all UEsOption 2: Dense Urban 100% outdoor UE with 30km/hr (optional) |
| Maximum UE Tx Power | Option 1: total 23dBm and max EIRP 43 dBm **of two panels**Option 2: 23 dBm and max EIRP 43 dBm **per panel** (baseline) |
| BS receiver Noise Figure | 7 dB |
| BS Antenna Configuration | For dense urban: (M, N, P, Mg, Ng) = (4, 8, 2, 2, 2). (dV, dH) = (0.5, 0.5) λ. (dg,V, dg,H) = (2.0, 4.0) λFor Indoor: (M, N, P, Mg, Ng) = (4, 4, 2, 1, 1). (dV, dH) = (0.5, 0.5) λNote: Other structure are optional and reported by company. Note: Companies to explain TXRU weights mapping.Note: Companies to explain beam selection.Note: Companies to explain number of BS beams |
| BS Antenna radiation pattern | TR 38.802 Table A.2.1-6, Table A.2.1-7 |
| UE antenna configuration | Option 1: Panel structure: 1x4x2 or (M, N, P) = (1, 4, 2), dH = 0.5 λ. Number of panels: 2, 3 or 4Note: Companies to explain the number and locations of panels. Option 2: (M, N, P, Mg, Ng) = (2, 4, 2, 1, 2); (dV, dH) = (0.5, 0.5)λ. (dg,V, dg,H) = (0, 0)λ. \* Θmg,ng=90°; Ω0,1=Ω0,0+180. The polarization angles are 0 and 90Note: Other panel structure is optional and to be reported by company |
| UE Antenna radiation pattern | TR 38.802 Table A.2.1-8 |
| UE dropping | Random |
| UE and panel orientation | Vertical but random in azimuth |
| Traffic Model | Option 1: FTP model 1 with packet size 0.5Mbytes (other value is not precluded).Option 2: FTP mode 3Other traffic models including the full buffer are optional and can be reported by the company |
| Control and RS overhead | Companies explain details of the assumptions  |
| BF/Precoder scheme | Companies explain what scheme is used |
| UE Antenna height | 1.5 m |
| UL MIMO Mode, rank | UL SU-MIMO/MU-MIMOUp to rank 4 for STxMP with 2 panels. |

**Table A2: LLS assumption for STxMP of Rel-18**

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| **Parameters** | **Values** |
| Frequency Range | FR2 @ 30 GHz, SCS: 120 kHz,  |
| Channel model | CDL for FR2 (TDL for FR2 can be optionally used) |
| BS antenna configuration | 2 TRP and 2 Rx ports per TRP |
| UE antenna configuration | 2 panels and 2 Tx ports on each panel |
| Path-loss modeling | {0,3,6} dB gap between panels/TRPs |
| Blockage | Blockage model from Rel-16 (x dB power offset with probability p): Companies to report x and p, and other assumptions, if any. |
| Target BLER | [10^-3, 10^-4, 10^-5]: BLER values shown in plots should be based on enough number of samples, e.g., ~100/BLER samples |
| Baseline scheme | Rel-15/16 PUSCH and PUCCHRel-17 mTRP PUSCH/PUCCH TDM repletion scheme can be optional  |
| # of RBs/symbols | Companies to Report.  |
| DMRS pattern | * DM-RS configuration type 1 for PUSCH
* DM-RS configuration type 2 for PUSCH (optional)
* DM-RS according to PUCCH formats (companies to report the details for PUCCH DM-RS)
 |
| Code rates | Low (<0.2) and moderate (<0.4) |
| Frequency hopping | Reported by companies |
| UL transmission scheme | Codebook based UL transmission is baseline. Non-codebook based can be optional. |
| Redundancy Version | Reported by companies |
| Schemes | FDM-based, SDM-based and SFN scheme. |
| Receiver assumption | Reported by companies |

1. Reference

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| --- | --- | --- | --- |
| 1 | [R1-2203154](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203154.zip) | Discussion on UL precoding indication for multi-panel transmission | Huawei, HiSilicon |
| 2 | [R1-2203268](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203268.zip) | Enhancements on UL precoding indication for multi-panel transmission | ZTE |
| 3 | [R1-2203325](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203325.zip) | Discussion on UL precoding indication for multi-panel transmission | Spreadtrum Communications |
| 4 | [R1-2203383](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203383.zip) | Precoding for Uplink Multi-panel | InterDigital, Inc. |
| 5 | [R1-2203446](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203446.zip) | On UL precoding indication for multi-panel transmission | CATT |
| 6 | [R1-2203546](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203546.zip) | Views on UL precoding indication for multi-panel transmission | vivo |
| 7 | [R1-2203686](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203686.zip) | Discussion on UL precoding indication for multi-panel transmission | NEC |
| 8 | [R1-2203726](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203726.zip) | Considerations on UL precoding indication for multi-panel transmission | Sony |
| 9 | [R1-2203798](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203798.zip) | Enhancements on multi-panel uplink transmission | xiaomi |
| 10 | [R1-2203893](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203893.zip) | Views on UL precoding indication for STxMP | Samsung |
| 11 | [R1-2203958](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2203958.zip) | Transmission scheme and UL precoding indicaton for multi-panel transmission | OPPO |
| 12 | [R1-2204146](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204146.ZIP) | UL precoding indication for multi-panel transmission | LG Electronics |
| 13 | [R1-2204167](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204167.zip) | UL precoding indication for multi-panel transmission | Lenovo |
| 14 | [R1-2204234](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204234.zip) | Views on UL precoding indication for multi-panel simultanous PUSCH transmissions | Apple |
| 15 | [R1-2204292](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204292.zip) | Discussion on UL precoding indication for multi-panel transmission | CMCC |
| 16 | [R1-2204372](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204372.zip) | Discussion on multi-panel transmission | NTT DOCOMO, INC. |
| 17 | [R1-2204511](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204511.zip) | Views on UL multi-panel transmission | Sharp |
| 18 | [R1-2204543](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204543.zip) | UL precoding indication for multi-panel transmission | Nokia, Nokia Shanghai Bell |
| 19 | [R1-2204685](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204685.zip) | UL precoding indication for multi-panel transmission | MediaTek Inc. |
| 20 | [R1-2204790](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204790.zip) | UL precoding indication for multi-panel transmission | Intel Corporation |
| 21 | [R1-2204875](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2204875.zip) | UL precoding indication for multi-panel transmission | Ericsson |
| 22 | [R1-2205019](https://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_109-e/Docs/R1-2205019.zip) | Simultaneous multi-panel transmission | Qualcomm Incorporated |