**3GPP TSG-RAN4 Meeting #113R4-** **2418745**

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**Agenda item: 7.12.2.3**

**Source: CMCC**

**Title:**  Reference target values for FR1 UMa and UMi dynamic channel models

**Document for:** Approval

# Introduction

This contribution gives the update results of FR1 UMa and UMi dynamic channel models, and the comparison results of PL, TCF, and SCF for UMa and UMi scenario in [2] are given in Appendices to see more clearly.

# Details

The updated reference values of FR1 dynamic channel models including PL, PDP, Temporal Correlation Function(TCF), and the Spatial Correlation Function(SCF) value for UMa and UMi channel model are given. The details are as follows.

### PL target values

#### PL target values for Uma

**Table 2.1.1-1 PL target value for UMa channel model**

|  |  |
| --- | --- |
| Segment | value |
| 1 | -0.81 |
| 2 | 0.00 |
| 3 | -28.96 |
| 4 | -27.16 |
| 5 | -20.85 |
| 6 | -29.35 |
| 7 | -0.02 |
| 8 | -19.56 |
| 9 | -0.69 |

#### PL target values for Umi

**Table 2.1.2-1 PL target value for UMi channel model**

|  |  |
| --- | --- |
| Segment | value |
| 1 |  |
| 2 | 0.00 |
| 3 | -28. |
| 4 | -27.16 |
| 5 | -20.85 |
| 6 | -29.35 |
| 7 | -0.02 |

### PDP target values

The dynamic theoretical PDP target results at the centers of each segment of Uma and Umi scenario are provided here. It is noted that the following PDP results correspond to the X2V channel, i.e., ranging from the superposition of two orthogonally polarized co-located gNB antennas to the Dipole antennas at the center of test area, and the start and end time of each segment is reference to the Table 4.2.1.2- 1 in [1], and in the case of segments with time variant excess delays, the initial and final delays of clusters has been rounded to the delay resolution of 5ns.

#### PDP target values for UMa



**Figure2.2.1-1 PDP for UMa channel model at segment 1**

**Table 2.2.1-1 PDP reference value for UMa channel model at segment 1**

|  |  |
| --- | --- |
| Delay [ns] | Power [dB] |
| 0 | 0.00 |
| 130 | -18.21 |
| 170 | -19.33 |
| 245 | -22.23 |
| 380 | -35.69 |
| 745 | -25.20 |
| 885 | -31.54 |



**Figure 2.2.1-2 PDP for UMa channel model at segment 2**

**Table 2.2.1-2 PDP reference value for UMa channel model at segment 2**

|  |  |
| --- | --- |
| Delay [ns] | Power [dB] |
| 0 | 0.00 |
| 130 | -18.85 |
| 170 | -20.18 |
| 245 | -22.86 |
| 380 | -32.44 |
| 745 | -23.54 |
| 885 | -34.16 |



**Figure 2.2.1-3 PDP for UMa channel model at segment 3**

**Table 2.2.1-3 PDP reference value for UMa channel model at segment 3**

|  |  |
| --- | --- |
| Cluster Index | Power [dB] |
| 1 | -9.79 |
| 2 | 0.00 |
| 3 | -1.85 |
| 4 | -6.26 |
| 5 | -8.17 |
| 6 | -6.48 |
| 7 | -3.30 |
| 8 | -8.86 |
| 9 | -8.38 |
| 10 | -11.58 |
| 11 | -8.58 |
| 12 | -16.28 |
| 13 | -9.97 |
| 14 | -13.32 |
| 15 | -12.10 |
| 16 | -12.84 |
| 17 | -29.26 |
| 18 | -28.95 |
| 19 | -18.38 |
| 20 | -19.37 |
| 21 | -17.56 |
| 22 | -31.90 |
| 23 | -29.82 |



**Figure 2.2.1-4 PDP for UMa channel model at segment 4**

**Table 2.2.1-4 PDP reference value for UMa channel model at segment 4**

|  |  |
| --- | --- |
| Cluster Index | Power [dB] |
| 1 | -15.03 |
| 2 | 0.00 |
| 3 | -2.02 |
| 4 | -9.69 |
| 5 | -11.80 |
| 6 | -14.22 |
| 7 | -3.85 |
| 8 | -13.30 |
| 9 | -6.87 |
| 10 | -20.80 |
| 11 | -6.49 |
| 12 | -16.02 |
| 13 | -18.95 |
| 14 | -17.54 |
| 15 | -12.32 |
| 16 | -11.30 |
| 17 | -28.17 |
| 18 | -29.06 |
| 19 | -22.34 |
| 20 | -18.21 |
| 21 | -17.20 |
| 22 | -30.33 |
| 23 | -27.96 |



**Figure 2.2.1-5 PDP for UMa channel model at segment 5**

**Table 2.2.1-5 PDP reference value for UMa channel model at segment 5**

|  |  |
| --- | --- |
| Cluster Index | Power [dB] |
| 1 | -8.22 |
| 2 | -0.81 |
| 3 | -3.69 |
| 4 | -3.48 |
| 5 | -5.23 |
| 6 | 0.00 |
| 7 | -1.62 |
| 8 | -3.71 |
| 9 | -10.36 |
| 10 | -10.07 |
| 11 | -13.36 |
| 12 | -22.49 |
| 13 | -7.76 |
| 14 | -13.52 |
| 15 | -16.17 |
| 16 | -18.92 |
| 17 | -23.05 |
| 18 | -21.39 |
| 19 | -23.38 |
| 20 | -22.48 |
| 21 | -20.29 |
| 22 | -26.47 |
| 23 | -33.06 |



**Figure 2.2.1-6PDP for UMa channel model at segment 6**

**Table 2.2.1-6 PDP reference value for UMa channel model at segment 6**

|  |  |
| --- | --- |
| Delay [ns] | Power [dB] |
| 0 | -14.97 |
| 80 | -3.76 |
| 235 | 0.00 |
| 300 | -14.60 |
| 340 | -35.27 |
| 445 | -17.78 |
| 475 | -21.68 |
| 790 | -27.06 |
| 985 | -19.91 |
| 1550 | -19.77 |
| 1675 | -18.32 |
| 2040 | -22.40 |
| 2295 | -20.99 |
| 2415 | -22.67 |
| 2565 | -31.31 |



**Figure 2.2.1-7 PDP for UMa channel model at segment 7**

**Table 2.2.1-7 PDP reference value for UMa channel model at segment 7**

|  |  |
| --- | --- |
| Delay [ns] | Power [dB] |
| 0 | 0.00 |
| 50 | -15.32 |
| 65 | -20.53 |
| 175 | -13.93 |
| 240 | -20.41 |
| 335 | -24.30 |
| 495 | -19.28 |
| 1090 | -32.21 |
| 1875 | -32.14 |



**Figure 2.2.1-8 PDP for UMa channel model at segment 8**

**Table 2.2.1-8 PDP reference value for UMa channel model at segment 8**

|  |  |
| --- | --- |
| Cluster Index | Power [dB] |
| 1 | 0 |
| 2 | -4.99 |
| 3 | -7.20 |
| 4 | -10.76 |
| 5 | -14.50 |
| 6 | -14.67 |
| 7 | -8.36 |
| 8 | -13.34 |
| 9 | -13.22 |
| 10 | -18.84 |
| 11 | -11.51 |
| 12 | -19.20 |
| 13 | -24.50 |
| 14 | -20.16 |
| 15 | -25.90 |
| 16 | -27.14 |
| 17 | -22.36 |
| 18 | -24.84 |
| 19 | -25.53 |
| 20 | -32.2 |
| 21 | -35.15 |
| 22 | -26.78 |
| 23 | -38.04 |



**Figure 2.2.1-9 PDP for UMa channel model at segment 9**

**Table 2.2.1-9 PDP reference value for UMa channel model at segment 9**

|  |  |
| --- | --- |
| Delay [ns] | Power [dB] |
| 0 | 0.00 |
| 60 | -35.79 |
| 130 | -17.62 |
| 170 | -18.53 |
| 245 | -21.66 |
| 380 | -38.51 |
| 745 | -26.64 |
| 885 | -29.22 |
| 1180 | -38.42 |

#### PDP target values for UMi



**Figure 2.2.2-1 PDP for UMi channel model at segment 1**

**Table 2.2.2-1 PDP reference value for UMi channel model at segment 1**

|  |  |
| --- | --- |
| Cluster index | Power[dB] |
| 1 | 0 |
| 2 | -20.91 |
| 3 | -21.6 |
| 4 | -23.37 |
| 5 | -16.06 |
| 6 | -15.83 |
| 7 | -15.72 |
| 8 | -17.46 |
| 9 | -24.65 |
| 10 | -23.71 |
| 11 | -28.78 |
| 13 | -23.14 |
| 14 | -29.08 |
| 15 | -33.69 |
| 16 | -38.84 |
| 17 | -38.75 |
| 18 | -36.7 |



**Figure 2.2.2-2 PDP for UMi channel model at segment 2**

**Table 2.2.2-2 PDP reference value for UMi channel model at segment 2**

|  |  |
| --- | --- |
| Delay[ns] | Power[dB] |
| 1 | 0 |
| 35 | -34.65 |
| 75 | -17.09 |
| 100 | -17.84 |
| 140 | -21.14 |
| 430 | -28.51 |
| 510 | -27.83 |
| 680 | -37.11 |



**Figure 2.2.2-3 PDP for UMi channel model at segment 3**

**Table 2.2.2-3 PDP reference value for UMi channel model at segment 3**

|  |  |
| --- | --- |
| Cluster index | Power[dB] |
| 1 | -16.97 |
| 2 | 0 |
| 3 | -2.82 |
| 4 | -2.83 |
| 5 | -4.79 |
| 6 | -1.54 |
| 7 | -1.99 |
| 8 | -4.41 |
| 9 | -5.85 |
| 10 | -9.01 |
| 11 | -6.07 |
| 12 | -26.14 |
| 13 | -7.52 |
| 14 | -21.27 |
| 15 | -20.13 |
| 16 | -10.72 |
| 17 | -15.08 |
| 18 | -16.1 |
| 19 | -16.85 |
| 20 | -16.78 |
| 21 | -15.52 |
| 22 | -19.07 |
| 23 | -23.55 |



**Figure 2.2.2-4 PDP for UMi channel model at segment 4**

**Table 2.2.2-4 PDP reference value for UMi channel model at segment 4**

|  |  |
| --- | --- |
| cluster index | Power[dB] |
| 1 | -11.06 |
| 2 | 0 |
| 3 | -2.51 |
| 4 | -4.21 |
| 5 | -6.08 |
| 6 | -1.93 |
| 7 | -1.95 |
| 8 | -5.14 |
| 9 | -7.74 |
| 10 | -11.41 |
| 11 | -8.36 |
| 12 | -21.68 |
| 13 | -9.2 |
| 14 | -15.72 |
| 15 | -16.44 |
| 16 | -13.58 |
| 17 | -20.76 |
| 18 | -20.54 |
| 19 | -19.52 |
| 20 | -19.26 |
| 21 | -17.92 |
| 22 | -24.18 |
| 23 | -27.67 |



**Figure 2.2.2-5 PDP for UMi channel model at segment 5**

**Table 2.2.2-5 PDP reference value for UMi channel model at segment 5**

|  |  |
| --- | --- |
| cluster index | Power[dB] |
| 1 | -10.94 |
| 2 | 0 |
| 3 | -1.95 |
| 4 | -5.58 |
| 5 | -7.51 |
| 6 | -5.85 |
| 7 | -3.07 |
| 8 | -8.12 |
| 9 | -8.05 |
| 10 | -11.12 |
| 11 | -8.44 |
| 12 | -17.45 |
| 13 | -9.41 |
| 14 | -14.29 |
| 15 | -13.21 |
| 16 | -12.51 |
| 17 | -26.78 |
| 18 | -26.45 |
| 19 | -17.49 |
| 20 | -18.8 |
| 21 | -16.61 |
| 22 | -29.83 |
| 23 | -28.81 |



**Figure 2.2.2-6 PDP for UMi channel model at segment 6**

**Table 2.2.2-6 PDP reference value for UMi channel model at segment 6**

|  |  |
| --- | --- |
| Delay[ns] | Powers[dB] |
| 0 | 0 |
| 30 | -20.51 |
| 100 | -16.26 |
| 140 | -25.25 |
| 195 | -32.91 |
| 285 | -19.4 |



**Figure 2.2.2-7 PDP for UMi channel model at segment 7**

**Table 2.2.2-7 PDP reference value for UMi channel model at segment 7**

|  |  |
| --- | --- |
| Delay[ns] | Powers[dB] |
| 0 | 0 |
| 30 | -21.16 |
| 100 | -15.44 |
| 140 | -23.53 |
| 195 | -29.91 |
| 285 | -19.41 |

### TCF target values

Moreover, the theoretical TC results at the center of each segment for the X2V for UMa and UMi dynamic channel are also provided.

#### TCF target values for UMa

 

 

 

 



**Figure 2.3.1-1 TCF curves for UMa channel model at different segments**

**Table 2.3.1-1 TCF reference values for UMa channel model at Δt=4.6 ms and Δt=20.2 ms**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **Δt=4.6 ms** | 0.97 | 0.96 | 0.98 | 0.45 | 0.67 | 0.55 | 0.81 | 0.79 | 0.94 |
| **Δt=20.2 ms** | 0.87 | 0.88 | 0.87 | 0.36 | 0.35 | 0.12 | 0.23 | 0.39 | 0.62 |

#### TCF target values for UMi



 

 



**Figure 2.3.2-1 TCF curves for UMi channel model at different segments**

**Table 2.3.2-1 TCF reference values for UMi channel model at Δt=4.6 ms and Δt=20.2 ms**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| **Δt=4.6 ms** | 0.665 | 0.952 | 0.542 | 0.746 | 0.749 | 0.956 | 0.962 |
| **Δt=20.2 ms** | 0.368 | 0.858 | 0.196 | 0.045 | 0.37 | 0.813 | 0.847 |

### SCF target values

#### SCF target values for Uma

 

 

 

 



**Figure 2.4.1-1 SCF curves for UMa channel model at different segments**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Point 2 | 0.98 | 0.96 | 0.80 | 0.70 | 0.83 | 0.79 | 0.93 | 0.83 | 0.96 |
| Point 5 | 0.90 | 0.61 | 0.16 | 0.72 | 0.42 | 0.39 | 0.48 | 0.26 | 0.57 |
| Point 11 | 0.93 | 0.32 | 0.11 | 0.49 | 0.16 | 0.45 | 0.37 | 0.61 | 0.22 |

**Table 2.4.1-1 SCF reference values for UMa channel model sampling point 2 5 11**

#### SCF target values for UMi









**Figure 2.4.2-1 SCF curves for UMi channel model at different segments**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Point 2 | 0.94 | 0.98 | 0.788 | 0.765 | 0.856 | 0.971 | 0.979 |
| Point 5 | 0.748 | 0.932 | 0.224 | 0.324 | 0.579 | 0.805 | 0.944 |
| Point 11 | 0.727 | 0.934 | 0.158 | 0.32 | 0.29 | 0.679 | 0.935 |

**Table 2.4.2-1 SCF reference values for UMi channel model sampling point 2 5 11**

**Based on the comparison results between CMCC and CE vendors in [1] and [2], we have following observations and proposals.**

**Observation 1: Regarding PL target values, the UMi PL target values in [1] are not be normalized, and the values in Table 8.2.2.4-2 cannot match the values in figure 8.2.2.4-2.**

**Proposal 1: It is proposed that CE vendors can update the normalized PL target values for Umi channel models as well as maybe update the plot in figure 8.2.2.4-2 in[1].**

**Observation 2: Regarding PDP target values, in the case of the segment that the same CDL channel model throughout the segment, i.e., segment 1,2,6,7, and 9 in UMa channel model and segment 2,6, and 7 in UMi channel model, the difference between CMCC and CE vendors is relatively large, so it is proposed that the original PDP results can be given of these segments.**

**Proposal 2：For segment that the same CDL channel model throughout the segment, it is proposed that CE vendors can supply the original PDP results without the rounded to the delay resolution by 5ns to make sure that the original PDP values can be aligned.**

**Observation 3: Regarding TCF, SCF target values of UMa channel models, and SCF target values of UMi channel model, the difference between CMCC and CE vendors is relatively small.**

**Observation 4: Regarding TCF target values of UMi channel model, there still exist one difference at 0.2 between CMCC and CE vendors.**

**Proposal 3: The alignment has made a great progress compared with the progress in last RAN4meeting, and it is proposed RAN4 can give more time to achieve the target values alignment among different vendors.**

# 3 Conclusions

**Observation 1: Regarding PL target values, the UMi PL target values in [1] are not be normalized, and the values in Table 8.2.2.4-2 cannot match the values in figure 8.2.2.4-2.**

**Proposal 1: It is proposed that CE vendors can update the normalized PL target values for Umi channel models as well as maybe update the plot in figure 8.2.2.4-2 in[1].**

**Observation 2: Regarding PDP target values, in the case of the segment that the same CDL channel model throughout the segment, i.e., segment 1,2,6,7, and 9 in UMa channel model and segment 2,6, and 7 in UMi channel model, the difference between CMCC and CE vendors is relatively large, so it is proposed that the original PDP results can be given of these segments.**

**Proposal 2：For segment that the same CDL channel model throughout the segment, it is proposed that CE vendors can supply the original PDP results without the rounded to the delay resolution by 5ns to make sure that the original PDP values can be aligned.**

**Observation 3: Regarding TCF, SCF target values of UMa channel models, and SCF target values of UMi channel model, the difference between CMCC and CE vendors is relatively small.**

**Observation 4: Regarding TCF target values of UMi channel model, there still exist one difference at 0.2 between CMCC and CE vendors.**

**Proposal 3: The alignment has made a great progress compared with the progress in last RAN4meeting, and it is proposed RAN4 can give more time to achieve the target values alignment among different vendors.**

# 4 References

[1] R4-2416478 TP on Dyn MIMO\_v3, Keysight Technologies UK Ltd, Spirent Communications

[2] R4-2419397 TP on Dynamic MIMO OTA Testing, Keysight Technologies UK Ltd, Spirent Communications

# Annex A

The comparison results of UMa dynamic channel model target values including PL, PDP, TCF and SCF are given in follows based on [2].

#### A.1 Comparison results for UMa channel model

##### A.1.1 PL Comparison results

|  |  |  |  |
| --- | --- | --- | --- |
| Segment | CMCC value | KS value | diff |
| 1 | -0.81 | -0.8 | -0.01 |
| 2 | 0.00 | 0 | 0 |
| 3 | -28.96 | -29.5 | 0.54 |
| 4 | -27.16 | -27.6 | 0.44 |
| 5 | -20.85 | -21.5 | 0.65 |
| 6 | -29.35 | -30.1 | 0.75 |
| 7 | -0.02 | -0.1 | 0.08 |
| 8 | -19.56 | -19.8 | 0.24 |
| 9 | -0.69 | -0.7 | 0.01 |

##### A.1.2 PDP Comparison results



Figure A.1.2-1: PDP comparison results for UMa channel model segment 1

Table A.1.2-1: PDP comparison results for UMa channel model segment 1

|  |  |  |  |
| --- | --- | --- | --- |
| Delay [ns] | CMCC | KS | diff |
| 0 | 0.00 | 0 | 0 |
| 130 | -18.21 | -18.5 | 0.29 |
| 170 | -19.33 | -20.2 | 0.87 |
| 245 | -22.23 | -22.5 | 0.27 |
| 380 | -35.71 | -36 | 0.29 |
| 745 | -25.21 | -25.5 | 0.29 |
| 885 | -31.13 | -31.9 | 0.77 |



Figure A.1.2-2: PDP comparison results for UMa channel model segment 2

Table A.1.2-2: PDP comparison results for UMa channel model segment 2

|  |  |  |  |
| --- | --- | --- | --- |
| Delay [ns] | CMCC | KS | diff |
| 0 | 0.00 | 0 | 0 |
| 130 | -18.85 | -19.2 | 0.35 |
| 170 | -20.18 | -20.9 | 0.72 |
| 245 | -22.86 | -23.2 | 0.34 |
| 380 | -32.44 | -32.8 | 0.36 |
| 745 | -23.54 | -23.9 | 0.36 |
| 885 | -34.16 | -34.5 | 0.34 |



Figure A.1.2-3: PDP comparison results for UMa channel model segment 3

Table A.1.2-3: PDP comparison results for UMa channel model segment 3

|  |  |  |  |
| --- | --- | --- | --- |
| Cluster Index | CMCC | KS | diff |
| 1 | -9.79 | -9.8 | 0.01 |
| 2 | 0 | 0 | 0 |
| 3 | -1.85 | -1.9 | 0.05 |
| 4 | -6.26 | -6.3 | 0.04 |
| 5 | -8.17 | -8.2 | 0.03 |
| 6 | -6.48 | -6.6 | 0.12 |
| 7 | -3.3 | -3.3 | 0 |
| 8 | -8.86 | -8.9 | 0.04 |
| 9 | -8.38 | -8.3 | -0.08 |
| 10 | -11.58 | -11.7 | 0.12 |
| 11 | -8.58 | -8.5 | -0.08 |
| 12 | -16.28 | -16.3 | 0.02 |
| 13 | -9.97 | -10 | 0.03 |
| 14 | -13.32 | -13.4 | 0.08 |
| 15 | -12.1 | -12.1 | 0 |
| 16 | -12.84 | -12.8 | -0.04 |
| 17 | -29.26 | -29.3 | 0.04 |
| 18 | -28.95 | -29 | 0.05 |
| 19 | -18.38 | -18.4 | 0.02 |
| 20 | -19.37 | -19.3 | -0.07 |
| 21 | -17.56 | -17.5 | -0.06 |
| 22 | -31.9 | -31.9 | 0 |
| 23 | -29.82 | -29.8 | -0.02 |



Figure A.1.2-4: PDP comparison results for UMa channel model segment 4

Table A.1.2-4: PDP comparison results for UMa channel model segment 4

|  |  |  |  |
| --- | --- | --- | --- |
| Cluster Index | CMCC | KS | diff |
| 1 | -15.03 | -15 | -0.03 |
| 2 | 0.00 | 0 | 0 |
| 3 | -2.02 | -2 | -0.02 |
| 4 | -9.69 | -9.7 | 0.01 |
| 5 | -11.80 | -11.8 | 0 |
| 6 | -14.22 | -14.2 | -0.02 |
| 7 | -3.85 | -3.9 | 0.05 |
| 8 | -13.30 | -13.3 | 0 |
| 9 | -6.87 | -6.9 | 0.03 |
| 10 | -20.80 | -20.8 | 0 |
| 11 | -6.49 | -6.5 | 0.01 |
| 12 | -16.02 | -16 | -0.02 |
| 13 | -18.95 | -19 | 0.05 |
| 14 | -17.54 | -17.5 | -0.04 |
| 15 | -12.32 | -12.3 | -0.02 |
| 16 | -11.30 | -11.3 | 0 |
| 17 | -28.17 | -28.2 | 0.03 |
| 18 | -29.06 | -29.1 | 0.04 |
| 19 | -22.34 | -22.3 | -0.04 |
| 20 | -18.21 | -18.2 | -0.01 |
| 21 | -17.20 | -17.2 | 0 |
| 22 | -30.33 | -30.3 | -0.03 |
| 23 | -27.96 | -28 | 0.04 |



Figure A.1.2-5: PDP comparison results for UMa channel model segment 5

Table A.1.2-5: PDP comparison results for UMa channel model segment 5

|  |  |  |  |
| --- | --- | --- | --- |
| Cluster Index | CMCC | KS | diff |
| 1 | -8.22 | -8.2 | -0.02 |
| 2 | -0.81 | -0.8 | -0.01 |
| 3 | -3.69 | -3.7 | 0.01 |
| 4 | -3.48 | -3.5 | 0.02 |
| 5 | -5.23 | -5.2 | -0.03 |
| 6 | 0.00 | 0 | 0 |
| 7 | -1.62 | -1.6 | -0.02 |
| 8 | -3.71 | -3.7 | -0.01 |
| 9 | -10.36 | -10.4 | 0.04 |
| 10 | -10.07 | -10.1 | 0.03 |
| 11 | -13.36 | -13.4 | 0.04 |
| 12 | -22.49 | -22.5 | 0.01 |
| 13 | -7.76 | -7.9 | 0.14 |
| 14 | -13.52 | -13.5 | -0.02 |
| 15 | -16.17 | -16.2 | 0.03 |
| 16 | -18.92 | -18.9 | -0.02 |
| 17 | -23.05 | -23.1 | 0.05 |
| 18 | -21.39 | -21.4 | 0.01 |
| 19 | -23.38 | -23.4 | 0.02 |
| 20 | -22.48 | -22.5 | 0.02 |
| 21 | -20.29 | -20.3 | 0.01 |
| 22 | -26.47 | -26.5 | 0.03 |
| 23 | -33.06 | -33.1 | 0.04 |



Figure A.1.2-6: PDP comparison results for UMa channel model segment 6

Table A.1.2-6: PDP comparison results for UMa channel model segment 6

|  |  |  |  |
| --- | --- | --- | --- |
| Delay [ns] | CMCC | KS | diff |
| 0 | -14.97 | -13 | -1.97 |
| 80 | -3.76 | -3.3 | -0.49 |
| 235 | 0.00 | 0 | 0 |
| 300 | -14.60 | -12.6 | -1.19 |
| 340 | -35.27 | -33.3 | -2.05 |
| 445 | -17.78 | -15.8 | -2.02 |
| 475 | -21.68 | -19.7 | -2.03 |
| 790 | -27.06 | -25.1 | -2.03 |
| 985 | -19.91 | -18 | -1.83 |
| 1550 | -19.77 | -17.8 | -1.9 |
| 1675 | -18.32 | -16.4 | -1.85 |
| 2040 | -20.99 | -20.4 | -1.93 |
| 2295 | -22.67 | -19 | -1.92 |
| 2415 | -31.31 | -20.7 | -1.89 |
| 2565 | -31.19 | -29.4 | -1.79 |



Figure A.1.2-7: PDP comparison results for UMa channel model segment 7

Table A.1.2-7: PDP comparison results for UMa channel model segment 7

|  |  |  |  |
| --- | --- | --- | --- |
| Delay [ns] | CMCC | KS | diff |
| 0 | 0.00 | 0 | 0 |
| 50 | -15.32 | -17.1 | 1.78 |
| 65 | -20.53 | -21.2 | 0.67 |
| 175 | -13.93 | -15 | 1.07 |
| 240 | -20.41 | -21 | 0.59 |
| 335 | -24.30 | -24.9 | 0.6 |
| 495 | -19.28 | -19.9 | 0.62 |
| 1090 | -32.21 | -32.8 | 0.59 |
| 1875 | -32.14 | -32.8 | 0.66 |



Figure A.1.2-8: PDP comparison results for UMa channel model segment 8

Table A.1.2-8: PDP comparison results for UMa channel model segment 8

|  |  |  |  |
| --- | --- | --- | --- |
| Cluster Index | CMCC | KS | diff |
| 1 | 0 | 0 | 0 |
| 2 | -4.99 | -5.7 | 0.71 |
| 3 | -7.20 | -7.9 | 0.7 |
| 4 | -10.76 | -11.5 | 0.74 |
| 5 | -14.50 | -15.2 | 0.7 |
| 6 | -14.67 | -15.4 | 0.73 |
| 7 | -8.36 | -9.1 | 0.74 |
| 8 | -13.34 | -14.1 | 0.76 |
| 9 | -13.22 | -14 | 0.78 |
| 10 | -18.84 | -19.6 | 0.76 |
| 11 | -11.51 | -12.3 | 0.79 |
| 12 | -19.20 | -19.9 | 0.7 |
| 13 | -24.50 | -25.2 | 0.7 |
| 14 | -20.16 | -20.9 | 0.74 |
| 15 | -25.90 | -26.6 | 0.7 |
| 16 | -27.14 | -27.9 | 0.76 |
| 17 | -22.36 | -23.1 | 0.74 |
| 18 | -24.84 | -25.6 | 0.76 |
| 19 | -25.53 | -26.3 | 0.77 |
| 20 | -32.2 | -33.4 | 1.2 |
| 21 | -35.15 | -35.9 | 0.75 |
| 22 | -26.78 | -27.5 | 0.72 |
| 23 | -38.04 | -38.8 | 0.76 |



Figure A.1.2-9: PDP comparison results for UMa channel model segment 9

Table A.1.2-9: PDP comparison results for UMa channel model segment 9

|  |  |  |  |
| --- | --- | --- | --- |
| Delay [ns] | CMCC | KS | diff |
| 0 | 0.00 | 0 | 0 |
| 60 | -35.79 | -36.1 | 0.31 |
| 130 | -17.62 | -17.9 | 0.28 |
| 170 | -18.53 | -19.5 | 0.97 |
| 245 | -21.66 | -22 | 0.34 |
| 380 | -38.51 | -38.8 | 0.29 |
| 745 | -26.64 | -27 | 0.36 |
| 885 | -29.22 | -29.5 | 0.28 |
| 1180 | -38.42 | -38.7 | 0.28 |

##### A.1.3 TCF Comparison results

**Table A.1.3-1 TCF** **comparison results for UMa channel model at Δt=4.6 ms**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| CMCC | 0.97 | 0.961 | 0.984 | 0.452 | 0.66 | 0.549 | 0.803 | 0.854 | 0.941 |
| KS | 0.97 | 0.961 | 0.994 | 0.436 | 0.648 | 0.523 | 0.801 | 0.837 | 0.94 |
| diff | 0 | 0 | -0.01 | 0.016 | 0.012 | 0.026 | 0.002 | 0.017 | 0.001 |

**Table A.1.3-2 TCF** **comparison results for UMa channel model at Δt=20.2 ms**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| CMCC | 0.87 | 0.88 | 0.87 | 0.36 | 0.35 | 0.12 | 0.23 | 0.39 | 0.62 |
| KS | 0.876 | 0.879 | 0.886 | 0.355 | 0.345 | 0.1 | 0.228 | 0.399 | 0.616 |
| diff | -0.006 | 0.001 | -0.016 | 0.005 | 0.005 | 0.02 | 0.002 | -0.009 | 0.004 |

##### A.1.4 SCF Comparison results

**Table A.1.4-1 SCF** **comparison results for UMa channel model at sampling point 2**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| CMCC | 0.98 | 0.96 | 0.8 | 0.7 | 0.83 | 0.79 | 0.93 | 0.83 | 0.96 |
| KS | 0.986 | 0.963 | 0.8 | 0.699 | 0.831 | 0.794 | 0.928 | 0.834 | 0.959 |
| diff | -0.006 | -0.003 | 0 | 0.001 | -0.001 | -0.004 | 0.002 | -0.004 | 0.001 |

**Table A.1.4-2 SCF** **comparison results for UMa channel model at sampling point 5**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| CMCC | 0.90 | 0.61 | 0.16 | 0.72 | 0.42 | 0.39 | 0.48 | 0.26 | 0.57 |
| KS | 0.908 | 0.611 | 0.160 | 0.721 | 0.414 | 0.393 | 0.481 | 0.283 | 0.574 |
| diff | -0.008 | -0.001 | 0 | -0.001 | 0.006 | -0.003 | -0.001 | -0.023 | -0.004 |

**Table A.1.4-3 SCF** **comparison results for UMa channel model at sampling point 11**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| CMCC | 0.93 | 0.32 | 0.11 | 0.49 | 0.16 | 0.45 | 0.37 | 0.61 | 0.22 |
| KS | 0.932 | 0.326 | 0.111 | 0.492 | 0.156 | 0.454 | 0.367 | 0.605 | 0.22 |
| diff | -0.002 | -0.006 | -0.001 | -0.002 | 0.004 | -0.004 | 0.003 | 0.005 | 0 |

#### A.2 Comparison results for UMi channel model

##### A.2.1 PL Comparison results

|  |  |  |  |
| --- | --- | --- | --- |
| Segment | CMCC value | KS value | diff |
| 1 | -7.38 | -3.7 | -3.68 |
| 2 | 0 | 0 | 0 |
| 3 | -16.06 | -13.1 | -2.96 |
| 4 | -12.31 | -13.6 | 1.29 |
| 5 | -15.94 | -13.2 | -2.74 |
| 6 | -0.93 | -0.6 | -0.33 |
| 7 | -0.66 | -1 | 0.34 |

##### A.2.2 PDP Comparison results



Figure A.2.2-1: PDP comparison results for UMi channel model segment 1

Table A.2.2-1: PDP comparison results for UMi channel model segment 1

|  |  |  |  |
| --- | --- | --- | --- |
| Cluster index | CMCC | KS | diff |
| 1 | 0 | 0 | 0 |
| 2 | -20.91 | -21.9 | 0.99 |
| 3 | -21.6 | -22.5 | 0.9 |
| 4 | -23.37 | -24.3 | 0.93 |
| 5 | -16.06 | -16.8 | 0.74 |
| 6 | -15.83 | -16.7 | 0.87 |
| 7 | -15.72 | -16.5 | 0.78 |
| 8 | -17.46 | -18.3 | 0.84 |
| 9 | -24.65 | -25.5 | 0.85 |
| 10 | -23.71 | -24.5 | 0.79 |
| 11 | -28.78 | -29.6 | 0.82 |
| 13 | -23.14 | -24 | 0.86 |
| 14 | -29.08 | -30 | 0.92 |
| 15 | -33.69 | -34.7 | 1.01 |
| 16 | -38.84 | -40 | 1.16 |
| 17 | -38.75 | -39.9 | 1.15 |
| 18 | -36.7 | -37.8 | 1.1 |



Figure A.2.2-2: PDP comparison results for UMi channel model segment 2

Table A.2.2-2: PDP comparison results for UMi channel model segment 2

|  |  |  |  |
| --- | --- | --- | --- |
| Delay | CMCC | KS | diff |
| 1 | 0 | 0 | 0 |
| 35 | -34.65 | -35 | 0.35 |
| 75 | -17.09 | -17.4 | 0.31 |
| 100 | -17.84 | -18.8 | 0.96 |
| 140 | -21.14 | -21.5 | 0.36 |
| 430 | -28.51 | -28.8 | 0.29 |
| 510 | -27.83 | -28.2 | 0.37 |
| 680 | -37.12 | -37.5 | 0.38 |



Figure A.2.2-3: PDP comparison results for UMi channel model segment 3

Table A.2.2-3: PDP comparison results for UMi channel model segment 3

|  |  |  |  |
| --- | --- | --- | --- |
| Cluster index | CMCC | KS | diff |
| 1 | -16.97 | -17.1 | 0.13 |
| 2 | 0 | 0 | 0 |
| 3 | -2.82 | -2.8 | -0.02 |
| 4 | -2.83 | -2.8 | -0.03 |
| 5 | -4.79 | -4.8 | 0.01 |
| 6 | -1.54 | -1.6 | 0.06 |
| 7 | -1.99 | -2 | 0.01 |
| 8 | -4.41 | -4.4 | -0.01 |
| 9 | -5.85 | -5.9 | 0.05 |
| 10 | -9.01 | -9 | -0.01 |
| 11 | -6.07 | -6.1 | 0.03 |
| 12 | -26.14 | -26.4 | 0.26 |
| 13 | -7.52 | -7.5 | -0.02 |
| 14 | -21.27 | -21.5 | 0.23 |
| 15 | -20.13 | -20.3 | 0.17 |
| 16 | -10.72 | -10.7 | -0.02 |
| 17 | -15.08 | -15.2 | 0.12 |
| 18 | -16.1 | -16.2 | 0.1 |
| 19 | -16.85 | -16.8 | -0.05 |
| 20 | -16.78 | -16.8 | 0.02 |
| 21 | -15.52 | -15.5 | -0.02 |
| 22 | -19.07 | -19.2 | 0.13 |
| 23 | -23.55 | -23.6 | 0.05 |



Figure A.2.2-4: PDP comparison results for UMi channel model segment 4

Table A.2.2-4: PDP comparison results for UMi channel model segment 4

|  |  |  |  |
| --- | --- | --- | --- |
| cluster index | CMCC | KS | diff |
| 1 | -11.06 | -11.3 | 0.24 |
| 2 | 0 | 0 | 0 |
| 3 | -2.51 | -2.5 | -0.01 |
| 4 | -4.21 | -4.3 | 0.09 |
| 5 | -6.08 | -6.1 | 0.02 |
| 6 | -1.93 | -2 | 0.07 |
| 7 | -1.95 | -2 | 0.05 |
| 8 | -5.14 | -5.2 | 0.06 |
| 9 | -7.74 | -7.8 | 0.06 |
| 10 | -11.41 | -11.5 | 0.09 |
| 11 | -8.36 | -8.4 | 0.04 |
| 12 | -21.68 | -21.8 | 0.12 |
| 13 | -9.2 | -9.3 | 0.1 |
| 14 | -15.72 | -15.9 | 0.18 |
| 15 | -16.44 | -16.6 | 0.16 |
| 16 | -13.58 | -13.6 | 0.02 |
| 17 | -20.76 | -21 | 0.24 |
| 18 | -20.54 | -20.8 | 0.26 |
| 19 | -19.52 | -19.5 | -0.02 |
| 20 | -19.26 | -19.3 | 0.04 |
| 21 | -17.92 | -18 | 0.08 |
| 22 | -24.18 | -24.4 | 0.22 |
| 23 | -27.67 | -27.7 | 0.03 |



Figure A.2.2-5: PDP comparison results for UMi channel model segment 5

Table A.2.2-5: PDP comparison results for UMi channel model segment 5

|  |  |  |  |
| --- | --- | --- | --- |
| cluster index | CMCC | KS | diff |
| 1 | -10.94 | -11 | 0.06 |
| 2 | 0 | 0 | 0 |
| 3 | -1.95 | -2 | 0.05 |
| 4 | -5.58 | -5.6 | 0.02 |
| 5 | -7.51 | -7.5 | -0.01 |
| 6 | -5.85 | -5.9 | 0.05 |
| 7 | -3.07 | -3.1 | 0.03 |
| 8 | -8.12 | -8.2 | 0.08 |
| 9 | -8.05 | -8.1 | 0.05 |
| 10 | -11.12 | -11.2 | 0.08 |
| 11 | -8.44 | -8.4 | -0.04 |
| 12 | -17.45 | -17.6 | 0.15 |
| 13 | -9.41 | -9.4 | -0.01 |
| 14 | -14.29 | -14.4 | 0.11 |
| 15 | -13.21 | -13.3 | 0.09 |
| 16 | -12.51 | -12.5 | -0.01 |
| 17 | -26.78 | -27.1 | 0.32 |
| 18 | -26.45 | -26.7 | 0.25 |
| 19 | -17.49 | -17.5 | 0.01 |
| 20 | -18.8 | -18.8 | 0 |
| 21 | -16.61 | -16.6 | -0.01 |
| 22 | -29.83 | -30.1 | 0.27 |
| 23 | -28.81 | -28.9 | 0.09 |



Figure A.2.2-6: PDP comparison results for UMi channel model segment 6

Table A.2.2-6: PDP comparison results for UMi channel model segment 6

|  |  |  |  |
| --- | --- | --- | --- |
| Delay | CMCC | KS | diff |
| 0 | 0 | 0 | 0 |
| 30 | -20.51 | -20.5 | -0.01 |
| 100 | -16.26 | -17.4 | 1.14 |
| 140 | -25.25 | -25.9 | 0.65 |
| 195 | -32.91 | -33.6 | 0.69 |
| 285 | -19.4 | -20 | 0.6 |



Figure A.2.2-6: PDP comparison results for UMi channel model segment 7

Table A.2.2-6: PDP comparison results for UMi channel model segment 7

|  |  |  |  |
| --- | --- | --- | --- |
| Delay | CMCC | KS | diff |
| 0 | 0 | 0 | 0 |
| 30 | -21.16 | -20.9 | -0.26 |
| 100 | -15.44 | -16.5 | 1.06 |
| 140 | -23.53 | -24.2 | 0.67 |
| 195 | -29.91 | -30.6 | 0.69 |
| 285 | -19.41 | -20 | 0.59 |

##### A.2.3 TCF Comparison results

**Table A.2.3-1 TCF** **comparison results for UMi channel model at Δt=4.6 ms**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| CMCC | 0.665 | 0.952 | 0.542 | 0.746 | 0.749 | 0.956 | 0.962 |
| KS | 0.871 | 0.952 | 0.514 | 0.698 | 0.743 | 0.959 | 0.965 |
| diff | -0.206 | 0 | 0.028 | 0.048 | 0.006 | -0.003 | -0.003 |

**Table A.2.3-2 TCF** **comparison results for UMi channel model at Δt=20.2ms**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| CMCC | 0.368 | 0.858 | 0.196 | 0.045 | 0.37 | 0.813 | 0.847 |
| KS | 0.437 | 0.857 | 0.195 | 0.071 | 0.372 | 0.814 | 0.854 |
| diff | -0.069 | 0.001 | 0.001 | -0.026 | -0.002 | -0.001 | -0.007 |

##### A.2.4 SCF Comparison results

**Table A.2.4-1 SCF** **comparison results for UMi channel model at sampling point 2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| CMCC | 0.94 | 0.98 | 0.788 | 0.765 | 0.856 | 0.971 | 0.979 |
| KS | 0.944 | 0.981 | 0.787 | 0.764 | 0.856 | 0.973 | 0.982 |
| diff | -0.004 | -0.001 | 0.001 | 0.001 | 0 | -0.002 | -0.003 |

**Table A.2.4-2 SCF** **comparison results for UMi channel model at sampling point 5**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| CMCC | 0.748 | 0.932 | 0.224 | 0.324 | 0.579 | 0.805 | 0.944 |
| KS | 0.758 | 0.937 | 0.228 | 0.328 | 0.572 | 0.809 | 0.95 |
| diff | -0.01 | -0.005 | -0.004 | -0.004 | 0.007 | -0.004 | -0.006 |

**Table A.2.4-3 SCF** **comparison results for UMi channel model at sampling point 11**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Segment Index | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| CMCC | 0.727 | 0.934 | 0.158 | 0.32 | 0.29 | 0.679 | 0.935 |
| KS | 0.733 | 0.939 | 0.153 | 0.314 | 0.286 | 0.685 | 0.943 |
| diff | -0.006 | -0.005 | 0.005 | 0.006 | 0.004 | -0.006 | -0.008 |